NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

June 23, 2020

Group Chairman's Factual Report

OPERATIONAL FACTORS/HUMAN PERFORMANCE

DCA19LA134

Table Of Contents

A. ACCIDENT

Operator:	American Airlines
Location:	Jamaica, New York
Date:	April 10, 2019
Time:	2040 EDT[1]
	0040Z
Airplane:	Airbus A321, N114NN, American 300

B. OPERATIONAL FACTORS/HUMAN PERFORMANCE GROUP

Shawn Etcher
Group Chairman – Operational Factors
Operational Factors Division (AS-30)
National Transportation Safety Board

Sathya Silva, PhD
Group Chairman – Human Performance
Human Performance Division (AS-60)
National Transportation Safety Board

Patrick Lusch - Member
Air Safety Investigator – AVP 100
Federal Aviation Administration

Jon Witten - Member
Airbus Technical Pilot
American Airlines

John Carey - Member[2]
National Safety Committee
Allied Pilots Association

C. SUMMARY

On 10 April, 2019, about 2040 EDT, American Airlines flight 300, an Airbus A321, N114NN, experienced a left roll and the left wingtip struck the ground and a runway distance marker during takeoff from runway 31L at John F. Kennedy International Airport (JFK), Queens, New York. The flight crew safely returned to the airfield approximately 30 minutes later. There were no injuries to the 110 passengers and crew onboard and the airplane. Post flight inspection indicated the airplane was substantially damaged. The regularly scheduled passenger flight was operating under 14 *CFR* Part 121 from JFK to Los Angeles International Airport (LAX), Los Angeles, California.

D. DETAILS OF THE INVESTIGATION

The Operational Factors/Human Performance group was formed on April 23, 2019. Statements, documentation, and manuals were requested from the operator, and interviews with the flight crew were scheduled.

On April 26, 2019, the flightcrew was interviewed via teleconference. The first officer was interviewed first, followed by the captain's interview.

[1] All times in the report will be in eastern daylight time, also known as local lime, except as noted. At the time of the accident local time was UTC -4 hours.
[2] On July 6, 2020, Jeff Raines was replaced by the Allied Pilots Association and John Carey was assigned to the Operational Factors/Human Performance group.

On July 25, 2019, the Operational Factors/Human Performance group reconvened at the American Airlines training center in Irving, Texas. The group discussed with American Airlines procedures during takeoff in the A320[3] series aircraft, the differences in procedures with the A321 aircraft, and how that was taught and communicated to the pilots of the A320 series aircraft. Additionally, the team conducted simulator evaluations looking at various scenarios and input requirements.

E. FACTUAL INFORMATION

1.0 History of Flight[4]

The crew consisted of a captain, first officer (FO), and 6 flight attendants. The day of the accident was day 2 of a 2-day pairing, which consisted of only the accident flight. The flight crew had operated a flight that departed the night previous from LAX and arrived at JFK at 0700. The crew went to the hotel for their scheduled rest.

The crew stated that they reported at the airport for the event flight about one-hour and fifteen minutes prior to departure. The FO conducted the walk around and both crewmembers reviewed the weather and route of flight. According to the captain it was an "on-time operation" and everything was "looking good." The aircraft pushed from the gate on time.

The flightcrew stated that American Airlines had recently created new flows for the pushback and taxi phases of flight. The captain reported that during pushback he queried the FO about the trim settings to which the FO reported that those were to be done later, according to the latest guidance by the airline.

The crew selected the flaps to 1, taxied to runway 31L, and held short of the runway at taxiway kilo echo. The captain stated the taxi was "exactly the way I had done it before." He further provided that the time from brake release after pushback until they were applying power for takeoff was approximately 15 minutes. However, he further stated that he "did not feel rushed."

There were two other airplanes that departed before the accident flight was cleared to line up and wait. The captain taxied the airplane onto the runway, the FO noted the windsock, and reported they were legal to depart with the wind component. The captain recalled that the windsock indicated the wind was different then what the ATIS[5] had reported, and the FO reported that the windsock was a "little stiffer" than what was reported.

Once the flight was cleared for takeoff, the captain reported that when going down the runway with a right crosswind he applied left rudder. He further stated that it felt as though he was using more force with his left leg, but he could not explain why other than it just seemed different. He further stated that he kept the airplane near the centerline of the runway and at 80 knots

[3] Airbus SAS A-318 Series, A-319 Series, A-320 Series, A-321 Series and includes all models on TCDS A28NM. Source: FAA Order 8900.1, Figure 5-88, dated July 15, 2019.
[4] Sources: Attachment 1 – Flight Crew Interview Summaries and Statements.
[5] Automatic Terminal Information Service

everything was “ok.” Sometime between the V1[6] speed of 150 knots and rotation speed of 156 knots, the airplane made “a significant” turn to the left. The captain then stated that he was “looking at the runway edge” and knew he had to get the airplane into the air. He rotated the airplane and it began to roll to the left, he added right rudder and right aileron to try and upright the airplane and he recalled saying out loud something such as “it’s turning.” The captain recalled hearing the dual input audible alert when the FO applied sidestick input, which was the only alert he recalled.

The FO reported that when he announced “rotate” he looked up from the airspeed display and noticed the airplane was pointed about 30 degrees to the left of the runway heading and was banking approximately 30 degrees and described it as “rolling hard” and thought the airplane was going to “roll over.” He recalled that after the captain stated “I can’t control it” he grabbed his sidestick controller, applied right aileron and back pressure, and the airplane began to climb.

The captain of the flight that departed right after the accident flight[7] reported that there was 10-15 knot crosswind coming from right to left of the aircraft on the runway. The flight was cleared to line up and wait and the captain recalled seeing the American Airlines flight “significantly to the left of centerline” after it became airborne; however, they did not see the accident flight rotate. During the departure roll, their airplane was able to maintain centerline of the runway.

The flight attendants, on the accident flight, reported[8] that the taxi out and the beginning of the takeoff roll was “normal.” Most of the flight attendants stated that once the airplane had lifted off it “veered to the left” or “out of control.” Several flight attendants reported that there was “significant abnormal” aircraft attitude and adjustments. They further reported that they had not felt any impact forces.

Once the airplane was climbing out the captain called for the gear to be retracted and he moved the controls and the airplane was flying as if nothing had happened. The captain hand flew the airplane until passing 10,000 feet as he was determining that the airplane was operating properly, which he deemed it was.

The cabin crew contacted the flight deck to ask what had happened and the captain informed them he would get back to them.

The captain reported that at some point the FO stated that the flight should return to the JFK. Having not considered that at the time the captain determined after conducting a self-assessment that he may not be fit for duty following the experience and commanded the FO to get a vector back to JFK.

Once the flight received an initial heading back to JFK the captain transferred control of the airplane to the FO and then the captain coordinated with the company and informed the flight attendants of the return. One of the flight attendants informed the captain that a passenger informed

[6] The minimum speed in the takeoff, following a failure of the critical engine at which the pilot can continue the takeoff and achieve the required height above the takeoff surface within the takeoff distance. Source Title 14 *Code of Federal Regulations* Part 1.2 “Abbreviations and symbols.”
[7] Source: Operational Factors/Human Performance Attachment 3 - Following Aircraft Captain’s Statement.
[8] Source: Operational Factors/Human Performance Attachment 2 – Cabin Crew Statements

them of what appeared to be a "dent" in the wing. The captain then made an announcement to the passengers that they were returning to the airport.

The flight crew then ran the checklist for runway landing distance and requested runway 4L. They discussed whether to conduct a flap 3 or full flap landing and decided on a full flap landing. Additionally, they determined to set the autobrakes to low based on their overweight landing condition[9] and runway length available. The captain determined that the FO would make the landing.

The airplane touched down on runway 4L and came to a stop, the captain assumed control of the airplane, exited the runway at taxiway Golf, and taxied to their assigned gate. Once parked at the gate and the jetbridge was attached to the aircraft, maintenance personnel boarded and reported to the flightcrew that they had hit something. According to both crewmembers this was the first indication that they had structural damage.

2.0 Flight Crew Information

During the departure roll, the captain was the pilot flying (PF) and the first officer was the pilot monitoring (PM). Prior to landing the captain transferred control to the first officer who landed the airplane. According to documentation provided by American Airlines, the flightcrew had flown with each other on 8 previous occasions since August 2016, not including the accident trip pairing. The most recent of those occasions occurred on a 2-day trip that began on November 13, 2018.

2.1 The Captain[10]

The captain was 58 years old. At the time of the accident he was based at LAX. He reported approximately 25,000 hours of total flight experience and approximately 3,000 of those hours were in the Airbus A-320 series aircraft, and he thought most of those 3,000 hours were in the A-321, as he normally flew transcontinental and Hawaii flight out of LAX. He began flying at age 16 outside the U.S. with piston aircraft.

2.1.1 The Captain's Pilot Certification Record

FAA Records of the captain indicated the following:

Private Pilot – Airplane Single-Engine Land certificate issued November 24, 1981.

Commercial Pilot – Airplane Multiengine Land Limited to Center Thrust; Instrument Rating, Airplane – Multiengine, Limited to Center Thrust; Private Pilot Privileges Airplane Single-Engine Land certificate issued May 17, 1991.

[9] For information on the overweight landing checklist reference Operational Factors/Human Performance Attachment 11 - Quick Reference Handbook [Excerpt]

[10] Source: Attachment 1 – Flight Crew Interview Summaries and Statements.

Airline Transport Pilot – Airplane Multiengine Land; Private Privileges – Airplane Single- Engine Land certificate issued June 13, 1991.

Flight Engineer – Turbojet Powered; This Certificate Is Subject to the Provisions of Exemption No. 4901, As Amended certificate issued March 6, 1992.

Flight Engineer – Turbojet Powered certificate issued March 13, 1992.

Airline Transport Pilot – Airplane Multiengine Land, B-757[11], B767; Private Privileges – Airplane Single- Engine Land certificate issued November 25, 1993.

Airline Transport Pilot – Airplane Multiengine Land, A-320, B-757, B767; Private Privileges – Airplane Single- Engine Land; Limitations English Proficiency; A-320 Circling Approach, -VMC[12] Only certificate issued December 8, 2015.

2.1.2 The Captain's Pilot Certificates and Ratings Held at Time of the Accident

AIRLINE TRANSPORT PILOT (issued December 8, 2015)
Airplane Multiengine Land
A-320, B-757, B-767
Private Pilot Privileges – Airplane Single-Engine Land

MEDICAL CERTIFICATION FIRST CLASS (Issued January 2, 2019)
Limitations: None

2.1.3 The Captain's Training and Proficiency Checks Completed

A summary of the captain's recent training events at American Airlines was as follows[13]:

Date of Hire – American Airlines	January 16, 1992
Most Recent Maneuvers Validation (RVA)[14]	December 21, 2018
Most Recent A320 Maneuvers Training (RTS)	December 20, 2018
Most Recent Recurrent Ground School (RGS)	December 20, 2018
Most Recent Recurrent Human Factors & Safety Training (RHF)[15]	December 19, 2019

[11] The Boeing Company 757-200 Series, 757-200PF Series, 757-200CB Series, 757-300 Series, 767-200 Series, 767-300 Series, 767-300F Series, 767-400ER Series, 767-2C Series. Source: FAA Order 8900.1, Figure 5-88, dated July 15, 2019.
[12] Visual Meteorological Conditions.
[13] Source: Attachment 6 - Flight Crew Training Records.
[14] Maneuvers Validation required "*at least one takeoff with crosswind of 10-15 kts.*" Source: American Airlines AQP Volume 1 Section 104.5 and 105.6
[15] RHF was listed in the training record as a 1:30 course and was conducted approximately every 9 months. Source: Attachment 6 - Flight Crew Training Records [Excerpts]

Most Recent Flight Manual Briefing (FMB)	December 19, 2018
Most Recent Line Check (RLE)	March 28, 2018

2.1.4 The Captain's Flight Times[16]

Previous 24 hours	5:04
Preceding 30 days	64.19
Preceding 90 days	198.04
Total Hours A320- Series	3,004.97
Total Flight Hours	19,563.81

2.1.5 The Captain's Pre-Accident Activities

On April 8, the captain dropped his son off at school, ate breakfast, exercised for an hour, had lunch, washed his car that afternoon and watched an 1830 Angels game on television.

On April 9, he awoke naturally, had breakfast, showered, and conducted errands. He took a nap about 1400-1500 and awoke about 1800. He made dinner, prepared for his trip, and departed his house about 1945 for the flight from LAX to JFK.

On April 10, the day of the accident, he went to bed following the redeye flight about 0700 EDT. He estimated getting 4 hours of sleep, had a light breakfast of oatmeal and coffee, exercised, ate a protein bar, and took a nap for a few hours prior to their van pick up to the airport. He awoke from his nap, showered, and took the 1900 van for a 1930 show time. He reported he felt he received adequate rest prior to the event flight.

2.1.6 The Captain's Personal Information

The captain lived and was based in Los Angeles. He considered himself an evening person and preferred to stay up late to waking up early to an alarm. He had no major life changes in the 12 months prior that would have affected his performance. He described his health as "excellent," exercised at least 4 times per week, had a healthy diet and good vision. He did not use prescription medication, smoke tobacco, or use illicit drugs. He drank occasionally in the evening or during a sporting event. He estimated his last drink was 2 evenings prior to the event, while watching a game.

The accident FO stated he enjoyed flying with the captain and described him as easy to work with. He felt the captain was receptive to inputs from the FO and would reach out for input.

[16] Source: Attachment 5 - Flight Crew Hours

2.2 The First Officer

The first officer was 58 years old and was initially hired by Trans World Airways (TWA)[17] in April of 1990. He reported approximately 15,500 hours of total flight experience[18] and that he had "a couple thousand hours" of flight experience in the A-320 series aircraft, with "about 99 percent" of that experience in the A-321 aircraft.

2.2.1 The First Officer's Pilot Certification Record

Commercial Pilot – Airplane Multiengine Land, L-188[19]; Instrument Airplane certificate issued May 25, 1989.

Flight Engineer – Turbojet Powered; This Certificate Is Subject to the Provisions of Exemption No. 4901 certificate issued May 24, 1990.

Flight Engineer – Turbojet Powered certificate issued July 23, 1990.

Airline Transport Pilot – Airplane Multiengine Land, B-757, B-767, CE-500; Commercial Privileges L-188 certificate issued September 17, 1989.

Airline Transport Pilot – Airplane Multiengine Land, CE-500[20]; Commercial Privileges L-188 certificate issued March 22, 1999.

Airline Transport Pilot – Airplane Multiengine Land, B-757, B-767, CE-500, DC-9[21]; Commercial Privileges L-188; Limitation DC-9 Circling Approach – VMC Only, English Proficient certificate issued May 21, 2008.

Airline Transport Pilot – Airplane Multiengine Land, A-320, B-757, B-767, CE-500, DC-9; Commercial Privileges L-188; Limitation A-320, DC-9 Circling Approach – VMC Only, English Proficient certificate issued October 8, 2015.

2.2.2 The First Officer's Pilot Certificates and Ratings Held at Time of the Accident

AIRLINE TRANSPORT PILOT (issued October 8, 2015)
Airplane Multiengine Land
A-320, B-757, B-767, CE-500, DC-9
Commercial Pilot Privileges L-188
Limitations: A-320, DC-9 Circling Approach – VMC Only; English Proficient

---

[17] TWA was acquired by AMR Corp., which is the parent company of American Airlines, in April 2001.
[18] The pilot estimated that he had about 3,000 – 3,500 hours of total flight experience in the military and about 12,5000 total hours of civilian flight experience. Source: Attachment 1 – Flight Crew Interview Summaries and Statements.
[19] Lockheed Martin Corporation 188A, 188C, P-3 Series. Source: FAA Order 8900.1, Figure 5-88, dated July 15, 2019.
[20] Textron Aviation Inc. 500, 501, 550, S550, 551. Source FAA Order 8900.1, Figure 5-88, dated July 15, 2019.
[21] The Boeing Company DC-9-11, DC-9-12, DC-9-13, DC-9-14, DC-9-15, DC-9-15F, DC-9-21, DC-9-31, DC-9-32, DC-9-32F, DC-9-33F, DC-9-34, DC-9-34F, DC-9-41, DC-9-51, DC-9-81, DC-9-82, DC-9-83, DC-9-87, MD-88, MD-90-30, 717-200. Source: FAA Order 8900.1, Figure 5-88, dated July 15, 2019.

MEDICAL CERTIFICATION FIRST CLASS (issued April 9, 2019)
Restrictions: Yes – Special Authorization

2.2.3 The First Officer's Training and Proficiency Checks Completed

A summary of the first officer's recent training events at Miami Air was as follows:

Date of Hire – TWA	April, 1990
Most Recent Maneuvers Validation (RVA)	January 18, 2018
Most Recent A320 Maneuvers Training (RTS)	October 5, 2018
Most Recent Recurrent Ground School (RGS)	October 4, 2018
Most Recent Recurrent Human Factors & Safety Training (RHF)[22]	October 4, 2018
Most Recent Flight Manual Briefing (FMB)	October 4, 2018
Most Recent Line Check (RLE)	October 6, 2018

2.2.4 The First Officer's Flight Times[23]

Preceding 24 hours	5:04
Preceding 30 days	60:33
Preceding 90 days	185:44
Total Flight Experience[24]	10,102:52
Total Flight Experience – A-320	1,824:08

2.2.5 The First Officer's Pre-Accident Activities

On April 8, the FO flew a trip from Los Angeles to Dallas and return.

On April 9, he flew a 2230 departure out of LAX. He slept in but could not recall when he awoke.

On April 10, the day of the accident, he recalled getting 6 hours of sleep at the hotel the night before. He could not recall when he arrived at the airport but estimated he would have taken the 1900 van from the hotel to the airport for a report time of 1930.

[22] RHF was listed in the training record as a 1:30 course and was conducted approximately every 9 months. Source: Attachment 6 - Flight Crew Training Records [Excerpts]
[23] Source: Miami Air records and pilot statement.
[24] FAA medical certification information.

2.2.6 The First Officer's Personal Information

The FO lived in and was based in Los Angeles. He reported typically going to bed about 2200 to 2300 and awaking about 0700. This routine changed if he had a redeye flight as they arrived at the destination typically around 0200 Pacific time. When he flew redeye flights, he attempted to sleep in as late as he could the day of the flight.

He had a diagnosis of sleep apnea and used a CPAP machine consistently for the past 3 years including during travel. He drank alcohol occasionally and estimated his last drink prior to the accident was 2 days prior. He did not smoke tobacco, use illicit drugs, or take any prescription medications in the 72 hours prior to the event that would have affected his performance.

The accident captain stated that he believed the first officer would speak up regarding any concerns in the cockpit.

2.3 Flight Crew Trip Paring

The following trip pairing was the scheduled paring for the flightcrew when they reported for duty at LAX.

```
----------------------------------------------------------------------------
SEQ   5489   26 OPS    POSN CA FO
                 RPT 2131/2131
 1 1/2 80    28  LAX 2231/2231 M JFK 0700/0400  5.29
                                 RLS 0730/0430  5.29  0.00  5.29   6.59  6.29
                 JFK //SEE HIHTL//                                12.00
                 RPT 1930/1630
 2 2/3 80   300  JFK 2030/1730 D LAX 0003/0003  6.33
                                 RLS 0033/0033  6.33  0.00  6.33   8.03  7.33
TTL                                            12.02  0.00 12.02  27.02
----------------------------------------------------------------------------
```

The following was the modified trip pairing for the flight crew following the accident event. It included time in local station time.

```
    DT EQ  FLT STA DEP  M STA ARR  AC FLY    GTR  GRD     ACT
SKD 09 80   28 LAX 2231 M JFK 0700    5.29
ACT 09 80   28 LAX 2230 M JFK 0634    5.04   5.29
D/P GTR  5.29        P/C  0.00  TL  5.29
HALF DAY COUNT JFK  3
SKD ONDUTY  6.59 ODL  12.00
ACT ONDUTY  6.33 ODL  12.26
FDPT  6.03         START  2131  END  0334  ACC STA  LAX
SKD 10 80  300 JFK 2030 D JFK 2030    0.00        0.00
ACT 10 80  300 JFK 2025 D JFK 2117    0.52   0.52 0.47    AIR
SKD 10 80  300 JFK 2030 D LAX 0003 25 6.33                    PW
ACT 10 80  300 JFK 2030 D LAX 0003 25 6.33   6.33
D/P GTR  7.25        P/C  0.00  TL  7.25
SKD ONDUTY  8.03                        EXP    21.16
ACT ONDUTY  8.03
FDPT  1.47         START  1630  END  1817  ACC STA  LAX
SEQ GTR 12.54        P/C  0.00  TL 12.54 TAFB  27.02
```

Figure 1: Modified flightcrew pairing.

3.0 Aircraft Information

Photo 1: Accident Airplane. (Courtesy of Flightradar.com).

The accident airplane N114NN, Serial No. 6046, was an Airbus A321-231, and was manufactured in 2014. It was owned by Wells Fargo Trust Co., registered on April 11, 2014 as a transport category aircraft, and operated by American Airlines since its original registration. The airplane was powered by 2 IAE V2533-A5 engines. There was no MEL (Minimum Equipment List) and Configuration Deviation List (CDL) deferred maintenance items listed on the flight release.

After landing and returning to a gate the following entries were made in the Aircraft Maintenance Log:

> *At appox [sic] rotation speed on rwy 31L at JFK, aircraft veered to the left. The aircraft then rolled to the left immediately after takeoff. Recovery was performed and aircraft continued to climb out normally.*
>
> *After returning to the gate at JFK, foreign object was found lodged into left wingtip.*

For detailed airworthiness information see the Airworthiness Group Chairman report located in the docket associated with this accident.

4.0 Weight and Balance

The following weight and balance information was taken from the dispatch flight release. Limitations are indicated in **bold**[25] type. All weights below are in pounds (lbs.).

	Payload Sub-Total	**Total**
Basic Operating Weight		115,356
Passenger (102 total)[26]	19,782	

[25] Source: American Airlines A319/320/321 Operations Manual Volume 1.

[26] Passenger count included 1 child. The weight used by American Airlines for each passenger was 195 lbs. and for children was 87 lbs. Source: per American Airlines Weight and Balance Control Manual, Revision 41, dated December 18, 2018.

Cargo/Baggage	2,596	
Total Payload		22,378
Zero Fuel Weight		137,734
Maximum Zero Fuel Weight		**162,701**
Takeoff Fuel[27]		45,202
Takeoff Weight		182,936
Maximum Takeoff Weight		**206,132**
Takeoff Weight Center of Gravity		30.6[28]
Trim Setting		0.8-unit ND[29]
Planned Fuel Burn		35,973
Planned Landing Weight		146,963
Maximum Landing Weight		**171,519**

According to the aircraft maintenance logbook entry following the accident, an overweight landing was performed at 180,000 lbs. The crew further recorded that the "touchdown was smooth, utilizing full flap configuration."

5.0 Airport Information

John F. Kennedy International Airport (JFK) was located about 13 miles southeast of New York, New York, had an estimated field elevation of 13 feet msl, as located at a latitude /longitude of 43°38.23'N/073°46.43W The airport was serviced by an FAA Air Traffic Control Tower that was in operation 24 hours a day.

[27] Fuel included 13,759 lbs. in the left tank, 13,759 lbs. in the right tank 14,555 lbs. in the center tank, 4,149 lbs. in the A1 tank which equaled 46,222 minus planned taxi fuel of 1,020 lbs.
[28] At the calculated takeoff weight the CG range was approximately 17.5 to 39.8% Mean Aerodynamic Chord (MAC).
[29] Nose Down

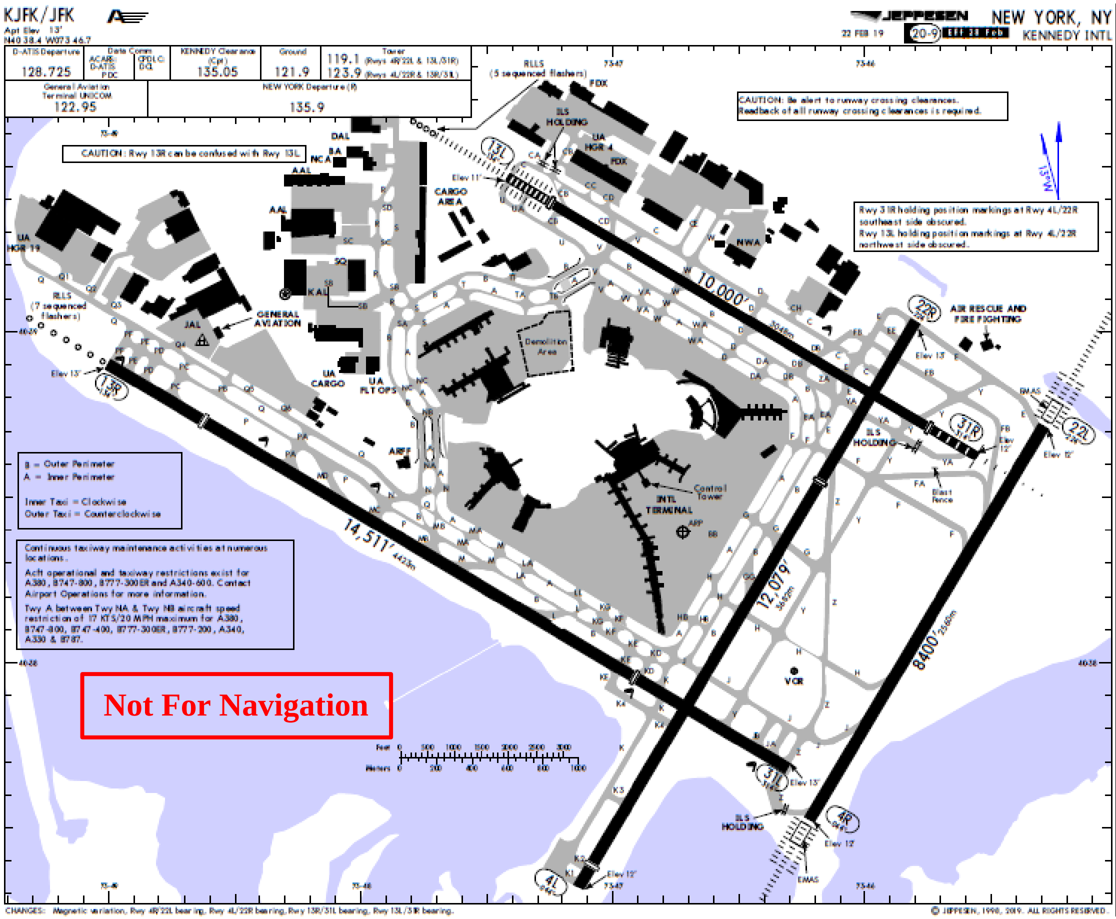


Figure 2: JFK Airport Chart (Source: Jeppesen).

6.0 Meteorological Information

The last recorded weather, prior to the accident, was the JFK METAR[30], which recorded the following ATIS information:

METAR KJFK 102351Z 33015KT 10SM FEW070 FEW250 11/M03 A2996 RMK AO2 PK WND 34026/2257 SLP145 T01111028 10161 20111 53034=

For detailed weather information see the Meteorology Group Chairman report located in the docket associated with this accident.

7.0 Relevant Systems

Flight Control surfaces are all electrically controlled and hydraulically activated. The stabilizer and rudder can also be mechanically controlled.

7.1 Cockpit Controls

Each pilot has a sidestick controller with which to exercise manual control of pitch and roll. The sidestick controllers are not coupled mechanically, and each controller transmit separate

[30] Meteorological Aerodrome Reports.

signals to the flight control computers. There are two pairs of pedals, which are rigidly interconnected and provide the pilot mechanical control of the rudder. Pilots use mechanically interconnected handwheels on each side of the center pedestal to control the trimmable horizontal stabilizer and a single switch on the center pedestal to set the rudder trim. There was no manual switch for trimming the ailerons.

According to the American Airlines A319/320/321 Operations Manual Volume II, Chapter 9 "Flight Controls," in normal law, regardless of the pilot's input, the computers will prevent exceedance of the safe envelope in pitch and roll axis.

7.1.1 Sidestick

The A321 was equipped with a sidestick located at each pilot's lateral console. Pilot's use their respective sidestick to fly the aircraft in pitch, roll, and indirectly yaw through coordinated turns. The sidestick was a fly-by-wire system and would send input signals to the flight control computers. The computers would interpret pilot input and move the flight control surfaces, as necessary.

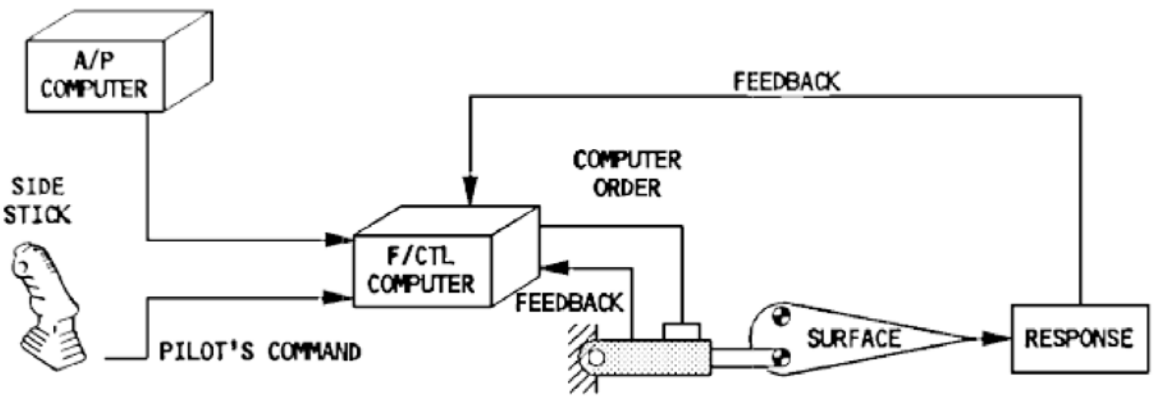


Figure 3: Fly-by Wire System.
(Source: American Airlines A319/320/321 OM Volume II)

Each sidestick was equipped with an autopilot disconnect/sidestick take over pushbutton.

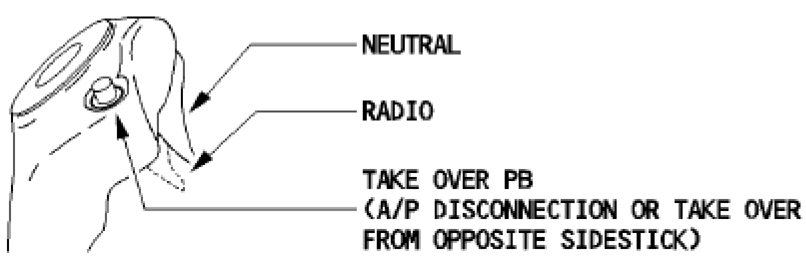


Figure 4: Sidestick Profile.

Sidestick priority logic[31]

[31] Source: American Airlines A319/320/321 Operations Manual Volume II "Flight Controls."

•When only one pilot operates the sidestick, it sends his control signals to the computers.
•When the other pilot operates his sidestick in the same or opposite direction, the system adds the signals of both pilots algebraically. The total is limited to the signal that would result from the maximum deflection of a single sidestick.

• Note •

In the event of simultaneous input on both sidesticks (2° deflection off the neutral position in any direction) the two green SIDE STICK PRIORITY lights on the glareshield come on and "DUAL INPUT" voice message is activated.

A pilot can deactivate the other sidestick and take full control by keeping his priority takeover pb depressed.

To latch the priority condition, press the takeover pb for more than 40 seconds. This allows the pilot to release his takeover pb without losing priority. However, a pilot can at any time reactivate a deactivated sidestick by momentarily pressing the takeover pb on either sidestick.

If both pilots press their takeover pbs, the pilot that presses last gets priority.

• Note •

If an AP is engaged, the first action on a takeover pb disengages it.

In a priority situation.

A red light illuminates in front of the pilot whose sidestick is deactivated.

A green light illuminates in front of the pilot who has taken control, if the other sidestick is not in the neutral position (indicates a potential and unwanted control demand).

• Note •

If the aircraft is on the ground commencing its takeoff run and one sidestick is deactivated, the takeoff "CONFIG" warning will activate.

7.1.2 Warning and Cautions

The American Airlines A319/320/321 Operations Manual Volume 2 provided the following information, in part, for the warnings and cautions available for the flight control system[32]:

[32] A list of takeoff configuration warning messages is provided in Operational Factors Human Performance Attachment 10 – American Airlines Operations Manual Vol 1 and 2 (Excerpts), pg. 21.

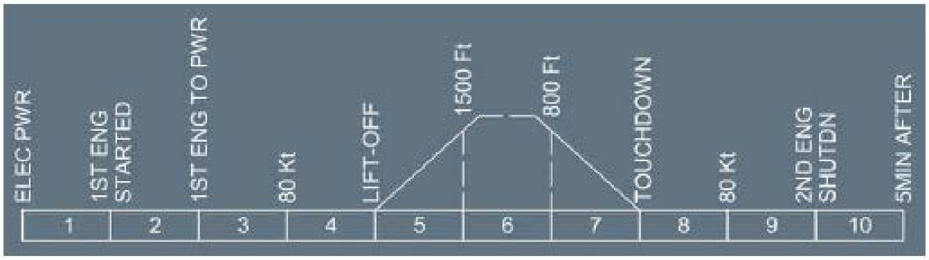


Figure 5: Flight Phase Inhibited Chart.
(Source: American Airlines A319/320/321 Operations Manual Volume II).

<table>
<tr><th>E/WD: FAILURE TITLE
conditions</th><th>AURAL WARNING</th><th>MASTER LIGHT</th><th>SD PAGE CALLED</th><th>LOCAL WARNING</th><th>FLT PHASE INHIB</th></tr>
<tr><td>CONFIG R (L) SIDESTICK FAULT (BY TAKE OVER)
L or R sidestick is inoperative (takeover pb pressed more than 30 s) when thrust levers are set at TO, or Flex TO, or when pressing TO CONFIG pb.</td><td rowspan="2">CRC</td><td rowspan="2">MASTER WARNING</td><td>NIL</td><td>Red[1] SIDESTICK PRIORITY lt</td><td>5, 6, 7, 8</td></tr>
<tr><td>L + R ELEV FAULT
Loss of both elevators.</td><td rowspan="7">F/CTL</td><td>PFD message</td><td>NIL</td></tr>
<tr><td>PITCH TRIM/MCDU/CG DISAGREE
The system detects that any of the following disagree:
— The real pitch trim value,
— The pitch trim value calculated by the FAC, based on the CG,
— The pitch trim value entered in the
— MCDU.</td><td rowspan="6">SINGLE CHIME</td><td rowspan="6">MASTER CAUTION</td><td rowspan="2">NIL</td><td>1, 4, 5, 6, 7, 8, 9, 10</td></tr>
<tr><td>L (R) SIDESTICK FAULT
Transducers, on pitch or roll axis, are failed on one sidestick.</td><td>NIL</td></tr>
<tr><td>ELAC 1 (2) FAULT
Failure of ELAC.</td><td>FAULT lt on ELAC pb</td><td rowspan="2">3, 4, 5, 6, 7, 8</td></tr>
<tr><td>ELAC 1 (2) FAULT
One sidestick transducer fault.</td><td>NIL</td></tr>
<tr><td>SEC 1 (2) (3) FAULT
Failure of one SEC</td><td>FAULT lt on SEC pb</td><td>3, 4, 5</td></tr>
<tr><td>FCDC 1 + 2 FAULT
Failure of both FCDCs</td><td>NIL</td><td>4, 5, 7</td></tr>
</table>

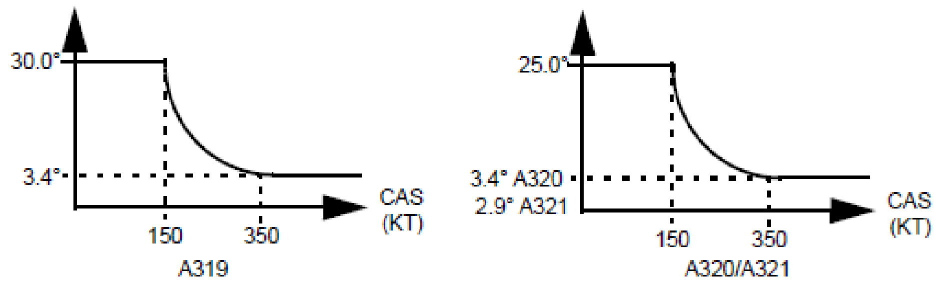
E/WD: FAILURE TITLE conditions	AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNING	FLT PHASE INHIB
DIRECT LAW Direct laws are active.	SINGLE CHIME	MASTER CAUTION	F/CTL	PFD message	4, 5, 7, 8
ALTN LAW Alternate laws are active.			NIL	NIL	4, 5, 7, 8
DUAL INPUT Both sidesticks are moved simultaneously.	Synthetic voice repeated every 5 s	NIL		SIDESTICK Priority light	NIL

Figure 6: Flight Control System Failure Conditions.
(Source: American Airlines OM Volume II, Chapter 9.3.1)

7.2 Rudder

The American Airlines A319/320/321 Operations Manual Volume 1, Section 2 "Maneuvers" provided the following information on rudder usage and control:

> ***Rudder Usage.*** *The use of full rudder for control of engine failure and crosswind takeoffs and landings is well within the structural capability of the aircraft. Engine out takeoff and crosswind landing requirements define the maximum rudder deflection (authority). For conditions other than engine failures and crosswind takeoffs and landings, large rudder inputs are typically not required.*
>
> *The rudder control system includes a turn coordination function to achieve turn coordination.*
>
> ***Rudder Control.*** *The rudder surface is controlled by three actuators, commanded by a cable run from rudder pedals, to which additional flight control input (yaw damping and turn coordination functions coming from the ELACs and FACs) are added.*
>
> *The rudder travel limiter, controlled by the FACs, is designed to progressively reduce the available total rudder travel depending on aircraft speed.*
>
> *This provides sufficient yaw control within the entire flight envelope, including engine failure and maximum asymmetric thrust, limiting loads on the stabilizer and rudder so that they remain in certification limits.*
>
> *Rudder travel is limited as a function of the aircraft speed, as shown below:*



- *At low speeds, the rudder deflection required to maneuver the aircraft is large, and so are the resulting rudder displacement and forces.*
- *At high speeds, the rudder authority is limited but the gearing between the pedals and rudder does not change. Therefore less force is required to achieve maximum available rudder deflection.*

As speed increases, the rudder deflection required by any yaw maneuver (e.g., engine failure and maximum asymmetric thrust) decreases, and consequently, so do rudder pedal displacement and associated forces.
Rudder pedal displacement is almost linearly proportional to rudder deflection. The rudder pedal displacement and the resulting pedal forces to achieve a given rudder deflection are independent from aircraft speed.

- *To start moving the rudder pedals from the neutral position, a minimum force of +/- 22.5 pounds must be applied ("breakout force").*
- *At low speeds, i.e., up to 150 knots, maximum available rudder deflection (31.6°) is obtained by moving the rudder pedals to their maximum travel which represents 67.5 pounds of force applied on the pedals.*
- *At higher speeds, for example at 350 knots, the maximum available rudder deflection is reduced to 4°. It is consequently obtained with less rudder pedal displacement which represents approximately 27 pounds of force applied on the pedals (40% of the maximum force to reach full pedal travel).*

WARNING

Full or nearly full rudder deflection in one direction followed by full or nearly full rudder deflection in the opposite direction, or certain combinations of sideslip angle and opposite rudder deflection can result in potentially dangerous loads on the vertical stabilizer, even at speeds below the design maneuvering speed.

Recovery from Stalls, Wake Vortices, Windshear or Unusual Attitudes require immediate and precise pitch and roll inputs, however the use of large rudder inputs are not recommended nor necessary for recovery. Only in extreme conditions, where proper pitch and roll inputs are unsuccessful should careful rudder input in the direction of the desired roll be considered to start the nose down or provide the desired bank angle.

• It is recommended that the rudder not be used in a stall recovery, and that stall recovery should be accomplished before proceeding with any unusual attitude recovery.
• Once the stall recovery is complete, the ailerons/spoilers should provide adequate rolling moment for unusual attitude recovery.

***Considerations**:*

• The aircraft has been designed to accommodate a rapid and immediate rudder pedal input in one direction from zero input to full.
• It is important to use the rudder so as to avoid large sideslip angles and resulting excessive roll rates. The amount of roll rate generated by using the rudder is proportional to the amount of sideslip, not the amount of rudder input.
• If the pilot reacts to an abrupt roll onset with a large rudder input in the opposite direction, the pilot can induce large amplitude oscillations. These large amplitude oscillations can generate loads that exceed the limit loads and possibly the ultimate loads, resulting in structural failure.
• A full or nearly full authority rudder reversal as the aircraft reaches an "over yaw"
sideslip angle may be beyond the structural design limits of the aircraft.
• Full or nearly full rudder deflection in one direction followed by full or nearly full rudder deflection in the opposite direction, or certain combinations of sideslip angle and opposite rudder deflection, can result in potentially dangerous loads on the vertical stabilizer, even at speeds below the design maneuvering speed.
• Rudder input is never the preferred initial response for events such as wake vortex encounter, windshear encounter, or to reduce bank angle preceding an imminent stall recovery. When normal means of roll control are unsuccessful, careful rudder input in the direction of the desired roll should be considered to induce or augment rolling moment, or to provide the desired bank angle.
• It is not recommended to use rudder in a stall recovery. Stall recovery should be accomplished before any unusual attitude recovery. Once the stall recovery is complete, the ailerons/spoilers should provide adequate rolling moment for unusual attitude recovery.

7.2.1 Yaw Control

The American Airlines A319/320/321 Operations Manual Volume II provided the following information on yaw control:

One rudder surface controls yaw.
Electrical Rudder Control
The yaw damping and turn coordination functions are automatic. The ELACs compute yaw orders for coordinating turns and damping yaw oscillations, and transmit them to the FACs.
Mechanical Rudder Control
The pilots can use conventional rudder pedals to control the rudder.
Rudder Actuation

Three independent hydraulic servojacks, operating in parallel, actuate the rudder. In automatic operation (yaw damping, turn coordination) a green servo actuator drives all three servojacks. A yellow servo actuator remains synchronized and takes over if there is a failure. There is no feedback to the rudder pedals from the yaw damping and turn coordination functions.

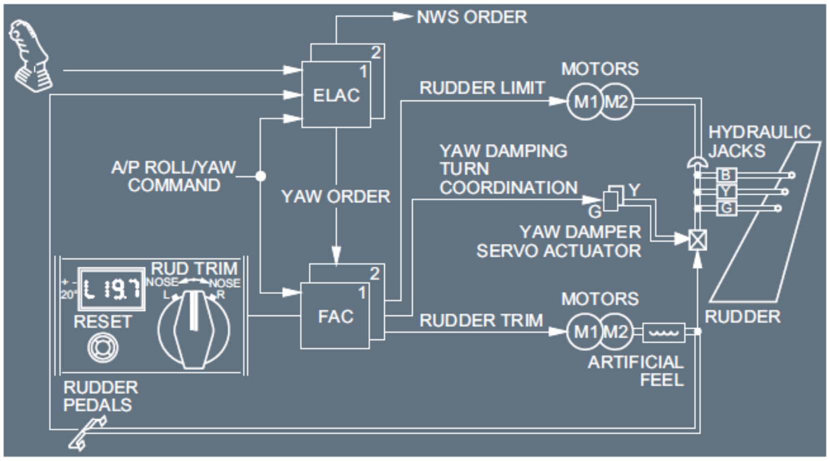


Figure 7: Yaw Control Diagram.
(Source: American Airlines A319/320/321 OM Volume II Chapter 9 System Description)

Rudder Travel Limit.

The maximum rudder travel deflection gradually reduces as the speed increases, to avoid structural loads:

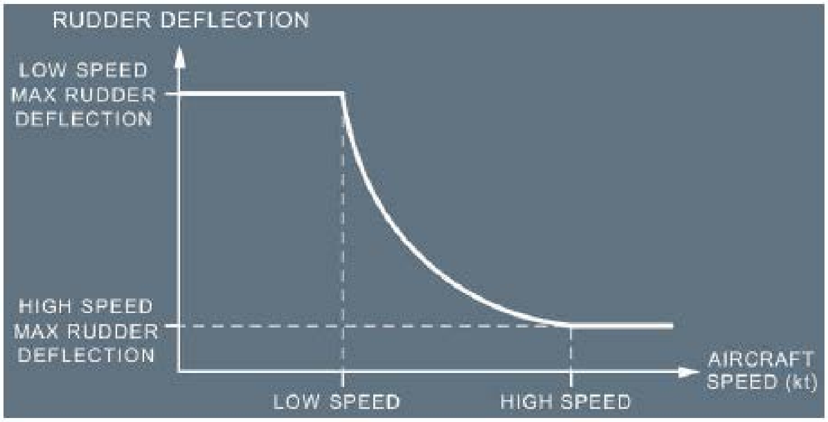


Figure 8: Rudder Deflection Travel Limit Chart.
(Source: American Airlines A319/320/321 OM Volume II, Chapter 9 System Description)

In the case of a failure that causes loss of the Rudder Travel limit system, the rudder deflection limit stops at the last value reached. At slats extension, full rudder travel authority is recovered. In all cases, the available rudder deflection provides sufficient yaw control within the entire flight envelope. This includes the case of maximum asymmetric thrust.

Relationship Between Sideslip/Rudder Deflection/Rudder Pedal Travel

Regardless of the aircraft speed, therefore the maximum rudder deflection, full rudder pedal travel remains available. However, except at low speed, maximum rudder deflection is achieved before reaching maximum rudder pedal travel.

Rudder Trim
The two electric motors that position the artificial feel unit also trim the rudder. In normal operation, motor N° 1 (controlled by FAC1), drives the trim, and FAC2 with motor N° 2 remains synchronized as a backup.

In manual flight, the pilot can apply rudder trim with the rotary RUD TRIM switch on the pedestal. The pilot can use a button on the RUD TRIM panel to reset the rudder trim to zero.

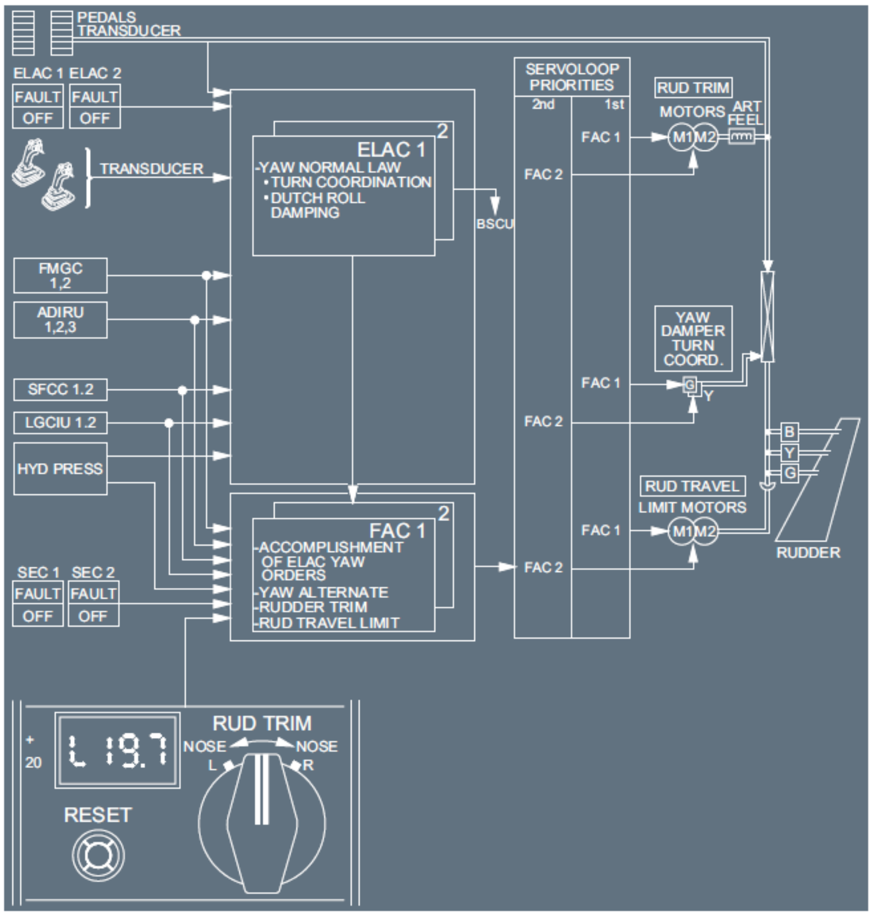


Figure 9: Rudder Schematic.
(Source: American Airlines Airbus A319/320/321 Operations Manual Vol. 2).

7.3 Roll Control

The American Airlines A319/320/321 Operations Manual Volume II provided the following information on the roll control system:

One aileron and four spoilers on each wing control the aircraft about the roll axis.
The maximum deflection of the ailerons is 25 °.
The ailerons extend 5 ° down when the flaps are extended (aileron droop).
The maximum deflection of the spoilers is:
A319/A320 – 35 °

A321 – 35 ° for spoilers 2, 4, and 5 and 7 ° for spoilers 3.

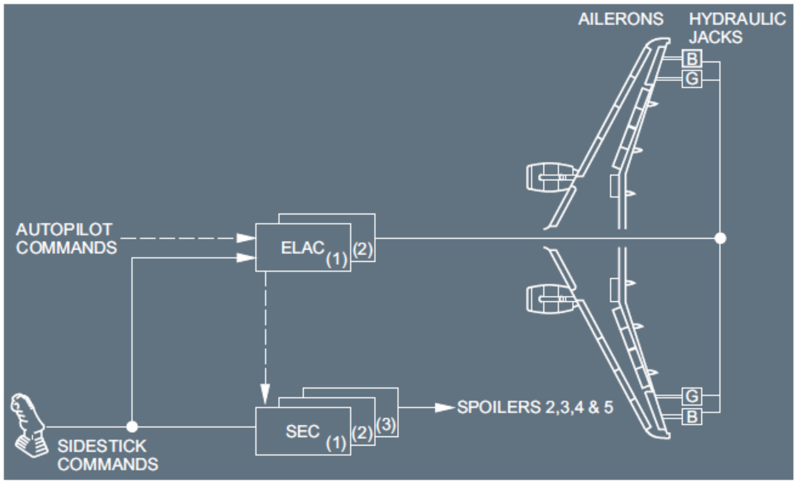


Figure 10: Roll Control Diagram.
(Source: American Airlines A319/320/321 OM Volume II, Chapter 9 System Description)

Electric Control

- *The ELAC 1 normally controls the ailerons. If ELAC1 fails, the system automatically transfers aileron control to ELAC2.If both ELACs fail, the ailerons revert to the damping mode.*
- *SEC3 controls the N° 2 spoilers, SEC1 the N° 3 and 4 spoilers, and SEC2 the N° 5 spoilers. If a SEC fails, the spoilers it controls are automatically retracted.*

Actuation

Ailerons
Each aileron has two electrically controlled hydraulic servojacks.
One of these servojacks per aileron operates at a time.
Each servojack has two control modes:
•Active: Jack position is controlled electrically
•Damping: Jack follows surface movement.
The system automatically selects damping mode, if both ELACs fail or in the event of blue and green hydraulic low pressure.

Spoilers
A servojack positions each spoiler. Each servojack receives hydraulic power from either the green, yellow, or blue hydraulic system, controlled by the SEC1, 2 or 3.
The system automatically retracts the spoilers to their zero position, if it detects a fault or loses electrical control.
If the system loses hydraulic pressure, the spoiler retains the deflection it had at the time of the loss, or a lesser deflection if aerodynamic forces push it down.
When a spoiler surface on one wing fails, the symmetric one on the other wing is inhibited.

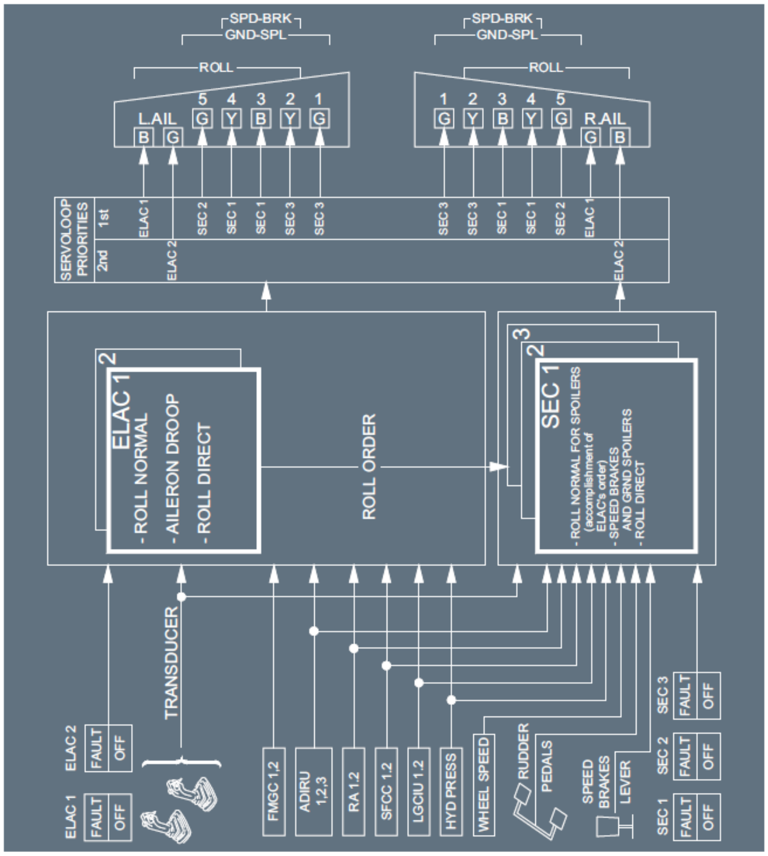


Figure 11: Roll Control Schematic.
(Source: American Airlines Airbus A319/320/321 Operations Manual Vol. 2).

7.4 Speed Brakes and Ground Spoilers

The American Airlines A319/320/321 Operations Manual Volume II provided the following information, in part, on the speed brakes and ground spoilers:

The pilot controls the speedbrakes with the speedbrake lever.
The speedbrakes are actually spoilers 2, 3 and 4.
Speedbrake extension is inhibited, if:

SEC1 and SEC3 both have faults.
An elevator (L or R) has a fault (in this case only spoilers 3 and 4 are inhibited).
Angle-of-attack protection is active.
Flaps are in configuration FULL (A319 / A320) and 3 or FULL (A321).
Thrust levers above MCT position.
Alpha Floor activation.

If an inhibition occurs when the speedbrakes are extended, they automatically retract and remain retracted until the inhibition condition disappears and the pilots reset the lever. (The speedbrakes can be extended again, 10 seconds or more after the lever is reset).
When a speedbrake surface on one wing fails, the symmetric one on the other wing is inhibited.

• Note •

1. For maintenance purposes, the speedbrake lever will extend the N° 1 surfaces when the aircraft is stopped on ground, regardless of the slat/flap configuration.
2. When the aircraft is flying faster than 315 kt or M 0.75 with the autopilot engaged, the speedbrake retraction rate is reduced (Retraction from FULL to in takes about 25 seconds).

The maximum deflection for the spoilers is:

<u>A319:</u>
•25 ° for spoilers 3 and 4;
•12.5 ° for spoiler 2 in configuration 3, and 17.5 ° in other configurations.
<u>A320:</u>
The maximum speedbrake deflection in manual flight is:
•40 ° for spoilers 3 and 4
•20 ° for spoiler 2.

The maximum speedbrake deflection with the autopilot engaged is:
•25 ° for spoilers 3 and 4
•12.5 ° for spoiler 2.
The maximum speedbrake deflection achievable with the autopilot engaged is obtained by setting the speedbrake lever to the half way position. On setting the position of the speedbrake lever from half to full, no increase in speedbrake deflection will be achieved.

<u>A321:</u>
•The maximum deflection for the spoilers 2, 3 and 4 is 25 °.

For these surfaces (which perform both roll and speedbrake functions) the roll function has priority. When the sum of a roll order and a simultaneous speedbrake order on one surface is greater than the maximum deflection available in flight, the same surface on the other wing is retracted until the difference between the two surfaces is equal to the roll order.

Ground Spoiler Control
Spoilers 1 to 5 act as ground spoilers. When a ground spoiler surface on one wing fails, the symmetric ground spoiler surface on the other wing is inhibited.
<u>Arming</u>
The pilot arms the ground spoilers by pulling the speedbrake control lever up into the armed position.
<u>Full Extension – Rejected Takeoff Phase</u>
•If the ground spoilers are armed and the speed exceeds 72 kt, the ground spoilers will automatically extend as soon as both thrust levers are reset to idle.
•If the ground spoilers are not armed and the speed exceeds 72 kt, the ground spoilers will automatically extend as soon as reverse is selected on one engine (the other thrust lever remains at idle).

<u>Full Extension - Landing Phase</u>
Basic Aircraft

•If the ground spoilers are armed and all thrust levers are at idle, the ground spoilers will automatically extend as soon as both main landing gears have touched down.
•If the ground spoilers are not armed and both main landing gears have touched down, the ground spoilers will automatically extend as soon as reverse is selected.

7.5 Flight Control Laws

The American Airlines A319/320/321 Operations Manual Volume 2 provided the following guidance, in part, on the different flight control laws:

7.5.1 Normal Law

Flight control normal law covers:
- three-axis control
- flight envelope protection
- alleviation of maneuver loads

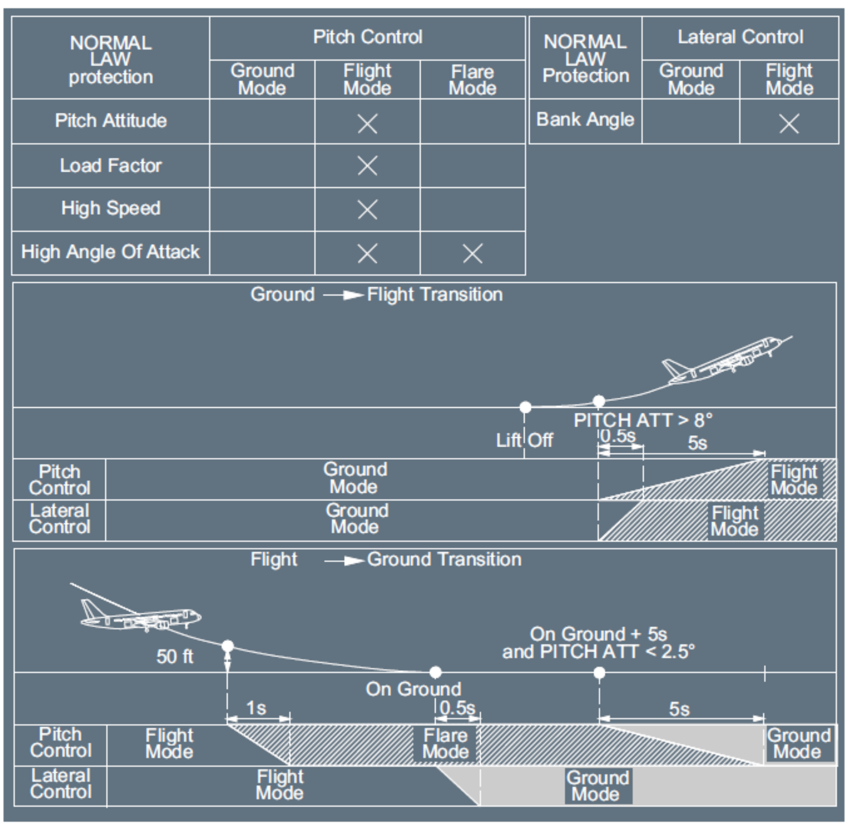


Figure 12: Normal Law Protection Range.
(Source: American Airlines A319/320/321 OM Volume II, Chapter 9 System Description)

Pitch Control.
Ground Mode.

Ground mode is a direct relationship between sidestick deflection and elevator deflection, without auto trim.

It automatically sets the trimmable horizontal stabilizer (THS) at 0 ° (inside the green band). A setting that the pilot enters manually to adjust for CG has priority for takeoff. When the aircraft reaches 75 kt during the takeoff roll, the system reduces the maximum up elevator deflection from 30 ° to 20 °.

Flight Mode
The normal-law flight mode is a load-factor-demand mode with automatic trim and protection throughout the flight envelope.

Following normal law, the sidestick controllers set the elevator and THS to maintain load factor proportional to stick deflection and independent of speed.

With the sidestick at neutral, wings level, the system maintains 1 g in pitch (corrected for pitch attitude), and there is no need for the pilot to trim by changing speed or configuration. Pitch trim is automatic both in manual mode and when the autopilot is engaged. In normal turns (up to 33 °C of bank) the pilot does not have to make any pitch corrections once the turn is established. The flight mode is active from takeoff to landing, and follows the logic shown schematically.

Automatic pitch trim freezes in the following situations:
The pilot enters a manual trim order.
The radio altitude is below 50 ft (100 ft with autopilot engaged).
The load factor goes below 0.5 g.
The aircraft is under high-speed or high-Mach protection.

When angle-of-attack protection is active, the THS setting is limited between the setting at the aircraft's entry into this protection and 3.5 ° nose down. (Neither the pilot nor the system can apply additional nose-up trim).

Similarly, when the load factor is higher than 1.25 g or when the aircraft exceeds 33 ° of bank, the THS setting is limited to values between the actual setting and 3.5 ° nose down. On some A320: When High Speed or High Mach Protection is active, the THS Setting is limited between the setting at the aircraft's entry into this protection and 11 ° nose-up.

Protections.
The normal law protects the aircraft throughout the flight envelope, as follows:
load factor limitation
pitch attitude protection
high-angle-of-attack (AOA) protection
high-speed protection

Lateral Control
Normal Control

When the aircraft is on the ground (in "on ground" mode), the sidestick commands the aileron and roll spoiler surface deflection. The amount of control surface deflection that results from a given amount of sidestick deflection depends upon aircraft speed. The pedals control rudder deflection through a direct mechanical linkage. The aircraft smoothly transitions to "in flight" mode shortly after liftoff. When the aircraft is in the "in flight" mode, normal law combines control of the ailerons, spoilers (except N° 1 spoilers), and rudder (for turn coordination) in the sidestick. While the system thereby gives the pilot control of the roll and heading, it also limits the roll rate and bank angle, coordinates the turns, and damps the dutch roll.

The roll rate requested by the pilot during flight is proportional to the sidestick deflection, with a maximum rate of 15°/second when the sidestick is at the stop. When the aircraft is in "flare" mode, the lateral control is the same as in "in flight" mode. After touchdown, the aircraft smoothly transitions from "in flight" mode to "ground" mode.

Bank Angle Protection

Inside the normal flight envelope, the system maintains positive spiral static stability for bank angles above 33 °. If the pilot releases the sidestick at a bank angle greater than 33 °, the bank angle automatically reduces to 33 °. Up to 33 °, the system holds the roll attitude constant when the sidestick is at neutral. If the pilot holds full lateral sidestick deflection, the bank angle goes to 67 ° and no further.

If Angle-of-Attack protection is active, and the pilot maintains full lateral deflection on the sidestick, the bank angle will not go beyond 45 °. If High Speed Protection is active, and the pilot maintains full lateral deflection on the sidestick, the bank angle will not go beyond 40 °. If high speed protection is operative, the system maintains positive spiral static stability from a bank angle of 0 °, so that with the sidestick released, the aircraft always returns to a bank angle of 0 °.

7.5.2 Alternate Law

Pitch Control.

Ground Mode

Under alternate law the ground mode becomes active on the ground 5 s after touchdown. It is identical to the ground mode of the normal law.

Flight Mode

In flight, the alternate law pitch mode follows a load-factor demand law much as the normal law pitch mode does, but it has less built-in protection (reduced protections).

7.5.3 Direct Law

Pitch Control.

The pitch direct law is a direct stick-to-elevator relationship (elevator deflection is proportional to stick deflection).

In all configurations the maximum elevator deflection varies as a function of CG. It is a compromise between adequate controllability with the CG forward, and not-too-sensitive

control with the CG aft.
There is no automatic trim: the pilot must trim manually.
The PFD displays in amber the message "USE MAN PITCH TRIM".
No protections are operative.
The α floor function is inoperative.
Overspeed and stall warnings are available as for alternate law.

Lateral Control
When flying in "direct law", the roll direct law associated with mechanical yaw control governs lateral control.
Roll Direct Law
The roll direct law is a direct stick-to-surface-position relationship. System gains are set automatically to correspond to slat/flap configuration.
With the aircraft in the clean configuration, the maximum roll rate is about 30°/s.
With slats extended, it is about 25°/s.
To limit roll rate, the roll direct law uses only ailerons and spoilers N° 4 and 5.
If spoiler N° 4 has failed, spoiler N° 3 replaces it.
If the ailerons have failed, all roll spoilers become active.
Yaw Mechanical Control
The pilot controls yaw with the rudder pedals.
The yaw damping and turn coordination functions are lost.

Abnormal Attitude Laws
In the case of an extraordinary unpredictable external event (e.g. mid-air collision) the flight parameters may go far beyond the limits of the protected envelope. In this case, specific control laws are activated to ensure aircraft recovery, and to allow a safe continuation of the flight.

• Note •

Abnormal attitudes cannot be reached as a consequence of recorded atmospheric disturbance.

8.0 Relevant Procedures

8.1 Crosswind and Tailwind Component Limits

The American Airlines A319/320/321 Operations Manual Volume 1, Section 1 "Limitations" provided a 50-knot maximum wind for takeoff, including gusts, and a 35-knot maximum crosswind, including gusts. Additionally it provided that the "*maximum crosswind values have been demonstrated with flight control in normal law as well as direct law with and without yaw damper.*"

Additionally, Airbus provided the following information on "Maximum Demonstrated Crosswind:"[33]

> *Today, maximum demonstrated crosswind figuring in the FCOM is derived from the maximum crosswind that has been encountered during the complete certification process and recorded in a particular manner that has been agreed in conjunction with the authorities. It is not necessarily the maximum aircraft crosswind capability of the aircraft. It is purely based upon data recorded within the aircraft during the period of the certification process. Furthermore, it is often observed to be significantly different from the wind provided by ATC.*

8.2 Crosswind Takeoff

The American Airlines A319/320/321 Operations Manual Volume I provided the following guidance for takeoffs with a crosswind or tailwind:

> *If crosswind component exceeds 20 knots or if a tailwind exists, the PF will apply full forward sidestick, to be progressively neutralized between 80 and 100 knots. The PF will advance the thrust levers to 50% N1 (CFM), 1.05 EPR (IAE), allow the engines to stabilize momentarily at that thrust and crosscheck engine instruments. After the engines have stabilized:*
>
> > *• CFM - rapidly increase the thrust to 70% N1, then, above 15 knots ground speed, to the FLX or TOGA detent no later than 40 knots groundspeed*
> > *• IAE - increase thrust to FLX or TOGA detent no later than 40 knots groundspeed*
>
> *The traditional use of upwind aileron is not recommended. In strong crosswind conditions, small lateral control sidestick input may be used to maintain wings level. Excessive lateral input causes spoiler deployment, which increases the aircraft's tendency to weathervane and increases drag.*
>
> *If some lateral control has been applied on the ground, center the sidestick during rotation so that the aircraft becomes airborne with a zero roll rate demand.*

9.0 Crew Resource Management Training

According to the company advanced qualification program manual, American Airlines provided pilots with threat and error management (TEM) crew resource management (CRM) ground training during basic and requalification indoctrination, qualification, continuing qualification, and requalification. Training involves communication skills, teamwork, task allocation, workload management, situation awareness, and decision making via interactive seminar presentation during the indoctrination phase and crew members are provided the opportunity to practice these skills during simulator sessions with video feedback. Further, when possible this training is integrated with cabin crew and dispatch.

TEM/CRM Ground training modules included:

---

[33] Source: Operational Factors/Human Performance Attachment 14 - The Airbus Safety Magazine, Issue 15, dated January 2013.

"Introduction to Threat and Error Management. A

- *History of CRM*
- *Threat and Error Management - 6th Generation CRM*
- *Risk and Resource Management using the Model*
- *Risk and Consequential Error*
- *Task Loading Problem Solving*
- *Threats and Additive Conditions*
- *Resources and Barriers to Avoid and Mitigate Error*
- *ABCs of Threat and Error Management*

Communication Fundamentals Module.

- *Normal Communication*
- *Emergency Communication*

Communications Processes and Decision Behaviors Module.

- *Assessing Threats*
- *Monitoring Skills*
- *Balancing Barriers to Error*
- *Inquiry/Advocacy/Assertion*
- *Effective Communication*
- *Conflict Resolution*
- *Decision Making /Critical Decisions*

Team Building and Team Maintenance Module.

- *Leadership/Followership*
- *Team Members*
- *Crew Self Critique*

Workload Management/Situational Awareness Module.

- *Preparation/Planning/Vigilance*
- *Workload Distribution/Distraction Avoidance*
- *Pilot Monitoring (PM) Pilot Flying (PF) and Other Flight Crew Division of Duties (Task Sharing)*
- *Positive Transfer of Aircraft Control*
- *Consistent Checklist Philosophy*
- *Emphasis on a Prioritization of Tasks (E.G. "Aviate, Navigate, Communicate")*
- *Maintaining Situational Awareness*
- *Use of Resources*
- *Automation Operating Policy*

Threat and Error Management Exercise.

- *Actively Monitor and Assess*
- *Balance Barriers and Resources*

- *Communicate Threats/Risks and Intentions*

Previous Aircraft Accidents/Incidents Module.
- *NTSB/FAA Accident Report Reviews*
- *Industry Reports*
- *Human Factors/Considerations*
- *Aviation Safety Action Program (ASAP)"*

F. LIST OF ATTACHMENTS

Attachment 1 – Flight Crew Interview Summaries and Written Statement
Attachment 2 – Cabin Crew Statements
Attachment 3 – Following Aircraft Captain's Statement
Attachment 4 – Flight Crew Schedules
Attachment 5 – Flight Crew Hours
Attachment 6 – Flight Crew Training Records [Excerpts]
Attachment 7 – Accident Flight Release and Field Reports
Attachment 8 – Accident Flight Load Close Out
Attachment 9 - Accident Flight ACARS Communication [Excerpts]
Attachment 10 – American Airlines Operations Manuals Volumes 1 & 2 [Excerpt]
Attachment 11 – American Airlines Quick Reference Handbook [Excerpt]
Attachment 12 – American Airlines AQP Volume 1 [Excerpt]
Attachment 13 – American Airlines Weight and Balance Control Manual [Excerpt]
Attachment 14 – The Airbus Safety Magazine, Issue 15 [Excerpt]
Attachment 15 – Operational Factors/Human Performance Group Party Forms

Submitted by:

____
Shawn Etcher
Air Safety Investigator

____
Sathya Silva, PhD
Human Performance Investigator

THIS PAGE INTENTIONALLY BLANK