National Transportation Safety Board
Aviation Accident Final Report

Location:	HAILEY, ID	**Accident Number:**	SEA93FA186
Date & Time:	08/26/1993, 1430 MDT	**Registration:**	FBYCV
Aircraft:	DASSAULT DA-10	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	2 None
Flight Conducted Under:	Part 91: General Aviation - Personal		

Analysis

BECAUSE OF THE FAILURE OF THE THRUST REVERSER RELAY CIRCUIT BOARD, THE THRUST REVERSERS FAILED TO DEPLOY WHEN SELECTED BY THE PILOT. BECAUSE THE REVERSERS FAILED TO DEPLOY, THE 'REVERSERS IN TRANSITION' LIGHTS, AND THE 'REVERSERS DEPLOYED' LIGHTS DID NOT ILLUMINATE. EVEN THOUGH THE AIRCRAFT FLIGHT MANUAL WARNS AGAINST MOVING THE REVERSER THROTTLE LEVERS INTO THE POWER RANGE WITHOUT THE ILLUMINATION OF THESE LIGHTS, THE PILOT DID SO ANYWAY. THE PILOT CONTINUED TO SELECT REVERSE POWER EVEN AFTER THE ACTIVATION OF THE THROTTLE MISMATCH WARNING HORN, RESULTING IN AN INCREASE IN FORWARD THRUST WHILE ATTEMPTING TO STOP. DURING THIS SEQUENCE OF EVENTS THE SECOND-IN-COMMAND MOVED THE PARKING BRAKE LEVER TO FULL OVERRIDE, LOCKING THE MAIN WHEEL BRAKES AND OVERRIDING THE ANTISKID SYTEM.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: THE PILOT-IN-COMMAND'S IMPROPER PROCEDURES. FACTORS INCLUDE FAILURE OF AN ELECTRICAL RELAY, INOPERATIVE THRUST REVERSER, POOR CREW COORDINATION, AND THE SECOND-IN-COMMAND'S IMPROPER PROCEDURES.

Findings

Occurrence #1: AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION
Phase of Operation: LANDING - ROLL

Findings
1. (F) ELECTRICAL SYSTEM,ELECTRIC RELAY - FAILURE,TOTAL
2. (F) THRUST REVERSER - INOPERATIVE

Occurrence #2: OVERRUN
Phase of Operation: LANDING - ROLL

Findings
3. (C) PROCEDURES/DIRECTIVES - IMPROPER - PILOT IN COMMAND
4. (F) PROCEDURES/DIRECTIVES - IMPROPER - COPILOT/SECOND PILOT
5. (F) CREW/GROUP COORDINATION - POOR - PILOT IN COMMAND

Occurrence #3: ON GROUND/WATER COLLISION WITH OBJECT
Phase of Operation: LANDING - ROLL

Findings
6. OBJECT - FENCE
7. TERRAIN CONDITION - DITCH

Factual Information

HISTORY OF FLIGHT

On August 26, 1993, at approximately 1430 mountain daylight time (MDT), a Dassault Falcon DA-10, FBYCV, skidded off the end of the runway during landing roll at Friedman Memorial Airport, Hailey, Idaho. The FAA certificated commercial pilot, who was acting as pilot-in-command (PIC), and a pilot certificated by the government of France, who was acting as second-in-command (SIC), were not injured, but the aircraft sustained substantial damage. The flight, which was operating under 14 CFR 91, was arriving from Great Falls International Airport, Great Falls, Montana. The pilot had canceled his IFR flight plan while in view of the airport, and was operating in visual meteorological conditions at the time of the accident. There was no report of an ELT activation.

According to the pilot-in-command, who had recently purchased the plane in Paris, France, the accident aircraft was on a multi-day flight to bring it to the Friedman Memorial Airport. The previous leg had been from Saskatoon, Saskatchewan to Great Falls, Montana. The second-in-command said that "Previous flights had been without problems or discrepancies, except for an intermittent antiskid problem on the left system and a rather poor braking action noticed during a long taxi after landing in Iqualit." According to the PIC, the "antiskid problem" had been a flickering/intermittent antiskid warning light illuminating while performing pre-takeoff checks during taxi.

After canceling their IFR flight plan, the crew executed a visual approach for a "flaps 52" full-stop landing on the 6,602 foot long runway 31. Both crew members reported that the aircraft became established on final at a speed of approximately landing approach speed (Vref) plus 15 knots to Vref plus 20 knots. According to the PIC, because of the reported winds, he expected to experience a five to eight knot tailwind at touchdown. He therefore began reducing power on final in order to insure a touchdown "on the numbers," right at Vref speed. According to the SIC, who had about eight times as many flight hours in this model aircraft as the PIC, this reduction in power caused the aircraft to establish a descent rate that resulted in a "firm" touchdown and a bounced landing. The PIC said that, although he realized he had pulled off a little too much power, and that the aircraft had "dropped a little hard," he did not realize at the time that the plane had bounced back into the air. Instead, he thought that the aircraft had simply bounced hard enough for the gear oleos to extend, but not hard enough for the wheels to come off the ground.

According to the PIC, since he did not realize that the aircraft had bounced back in the air, he began the thrust reverser activation/braking process soon after the initial touchdown. He further stated that he had moved the reverser throttles to the idle position, paused there for a very brief moment, and then selected a "low" reverse power setting without seeing either the amber TRANS (reverser in transition) lights or the green REV (reverser fully deployed) lights. The PIC also said that he does not believe that either pilot activated the airbrakes during the landing sequence and, although the flaps were found in the up position after the aircraft came to rest, both crew members were adamant about the fact that they were down during the landing. According to the SIC, the reverser activation portion of the landing sequence may have been initiated prior to the aircraft's final touchdown.

Both pilots said that after reverse power was selected they heard a noise associated with engine acceleration, but that it did not sound like they expected it should with the reverser

doors in the deployed position. They both also noticed that the aircraft was not slowing as expected. The PIC then applied more reverse power and initiated strong braking, but the aircraft still failed to slow. He therefore moved the reverse levers back to the stowed position, after which the SIC physically checked the main thrust levers in the idle position. The SIC stated that he then "... smashed down the thrust reverser levers to lock them in the stowed position with no thrust."

Then, according to the PIC, because the aircraft did not appear to be slowing and because his attention was focused outside, he again selected reverse power without determining if the TRANS or REV lights had illuminated. Also, at about this same time, because he did not detect the "strong braking action" which he had expected and because of the previous antiskid problems, the SIC moved the red parking/override brake handle to the number two/full override position. At this point, the PIC continued to apply full toe brake pressure and, since his training had taught him to move the parking brake handle to the number one/mid position during emergencies, he moved the red brake lever from the number two position to the number one detent. He also said that he may have cycled the thrust reverser levers one or two more times, but he wasn't sure.

Then, because it felt and sounded as if power was being added, and because the aircraft did not appear to be slowing, and maybe even accelerating, the PIC moved the red brake lever back to the originally selected number two position. Because he was concentrating on directional control and the fact that the aircraft was approaching the far end of the runway, the PIC does not have a clear recollection of the sequence of events that followed the repositioning of the brake lever.

As the aircraft neared the end of the runway, the SIC also began use of the toe brakes, but that resulted in "... no apparent effect." The aircraft eventually departed the end of the runway, skidded across open terrain, and passed through a chain-link perimeter fence. It then skidded across Highway 75, experienced a nose gear collapse when it impacted the edge of an asphalt bike path, and ultimately came to rest in a city park.

After the aircraft came to a stop, the SIC attempted to shut down the engines using the normal procedure of moving the thrust levers to the idle/cut-off position, but he "...had a lot of trouble...," and after a few tries elected to shut the engines down by pulling the "fire pull handles."

A number of witnesses who observed the initial touchdown were interviewed, and all agreed that the aircraft had bounced back into the air at least once, ultimately settling back on the surface at various estimated distances down the runway. A second group of witnesses, who did not see the initial touchdown, but who had turned to observe the aircraft after it had bounced back into the air, was also interviewed. This group of witnesses all agreed that the aircraft's final touchdown was between 2,000 and 2,500 feet from the runway threshold. Because they had not witnessed the initial touchdown, and because of the aircraft's approach angle and height above the runway, some individuals in this second group had assumed that this final touchdown was the aircraft's initial ground contact.

Nearly all of the witnessers said that smoke began coming from the area around the main tires almost immediately after the aircraft's final touchdown, and continued until the aircraft departed the end of the runway. None of the witnesses reported seeing the reversers deploy, and a few of the witness who were familiar enough with jet aircraft to expect their deployment,

specifically said that the reversers never moved from their fully stowed position. Most of these same witnesses said that more than once during the ground roll, the aircraft seemed to be accelerating instead of slowing down. Some even thought the pilot may have been starting a go-around.

Most witnesses did not recall noting the flap position during the approach and landing. A few said that they were sure that they saw the flaps in the "down" position, and none could specifically remember that they had noticed the flaps not being down.

WRECKAGE AND IMPACT INFORMATION

Both crew members, and all of the interviewed witnesses who were watching the airplane as it came down final, agreed that the aircraft initially touched down almost right on the numbers. The aircraft was observed to bounce one or more times, and ultimately settle on the runway around 2,000 feet from the threshold. At a point 2,250 feet from the approach end of the runway, skid marks were found that were clearly identifiable as the beginning of the skid track generated by the left main tires. The initial mark, which measured approximately 30 feet long, began as a thin black line, and within one foot had spread to a width equal to that of the remainder of the skid track.

About four feet past the end of this skid mark, a series of nine consistently spaced one foot long skid marks began. This series of marks continued for about 60 feet (see pictures #7 and #8).

At the end of these evenly spaced marks, the skid track from the inboard left main tire became a solid black skid deposit which remained approximately the same width from that point to where the aircraft exited the end of the runway. The outboard left main tire also generated a consistently discernable skid mark over this entire distance, but until about the last 1,000 feet of the runway, this tire generated only a very light rubber deposit.

The beginning of the skid mark created by the right main gear tires was not able to be accurately determined because its start was in the midst of an area that contained touchdown and braking tire marks from numerous other aircraft. The spacing and consistency of braking action on the right tires was also not determined for the same reason.

Approximately 15 feet further down the runway from where the left inboard tire skid mark became a solid deposit, the right outboard tire began generating the same type of solid unbroken skid pattern. This skid track also continued until the aircraft departed the runway. In much the same way as the left outboard tire had done, the right inboard tire also generated a faintly discernable but consistent skid mark up until about the last 1,000 to 1,500 feet of the runway. This skid mark also became heavier and more easily discernable on this last portion of the runway surface.

From the point where the first solid skid marks began, until the aircraft exited the end of the runway was approximately 4,290 feet. Once the aircraft departed the runway it skidded about 520 feet across a flat area of very short dry grass and dirt. It then impacted a chain link fence, went through a small ditch, skidded across an asphalt road, and entered a city park. As the aircraft skidded off the road, it went off a three to four foot drop-off and impacted the edge of an asphalt jogging path. At the point where the nose wheel impacted the path, it dug into the asphalt and the nose gear strut collapsed.

An inspection of the aircraft found that the left inboard main tire and the right outboard main tire had worn through, and both had deflated. The left outboard tire deflated as the fuse plug

melted and the right inboard tire remained filled with air. The leading edge slats on both wings and the tip of the left wing were dented, torn and buckled. The right wing leading edge had a tear/puncture of the skin behind the outboard section of the slat. The forward left front of the fuselage, back to and including the wing root fairing, showed impact denting and crushing. The underside of the fuselage near the nose wheel well was dented and crushed where the nose gear had folded back, and the vertical fin had been torn/punctured on its leading edge about three feet above the horizontal stabilizer. The underside wing root flex plates on both sides were buckled, but there was no indication of impact damage to the flaps.

FLIGHT RECORDERS

The aircraft's cockpit voice recorder (CVR) was brought to the NTSB audio laboratory, and a CVR group convened on September 9, 1993 for a readout and transcription of the tapes. The transcript shows that six seconds after the cockpit area microphone (CAM) picked up a thump sound "similar" to an aircraft touching down on the runway, a sound "similar" to the thrust reverser disagreement warning horn was heard over the CAM. The tape shows that the warning horn sound lasted for eight seconds, stopped for one second, came on again for three seconds, stopped for another second, sounded again for two seconds, went off for a third one second period, and then came back on for another two seconds. The horn then remained silent for twelve seconds before making one last blast lasting twelve continuous seconds.

Halfway through the last twelve second blast, a rumbling sound was heard over the CAM that was described as being "similar" to the sound of an aircraft departing the hard surface of the runway. At the same time as the last twelve second horn blast stopped, a sound was heard that was described as being the "sound of impact." A second "impact sound" was head about two seconds after the first, and six seconds after the last horn sound stopped, the rumbling noise stopped in a way that was described as "similar to an aircraft coming to rest."

The tape did not record the use of a complete challenge and response type crew interaction for accomplishing checklist items prior to landing. When this was pointed out to the PIC, he said that they had not yet worked out a method to insure crew coordination or coverage of all items on the checklist.

ADDITIONAL INFORMATION

FLIGHT MANUAL SUPPLEMENT: The Grumman Aerospace Corporation Airplane Flight Manual Supplement for Falcon 10 aircraft equipped with Grumman thrust reversers clearly instructs the pilot to check the TRANS and REV lights prior to moving the reverser throttles into the power range. The Normal Procedures Landing Checklist contains the following step:

Holding the nose wheel firmly on the runway, smoothly pull the reverser throttles to idle, checking the TRANS light ON then off, followed by the green REV lights ON.

This same supplement gives the following cautions in reference to the use of the reversers:

1. Do not apply reverse thrust without the REV light ON indication.

2. Caution is recommended in not moving the T/R levers beyond reverse idle until the REV light illuminates.

2. The audible warning horn will sound only if there is a mismatch between the throttle position (Main/Reverser) and thrust reverser door position. Mismatch positions are:

- Main throttles forward and reverser doors deployed. - Reverser throttles in power range and doors stowed.

According to the Falcon Jet representatives, if the reverser doors do not deploy, the TRANS and REV lights will not illuminate. He further stated that if the pilot fails to notice that the lights did not illuminate, and still moves the reverser throttles into the power position, the engines will accelerate, resulting in the production of forward thrust during the landing roll. He also said that if this happens, the warning horn will sound, providing the pilot with an indication that he should immediately move the reverser throttles back to the idle position. The pilot should then not reselect reverse power unless the TRANS and REV lights illuminate.

LANDING PERFORMANCE: At the request of the IIC, the Chief Pilot of Falcon Jet Corporation calculated the expected stopping distance of this aircraft, without the use of thrust reversers, based upon the conditions present at the time of the accident. According to these calculations, which were made using section six of the Falcon 10 Airplane Flight Manual, the aircraft should have been able to be stopped in approximately 2,800 feet (see attached charts).

REVERSER CIRCUITRY: As part of the investigation the wiring and electrical components common to both reversers where checked and tested. No shorts or discontinuities were found in any of the wiring, circuit breakers or diodes. In addition the following components were tested and showed no malfunctions:

- Main Landing Gear Switch (9G1)
- Ground/Flight Relay (22G)
- Ground/Flight Relay (31G)

During these tests, Printed Circuit Board C.I. 915, which incorporates the function of the K1 Relay, was found to be non- functional. A replacement P.C.B. was installed, and the thrust reversers then deployed normally using hydraulic pressure stored in the Thrust Reverser System Accumulator. During the two test deployments, both the amber TRANS lights and the green REV lights illuminated in their proper sequence. The audible mismatch warning horn was also found to be operating properly.

Additional individuals participating in this investigation:

Beck, Robin C. Boise, ID	Alpers, Gordon D. Western Aircraft Bethpage, NY	Grumman Aircraft
Aubert, Andre Le Bourget, France	Justice, Andre Dassault Falcon Service Le Bourget, France	Dassault Falcon Service

Pilot Information

Certificate:	Commercial	**Age:**	60, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 3 Valid Medical--w/ waivers/lim.	**Last FAA Medical Exam:**	09/20/1991
Occupational Pilot:		**Last Flight Review or Equivalent:**	
Flight Time:	3440 hours (Total, all aircraft), 40 hours (Total, this make and model), 4340 hours (Pilot In Command, all aircraft), 50 hours (Last 90 days, all aircraft), 22 hours (Last 30 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	DASSAULT	**Registration:**	FBYCV
Model/Series:	DA-10 DA-10	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Normal	**Serial Number:**	93
Landing Gear Type:	Retractable - Tricycle	**Seats:**	8
Date/Type of Last Inspection:	08/16/1993, Continuous Airworthiness	**Certified Max Gross Wt.:**	18740 lbs
Time Since Last Inspection:	26 Hours	**Engines:**	2 Turbo Fan
Airframe Total Time:	8607 Hours	**Engine Manufacturer:**	GARRETT
ELT:	Installed, not activated	**Engine Model/Series:**	TFE-731-2-1C
Registered Owner:	BANK NATIONALE PARIS	**Rated Power:**	3230 lbs
Operator:	BAC INC.	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Day
Observation Facility, Elevation:	SUN, 5315 ft msl	**Distance from Accident Site:**	0 Nautical Miles
Observation Time:	1435 MDT	**Direction from Accident Site:**	0°
Lowest Cloud Condition:	Clear / 0 ft agl	**Visibility**	30 Miles
Lowest Ceiling:	None / 0 ft agl	**Visibility (RVR):**	0 ft
Wind Speed/Gusts:	10 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	120°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30 inches Hg	**Temperature/Dew Point:**	20°C / 1°C
Precipitation and Obscuration:			
Departure Point:	GREAT FALLS, MT (GTF)	**Type of Flight Plan Filed:**	IFR
Destination:		**Type of Clearance:**	VFR
Departure Time:	1500 MDT	**Type of Airspace:**	Class E

Airport Information

Airport:	FRIEDMAN MEMORIAL AIRPORT (SUN)	**Runway Surface Type:**	Asphalt
Airport Elevation:	5315 ft	**Runway Surface Condition:**	Dry
Runway Used:	31	**IFR Approach:**	None
Runway Length/Width:	6602 ft / 100 ft	**VFR Approach/Landing:**	Full Stop

Wreckage and Impact Information

Crew Injuries:	2 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	N/A	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 None	**Latitude, Longitude:**	

Administrative Information

Investigator In Charge (IIC):	ORRIN K ANDERSON	**Report Date:**	08/01/1994
Additional Participating Persons:	BOB ROUNTREE; BOISE, ID, GEORGES PELLEGRINI; PARAMUS, NJ, JOHN A BUEHLER; VAN NUYS, CA, MICHAEL D SELLERS; BOISE, ID,		
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/.		