FILE NO. 3-1400

AIRCRAFT ACCIDENT REPORT

INTERNATIONAL BUSINESS MACHINES, INC., GRUMMAN G-1159, N720Q, KLINE, SOUTH CAROLINA JUNE 24, 1974

ADOPTED: MAY 14, 1975

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D. C. 20594
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16. Abstract

At 1645 e.d.t., June 24, 1974, a Grumman model G-1159, N720Q, crashed near Kline, South Carolina. The aircraft, which was owned and operated by International Business Machines, Inc., was on a training flight in visual meteorological conditions. The aircraft made several 360° rolls and then dove into a swampy area. The three crewmembers were killed and the aircraft was destroyed.

The National Transportation Safety Board determines that the probable cause of the accident was an unwanted extension of the ground and flight spoilers, which resulted in a loss of control at an altitude from which recovery could not be made. The ground spoilers probably deployed because of a hot electrical short circuit in the spoiler extend circuitry. Whereas the spoilers probably deployed symmetrically, the left ground spoiler actuator failed in flight and caused a loss of lateral control. The subsequent loss of pitch control was caused by the full nosedown elevator trim tab position and the high aircraft speed.

As a result of this accident, the National Transportation Safety Board made recommendations to the Federal Aviation Administration.

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TABLE OF CONTENTS

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INTERNATIONAL BUSINESS MACHINES, INC
GRUMMAN G-1159, N720Q
KLINE, SOUTH CAROLINA
JUNE 24, 1974

SYNOPSIS

At 1645 e.d.t. on June 24, 1974, a Grumman model G-1159, N720Q, crashed near Kline, South Carolina. The aircraft, which was owned and operated by International Business Machines, Inc., was on a training flight in visual meteorological conditions. The aircraft made several 360° rolls and then dove into a swampy area. The three crewmembers were killed, and the aircraft was destroyed.

The National Transportation Safety Board determines that the probable cause of the accident was an unwanted extension of the ground and flight spoilers, which resulted in a loss of control at an altitude from which recovery could not be made. The ground spoilers probably deployed because of a hot electrical short in the spoiler extend circuitry. Whereas the spoilers probably deployed symmetrically, the left ground spoiler actuator failed in flight and caused a loss of lateral control. The subsequent loss of pitch control was caused by the full nosedm elevator trim tab position and the high aircraft speed.

As a result of this accident, the National Transportation Safety Board made recommendations to the Federal Aviation Administration.

1. INVESTIGATION

1.1 History of the Flight

At 1520, 1/ June 24, 1974, a Grumman model G-1159, N720Q departed Savannah, Georgia, on a local training flight. The aircraft, which was owned and operated by International Business Machines, Inc., was under the command of a Grumman instructor pilot and the flight was intended to qualify an IBM pilot in the G-1159. At 1533, the instructor pilot cancelled his instrument flight plan; that was the last radio contact with the flight.

1/ All times herein are eastern daylight based on the 24-hour clock.

The training syllabus required airwork between 10,000 and 18,000 feet. 2/ The last portion of the airwork included low-speed flight man-ewers which included approach to a stall, stall barrier demnstrations, slow flight, unusual attitudes, simulated landings, and flight in the manual flight control condition. The flight was to end after a series of full-stop landings.

About 1645, ground witnesses near Kline, South Carolina, saw the aircraft in near-level flight, headed south-southwest and close to the base of clouds. Some witnesses saw the aircraft complete several rolls to the right, stop rolling in a nose low attitude, and dive into the ground at an angle of about 45° below the horizon. Several witnesses reported an explosive sound while the aircraft was rolling and saw smoke trailing behind the aircraft.

The impact area was at latitude 33°6.2'N and longitude 80°22.8'W. The ground elevation was 272 feet. The accident occurred in daylight.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	3	0	0
Nonfatal	0	0	0
None	0	0	

1.3 Damage to the Aircraft

The aircraft was destroyed.

1.4 Other Damage

None.

1.5 Crew Information

The pilots were certificated for the flight in accordance with current regulations. (See Appendix B.)

1.6 Aircraft Information

The aircraft was certificated and maintained in accordance with Federal Aviation Administration (FAA) regulations. The aircraft's center of gravity (c.g.) and the gross weight were within limits at the time of the accident. The aircraft had 20,000 pounds of Jet A fuel aboard at takeoff. (See Appendix C.)

2. All altitudes and elevations are mean sea level unless specified.

1.7 Meteorological Information

The flightcrew was briefed on the weather by Savannah Flight Service Station personnel.

The base of the scattered-to-broken clouds in the accident area was about 4,000 feet above the ground and the tops were about 12,000 feet. The visibility below the clouds was more than 3 miles. There was no severe weather in the accident area, and radar weather observations showed no weather echoes in the area of the accident.

The official weather-observing facilities near the accident site were reporting visual meteorological conditions.

The accident occurred in partial sunlight.

1.8 Aids to Navigation

Not applicable.

1.9 Communications

Not applicable.

1.10 Aerodrome and Ground Facilities

Not applicable.

1.11 Flight Recorders

Flight data and cockpit voice recorders were not installed nor were they required.

1.12 Aircraft Wreckage

The aircraft crashed in an uninhabited area. At impact, the aircraft's attitude was about 45° nosedown and 30° right wing dm . The impact crater was 73 feet wide, 55 feet long, and 10 feet deep. The aircraft fragmented, and there was no assemblage to the aircraft structure. Southwest of the impact crater, wreckage was scattered over an area 1,200 feet long and 800 feet wide. (See Appendix D.) The readings and settings of the various cockpit instruments, levers, and control devices could not be determined. All major airframe components were identified. The fractures observed were typical of those caused by overload failure. There was no evidence of in-flight separation of any structural component. There was no evidence of in-flight fire, explosion, or bird strike.

The engines showed no evidence of pre-impact failure or malfunction. Most of the engine compressor blades broke away opposite the direction of rotation with corresponding damage to the compressor case vanes. Both engines ingested dirt and debris, some of which was found as far rearward as the turbines. Fractures on both high-pressure compressor shafts were typical of those caused by high torsional stresses. Both engine reversers appeared to have been stowed.

The wing flap jackscrews were retracted. The horizontal stabilizer position, which is a function of the wing flap setting, corresponded to flaps "UP." The landing gear was retracted. The nickel-cadmium batteries showed no evidence of fire or overheat damage. The recovered generators, alternators, inverters, and rectifiers showed no evidence of overheat damage, fire, or electrical arcing. The recovered hydraulic components showed no evidence of contamination except for sand and mud found in the broken fittings.

There were numerous fractures on the flight control surfaces; major portions of all the surfaces were accounted for when the surfaces were assembled in a two-dimensional layout. Examination of the flight control system components indicated the following:

(1) The pre-impact position of the flight control manual reversion valve could not be determined.

(2) The leading edges of the spoiler panels, except for the left ground spoiler panel, were bent d m and aft. The leading edge of the left ground spoiler panel was bent up and aft.

(3) Impact marks equivalent to 55° spoiler extension were found on portions of both inboard flight spoilers. Similar marks equivalent to 35° and 37° extension were found on portions of the left outboard and right outboard flight spoilers, respectively. There were no similar marks on the left ground spoiler. Marks on the right ground spoiler indicated that the panel rotated about 70° during impact. The maximum normal spoiler extension angle is 55°.

(4) The left flight spoiler actuator was found with the piston extended 3 7/32 inches. The right flight spoiler actuator was found with the piston extended 3 3/8 inches. The piston extensions are equivalent to flight spoiler deflections of 24°.

(5) The left ground spoiler actuator was found with the piston extended 7/16 inch, equivalent to a 6.5° deflection. This piston was also bent equivalent to a 30° deflection. The right ground spoiler actuator was found with the piston extended 2 1/16 inches, equivalent to a 43° deflection.

(6) The ground spoiler control valve was separated from its mount, and dents, cuts, and abrasions were visible on all parts of the

valve. The valve was broken away from hydraulic and electrical connections.

(7) The rudder actuator was recovered in three pieces. The manifold and control valve portions were broken open, and the cylinder which contained the piston was broken open at the midassembly junction point. The piston was fully retracted to a position corresponding to full right rudder.

(8) The piston on the left aileron actuator was extended eleven-sixteenths of an inch, equivalent to an 8° trailing-edge-up (left wing down) deflection. The right aileron actuator was not recovered.

(9) The piston on the elevator actuator was extended 1 5/32 inches, equivalent to a 3° trailing-edge-up (aircraft noseup) deflection.

(10) The right elevator trim actuator was not recovered. The actuator drum on the left trim actuator was found jammed in a position corresponding to 8.5° nosedown trim. The elevator trim spool from the cockpit was jammed in the 8° nosedown trim position. The aileron tab actuator was jammed in the 9.5° left wing down position. The rudder trim actuator was jammed in the 0.75° left rudder position.

(11) The stall barrier actuator was intact and attached to some of the mounting structure; the piston was extended seventeen thirty-seconds of an inch. The piston mved freely, and the unit operated normally when tested.

1.13 Medical and Pathological Information

Insufficient tissue was found for autopsy or toxicological study.

1.14 Fire

Witnesses saw a ball of fire over the crash site just after inpact, but the fire did not continue to ground level. Brush in an area about 400 feet beyond the initial impact crater caught fire. However, no fire-fighting equipment was required at the wreckage site.

1.15 Survival Aspects

This was not a survivable accident.

1.16 Tests and Research

The left ground spoiler actuator was X-rayed. The X-ray indicated that the piston was unlocked and slightly extended. Hydraulic pressure was applied at 104 lb/in^2 to extend the actuator and the piston moved. When 81-lb/in^2 hydraulic pressure was applied, the unit retracted to the 5/32-inch position, but it would not retract fully nor would it lock. Another actuator unit taken from stock for comparison retracted and locked when an hydraulic pressure of 63 lb/in^2 was applied.

When the damaged actuator was disassembled, a bend was found in the piston shaft. The piston shaft deflection was measured to be 0.011 inch at the spoiler and attach point. There was no deflection of the piston shaft 1.4 inches from the spoiler end. Just beyond that point, the shaft was deflected 0.005 in the opposite direction. After the piston shaft deflection was ground away, the piston moved into the locked position. A 400-lb/in^2 hydraulic unlock and extension force was applied to the unit, but the piston remained in the locked position.

The right ground spoiler actuator moved into the locked position when an hydraulic force of 63 lb/in^2 was applied to the unit. When the actuator was disassembled there was no evidence of malfunction.

The ground spoiler control valve was tested and X-rayed. It was in the de-energized or spoiler-down position. The pilot piston in the valve body was broken. Metallurgical examination of the fracture surfaces shaved no brinelling or wear pattern. The broken pilot piston was installed in another control valve and tested. The control valve, with the broken pilot piston installed, operated for 800 cycles with no malfunctions.

The flow divider was X-rayed, and the piston shuttle was seen positioned to one side. When the unit was tapped, the piston would not move. When hydraulic fluid was poured into the unit, the piston became free. The unit was then flow checked, and it operated normally. When the unit was disassembled, the piston shuttle moved freely within the cylinder.

The hydraulic integrity of the rudder boost actuator was destroyed. The actuator, control valve, and manifold were recovered separately, and all these components had been broken open. A mark on the end of the cylinder was compatible with piston travel to the full right rudder position.

1.16.1 Aerodynamics

The airplane manufacturer prepared digital computer simulations of the clean configuration (landing gear and flaps up) and the landing configuration (gear and flaps down). Studies of the clean configuration were conducted to determine the potential significance of roll coupling during 360° rolls, the lateral control requirements caused by asymmetric deployment of ground and flight spoiler panels, the dynamic characteristics of control forces associated with symmetric deployment of ground and flight spoilers, and control column forces resulting from an electrical runaway of the elevator trim tab. The significant findings for the clean configuration were:

(1) There was no evidence of roll coupling instabilities. Asymmetric spoiler configurations can be controlled by 60 lbs. of wheel force, or less, except when all three spoiler panels on one side are extended 55°.

(2) With ground and flight spoilers extended 55°, asymmetric spoiler configurations were not controllable.

(3) The column control forces required for control after symmetric deployment of all spoiler panels to 55° are low.

(4) When all of the spoiler panels are deployed, full electric nosedown trim (8°) **is** not required.

(5) Runaway of the electric elevator trim to the full nosedown position, with powered flight controls, would require column forces ranging from 50 lbs. at 150 kn to 560 lbs. at 350 kn to maintain pitch control.

1.16.2 Wind Tunnel Test

Following a review of the foregoing, the bases of the aerodynamic data were reviewed. These data were based on low speed aerodynamic characteristics extrapolated to high speeds. In addition, the spoiler configuration of the manufactured aircraft differed from the configuration on the original wind tunnel test model. Consequently, the manufacturer, in coordination with the Safety Board and the Parties to the Investigation, tested a 1/15 scale Gulfstream II high speed model with the current spoiler configuration, in a transonic wind tunnel. Tests were performed at Mach numbers from 0.60 to 0.85 to supplement the low-speed aerodynamic data and to determine the relationship, if any, of the associated high-speed aerodynamic data characteristics to the operational circumstances of the accident. The specific test objectives were to determine the high-speed pitching moment increments caused by deployment of ground and flight spoilers and the aerodynamic effect of spoiler deflection on engine inlet airflow. The wind tunnel results disclosed no rational relationship between the observed high-speed aerodynamic characteristics and the accident circumstances.

Aerodynamic pitching moments caused by spoiler deployment were relatively small throughout the Mach number range to 0.80. The maximum operating speed for the airplane is 0.72 Mach. Deployment of the flight spoilers resulted in a small noseup pitching moment. Deployment of the ground spoilers resulted in a small nosedown pitching moment. The net effect of deploying both ground and flight spoilers reduced the incremental pitching effect to approximately zero or very slightly nosedown.

No aerodynamic trim requirement for full nosedown elevator trim was found.

The test data indicated that the engine inlet total pressure recovery remained essentially undisturbed until the inlet entered the stalled wing wake or flow-separated shock wave area.

A review of the flight training syllabus suggested that the aircraft may have been in the landing or approach configuration just before the accident occurred. The manufacturer therefore conducted an additional investigation of the airplane's transient response characteristics resulting from inadvertent ground spoiler deployment at speeds appropriate to this configuration. This investigation was also supplemented by further low-speed wind tunnel tests to provide aerodynamic data compatible with the current Gulfstream 1159 spoiler and landing flap geometry. The following simulated pilot responses were used: stick free, stick fixed, and stick pusher activated.

Unwanted ground spoiler extension produced increases in angle of attack ranging from 3.5° to 6.5° above the trimmed angle of attack. A maximum g loss of 0.8 g occurred, depending on the airspeed and the recovery technique simulated. Initial aircraft response was a plunging motion followed by a pitchover to a shallow dive attitude. The aircraft accelerated and recovered.

With the stick pusher operable, the peak angle of attack attained following a ground spoiler deployment was 15.5°. For the worst case, stick free, stick pusher inoperable, the peak transient angle of attack reached 19° at 100 kn calibrated airspeed. In all cases, the angle of attack reached its transient peak and then decreased to a level below 16.5°, the stall barrier angle of attack limit. There was no tendency toward deep stall and in all cases, an operable stick pusher prevented stall penetration.

The aircraft would experience a transient stall following ground spoiler deployment if the airspeed was within 8 kn of the normal stall speed. However, this occurred only if the stick pusher was overriden by about 100 pounds of pull force on the control column. Zero to negative g could result from the combined pusher input and excessive nosedown pilot input.

Elevator control effectiveness remained high through the stall angle of attack range, and pilot control techniques following ground spoiler deployment, including improper ones, would not result in a deep stall.

The manufacturer's pilots agreed that the normal reaction to an inadvertent ground spoiler deployment would be to push the nose down, add power, retract the landing gear and flaps, if extended, and increase speed. This maneuver was examined starting with normal approach speed and assuming a range of pilot control inputs, with the maneuver terminated above 300 kn. The time to reach 300 kn varied between ¼ minute to slightly over ½ minute. The altitude loss in this maneuver was about 4,500 feet.

The dynamic response characteristics for the clean configuration resulting from a ground spoiler panel failure were also considered at this time. The failure was simulated above 300 kn at a 20° descent angle with 60 pounds (full lateral control) wheel force being applied at the time of the failure. The speed brake handle was pulled and 250 pounds of pull force was applied to the control column. A sharp roll occurred opposite to the failed spoiler, at a rate of about 35°/sec, causing further increases in airspeed and dive angle. Deployment of the speed brakes helped stop the roll and facilitated a dive recovery. Each 360° roll resulted in an altitude loss of 3,500 to 4,500 feet and, in addition, 3,500 feet was required to recover from the ensuing dive.

Cumulative altitude loss subsequent to ground spoiler deployment -- including time to retract the landing gear and flaps, accelerate the engines, increasing the speed to 300 kn, and rolling one or two times after asymmetric ground spoiler failure, speed brake deployment and recovery from a dive -- was between 11,000 and 16,000 feet.

A correlation of wind tunnel and flight test trim elevator and tab settings indicated that 6° to 7° aircraft nose down tab settings were normal for zero stick force trim at higher airspeeds with the flight spoilers deployed. Assuming the spoiler panel and trim tab deflection found at inpact, it was determined that the pitch trim required a control column force of 55 pounds at 150 kn to 240 pounds at 450 kn. The lateral trim setting required less than 1° of aileron.

1.17 Other Information

1.17.1 Flight Control System

The elevators, ailerons, flight spoilers, and rudder are hydraulically powered and the pilot, through mechanical linkage, pushrods, and cables, causes hydraulic actuators to move the control surfaces. In the event of hydraulic failure or use of the flight power shutoff valve, the flight spoilers become inoperative and the elevator, ailerons, and the rudder revert to manual operation. The empennage is protected against structural damage by a system that limits rudder travel when higher airspeeds increase the airloads on the rudder.

1.17.2 Trim System

Manual trim control is provided about all three axes. The elevator trim tab limits are 20° trailing edge down (aircraft noseup) and 10° trailing edge up (aircraft nosedown). In addition to the manual longitudinal trim, there is an electrical trim tab capability of 18° trailing edge down and 8° trailing edge up. The aileron manual trim tab limits are 15° trailing edge up (wing down) and 15° trailing edge down (wing up). The rudder trim tab limits are 7.5° left and right. An electric trim runaway can be stopped by depressing the autopilot disconnect button and moving the Mach trim switch to (manual) or by holding the manual trim wheel with a 10- to 20-lb. force and moving the Mach trim switch to "manual."

1.17.3 Stall Protection

Stall protection is provided by a stall-warning stick shaker to warn of impending stalls and a stick pusher to reduce the angle of attack. The stick pusher is activated at an angle of attack of 16.50 and disengages when the angle of attack is decreased 1°. The pusher will also be activated if the angle of attack exceeds 14.5° and the angle of attack increased at a rate exceeding 2°/sec. A malfunction of the stick pusher can be overcome if the pilot applies control pressure.

1.17.4 Spoilers

The spoiler system consists of three hydraulically operated panels on each wing trailing edge. The *two* outboard panels on each wing serve as flight spoilers and extend upward to a maximum of 43° in conjunction with aileron movement. The flight spoilers are also used as speedbrakes and in this mode can be extended symmetrically through 43°. The speedbrake function and the flight spoiler function can be used simultaneously. With the speedbrakes fully deployed to 43°, the spoiler responds to lateral system commands by deploying to a maximum of 55°.

The inboard spoiler panel on each wing is used as the ground spoiler. When armed, the ground spoiler extends to the 55° position at touchdown. Extension of the ground spoilers automatically extends the flight spoilers to 55°. The ground spoilers are not intended for in-flight use.

The ground spoiler system includes a solenoid-operated valve to control deployment of the spoilers and is designed so that the following conditions must be met to energize the solenoid:

(1) Power must be on the main DC bus;

(2) the main landing gear must be on the ground and 'weight must be on the gear to close one or more landing gear switches;

(3) the ground spoiler switch must be "armed"; and

(4) both power levers must be in "ground idle."

There is no visual or aural device in the cockpit to indicate to the pilot that the ground spoilers have deployed. A "no ground spoiler" light on the instrument panel illuminates if the solenoid energizing conditions are met and if the spoilers do not deploy after landing. The ground spoiler panels are not visible from the cockpit.

The manufacturer's data indicate that, theoretically, the ground spoilers can be extended to a maximum of 55° at air speeds up to about 150 kn. At higher speeds, ground spoiler extension is force limited so that at 300 kn the spoilers extend only about 15°. If the spoilers extend to 55°, a check valve keeps them extended, and they do not blow down. However, either a hydraulic line failure, structural failure, or both would be expected because of airloads at aircraft velocities in excess of 300 kn.

When the ground spoilers are extended on the ground, the flight spoilers begin to extend after the ground spoilers have extended about 10°. All the spoiler panels will extend to a maximum of 55°. There is no hydraulic pressure available to extend the flight spoilers when the airplane is being operated in the manual flight control mode. During manual operation, extension of the ground spoilers would not cause the flight spoilers to extend. Theoretically, the operation of the spoiler system is the same if the ground spoilers extended in flight.

1.17.5 Manual Reversion Malfunction

Another operator of the Grumman G-1159 reported an unwanted lateral roll which occurred when the flight power shutoff valve was activated with the speed brakes extended. If the power shutoff valve is operated when the speed brakes are extended, hydraulic pressure to the speed brake actuators dumps. The airload on the spoiler panels causes them to blow down. However, they may not blow down evenly because of varying leakage rates past the actuator valve slides. A differential extension of the flight spoilers would cause the aircraft to roll. Any induced rolling motion can be countered by opposite aileron; but in manual control, the aileron roll capability is reduced and increased pilot effort is required.

2. ANALYSIS AND CONCLUSIONS

2.1 Analysis

The crewmembers were qualified and properly certified to conduct the flight. The aircraft was properly certificated and maintained in accordance with existing regulations. The crew's medical records contained no evidence of any incapacitating condition. The aircraft weight and c.g. were within limits throughout the flight. There was no evidence of in-flight separation or failure of any control surface or major structural component of the aircraft. There was no evidence of in-flight fire, explosion, or bird strike. The engines were operating at a relatively high power setting at impact, and there was no evidence of preimpact malfunction or distress. The nickel-cadmium batteries showed no evidence of thermal runaway or other malfunction. The recovered components of the electrical system and the hydraulic system displayed no evidence of preimpact malfunction or failure. There was no evidence of significant turbulence or icing in the accident area.

Whereas the preimpact integrity of the flight control system could not be determined, the maneuvers of the aircraft indicated that the flightcrew had at least partial control of the aircraft. Therefore, the thrust of the accident inquiry was to attempt to determine what affected the flightpath of the aircraft and caused it to dive into the ground at. a steep angle and at a high airspeed.

At impact the aircraft was about 45° nosedown and about 30° right wing down. Both engines were developing high power and the landing gear and wing flaps were retracted. The flight controls were intact and functional. The trim settings indicated that the pilots had trimmed the aircraft full nosedown by use of the electrical trim switch and left wing down by use of the manual aileron trim system. The rudder trim was in a position appropriate for normal flight. In addition to the elevator and aileron trim conditions, other significant findings were the position of the ground spoilers and the flight spoilers.

Calculations, based on the normal training schedule and the elapsed time allotted to each maneuver sequence, indicate that law-speed maneuvers were probably being conducted about the time the accident occurred. The instructor should have been demonstrating low-speed flight characteristics, simulated landings, stall barrier operation, or approaches to stalls. This work would normally have been accomplished at altitudes between 10,000 and 18,000 feet at airspeeds between Vref and 170 kn.

The evidence clearly indicates that the ground spoilers and the flight spoilers were extended at impact. Although the left ground spoiler was extended only about 6°, it was unlocked. This fact indicates that it had extended hydraulically and was subsequently blown down to a floating position as a result of a failure in the spoiler mechanism -- the spoiler actuator piston fractured. With the spoiler panel extended to its maximum deflection of 55°, an airspeed of more than 300 kn. would be required to cause a buckling failure like the one found on the actuator.

The ground spoiler system is designed to be operated only on the ground. In this case, however, the investigation disclosed that the ground spoilers extended in flight. The ground spoilers could have been unlocked and extended in flight if something struck the control valve in the wheelwell and jarred the valve into the extended position, or if an electrical malfunction caused the actuator to extend. The investigation disclosed no evidence that anything struck the control valve in flight. Ground impact apparently caused the external damage to the actuator body.

However, a hot electrical short is the only factor or occurrence that could negate the normal system interlock requirements for ground-spoiler operation by bypassing the various electrical switches installed in the system. The Safety Board believes that a hot electrical short probably caused the unwanted extension of the ground spoiler panels and, through the system's design, the flight spoilers as well. Although the ground spoilers were found unlocked and extended at impact, their exact position could not be determined. The inboard and outboard flight spoilers on each wing were extended between 24° and 55°, and 24° and 35°, respectively.

The aerodynamic studies conducted after this accident indicate that if the landing gear and wing flaps are retracted, the pitch trim forces which result from an unwanted spoiler deployment can be controlled easily. If ground and flight spoilers are deployed, the incremental pitching effect will be reduced to almost zero or slightly nosedown. As long as the engines operate and there is sufficient altitude, the aircraft can be accelerated to an airspeed that will allow a pilot to maintain level flight. Under some conditions, there would be an excess of thrust, and the aircraft could climb to higher altitudes with all the spoiler panels extended.

Deployment of the ground spoilers in flight at low speeds with the landing gear and wing flaps extended could cause a temporary loss of control. Normal reflexive action in such an occurrence would be to increase power, retract the gear and flaps, accelerate the aircraft, and attempt to obtain straight and level flight. The pilot could not know that the ground spoilers had been deployed, but would probably deduce from his previous experience that the flight spoilers were extended. He might, under these circumstances, attempt to retract the spoiler panels by cycling the flight spoiler control handle in the cockpit or by activating the flight power shutoff valve. Neither of these actions would have had any effect on the extended ground spoilers. Turning off the flight control power with the flight spoilers extended could have caused an unwanted rolling condition, which may have prompted the pilot to restore flight control power and to extend the flight spoilers asymmetrically. If hydraulic pressure were removed while the flight spoiler panels were extended, they would probably blow down at different rates because of the different internal leakage rates in the actuators. This situation has caused unwanted rolls in the past. Effective lateral control could be regained immediately by reactivating the hydraulic control system. Alternately, any roll input caused by asyuunetric flight spoiler deflection would stop when all the panels returned to the faired position, even with the hydraulic flight control system inoperative.

Based on the destruction of the aircraft, the Safety Board has estimated that the aircraft velocity at impact was in excess of 300 kn. The velocity required to fail the spoiler actuator was calculated to be above 300 kn. Witnesses' observations of the aircraft suggest that the aircraft was proceeding essentially level below the clouds when the consecutive rolls began. Although deactivation of the flight control power system with the flight spoilers extended could have resulted in a transient roll input, the consecutive rolls observed were most likely caused by failure of the ground spoiler actuator or hydraulic line and the consequent retraction of all the spoiler panels on the left wing of the aircraft. This condition would have caused the aircraft to roll rapidly to the right. In order for the actuator to fail, the aircraft must attain high speed and the spoilers must be extended to a large angle. Large asymmetric spoiler extensions, with their strong rolling inputs, cannot be controlled at high speed in either the powered or manual modes of flight control. In order to regain roll control under these circumstances, the aircraft would have to be decelerated substantially. To regain speed brake symmetry, if the aircraft was in the powered mode, the pilot could revert to the manual mode to blow the speed brake down or he could extend the speed brakes through use of the cockpit control.

It is possible that excessive nosedown trim was inadvertently applied during the attempted recovery from the rolls. It is also possible that one or both of the pilots were injured or disabled through the rolls and not able to assist in regaining control of the aircraft.

2.2 Conclusions

(a) Findings

1. The only evidence of an aircraft malfunction was the extended position of the ground spoiler panels at impact.

2. The elevator trim tab position was full nosedown to the electrical trim stop. The aileron manual trim was set 9.5° left wing down.

3. The landing gear and the wing flaps were retracted at impact.

4. The right and left ground spoilers were unlocked and extended in flight. Their exact position could not be determined. The inboard and outboard flight spoilers on each wing were extended between 24° and 55°, and 24° and 35°, respectively.

5. The left ground spoiler panel actuator was fractured, probably by high airloads.

6. The cause of the unwanted ground spoiler extension was probably a hot electrical short which bypassed the four ground spoiler interlocks installed in the system.

7. The extension of the ground spoilers caused the flight spoilers to extend.

8. This unwanted extension of the spoilers occurred at a relatively low airspeed and when the aircraft was in a landing approach configuration.

9. The unwanted extension of the spoilers resulted in an upset and a rapid loss of altitude.

10. The pilots probably attempted recovery from this upset by retracting the gear and flaps, increasing power, and accelerating the airplane to a speed of more than 300 kn.

11. The resulting high airloads failed the actuator rod of the left ground spoiler which resulted in lateral asymmetry and high rolling moments.

12. During their attempts to recover from the ensuing rolls, the pilots may have inadvertently activated the electrical elevator trim tab to the full nosedown position.

13. The pilots were unable to maintain pitch control and had insufficient altitude in which to recover from the ensuing dive.

(b) Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was an unwanted extension of the ground and flight spoilers, which resulted in a loss of control at an altitude from which recovery could not be made. The ground spoilers probably deployed because of a hot electrical short in the spoiler extend circuitry. Whereas the spoilers probably deployed symmetrically, the left ground spoiler actuator failed in flight and caused a loss of lateral control. The subsequent logs of pitch control was caused by the full nosedown elevator trim tab position and the high aircraft speed.

3. RECOMMENDATIONS

On August 14, 1974, the Safety Board submitted Safety Recommendation A-74-61 to the Administrator, Federal Aviation Administration. A copy of the recommendation and the FAA's response is contained in Appendix E.

The Grumman American Aviation Corporation has forwarded proposed changes in the longitudinal trim and ground spoiler systems to the Federal Aviation Administration for approval. The FAA has approved a change to the longitudinal trim system which has been published as Aircraft Service Change 186. The FAA has also issued a Notice of Proposed Rule Making in the Federal Register (Volume 40, Number 41, Page 8568, dated February 28, 1975) to require mandatory compliance with Aircraft Service Change No. 186. Another modification of the longitudinal system replacement of the single element trim switch with a double element switch is being prepared for FAA consideration.

A proposal to change the flight power shutoff system is being prepared and completion is expected by Grumman by September 1975. Upon completion, this proposal will be forwarded to the FAA for approval.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JOHN H. REED
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

/s/ WILLIAM R. HALEY
Member

May 14, 1975

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

At 2000 e.d.t. on June 24, 1974, the National Transportation Safety Board's Miami, Florida, Field Office was notified of the accident by the Federal Aviation Administration. Working groups were established for operations, witnesses, system, structures, and powerplants. Parties to the investigation included the Federal Aviation Administration, Grumman American Aviation Corporation, International Business Machines, Inc., Rolls-Royce Aero Engines, Inc., and the National Business Aircraft Association.

2. Hearing

A public hearing was not held.

APPENDIX B

CREW INFORMATION

Instructor Pilot Thomas W. O'Brien

Instructor Pilot Thomas W. O'Brien, 48, was a Grumman employee. He was hired March 1, 1967, as supervisor of flight training. He held Airline Transport Certificate 530492 for airplanes, multiengine land with ratings in the DA-20, CV 240/340/440, DC-3/4/6/7 and G-159/1159 with commercial privileges in airplanes, single engine land. His records shaved approximately 14,500 flight-hours, 4,000 hours of which were in the G-1159. About 155 hours were flown in the past 90 days. His first-class medical certificate, dated June 19, 1974, showed no limitations.

Type Rating Candidate Paul F. Whitman

Type rating candidate Paul F. Whitman, 40, was an IBM employee. He was hired by the operator on May 24, 1965. He held Airline Transport Certificate 1627058 for airplanes, multiengine land with ratings in the FH-27/227 and N-265 with cownercial privileges in airplanes, single engine land and the DC-6/7. He had been flying the N-265 Sabreliner as pilot-in-command. His records showed 7,801 flight-hours, 151 hours of which had been flown in the past 90 days; 265 hours were as copilot in the G-1159. His first-class medical certificate, dated February 13, 1974, had the limitation: "Wear corrective lenses while exercising the privileges of his airman certificate." He had completed Flight Safety Incorporation's G-1159 ground and flight simulator courses on two occasions.

Copilot Candidate James M. Murphy

Copilot candidate James M. Murphy, 29, was an employee of IBM, and hired by the operator on April 28, 1969. He held Airline Transport Certificate 2031939 for airplanes, multiengine land with a rating in the N-265 and cownercial privileges in airplanes, single engine land/multiengine sea. His records showed 2,390 flight hours, 117 hours of which had been flown in the past 90 days and 4 hours of which had been flown as copilot in the G-1159. His first-class medical certificate, dated March 13, 1974, showed no limitations. He had completed Flight Safety Incorporation's G-1159 ground and flight simulator course.

Each of the pilots had adequate crew rest before beginning the flight.

APPENDIX C

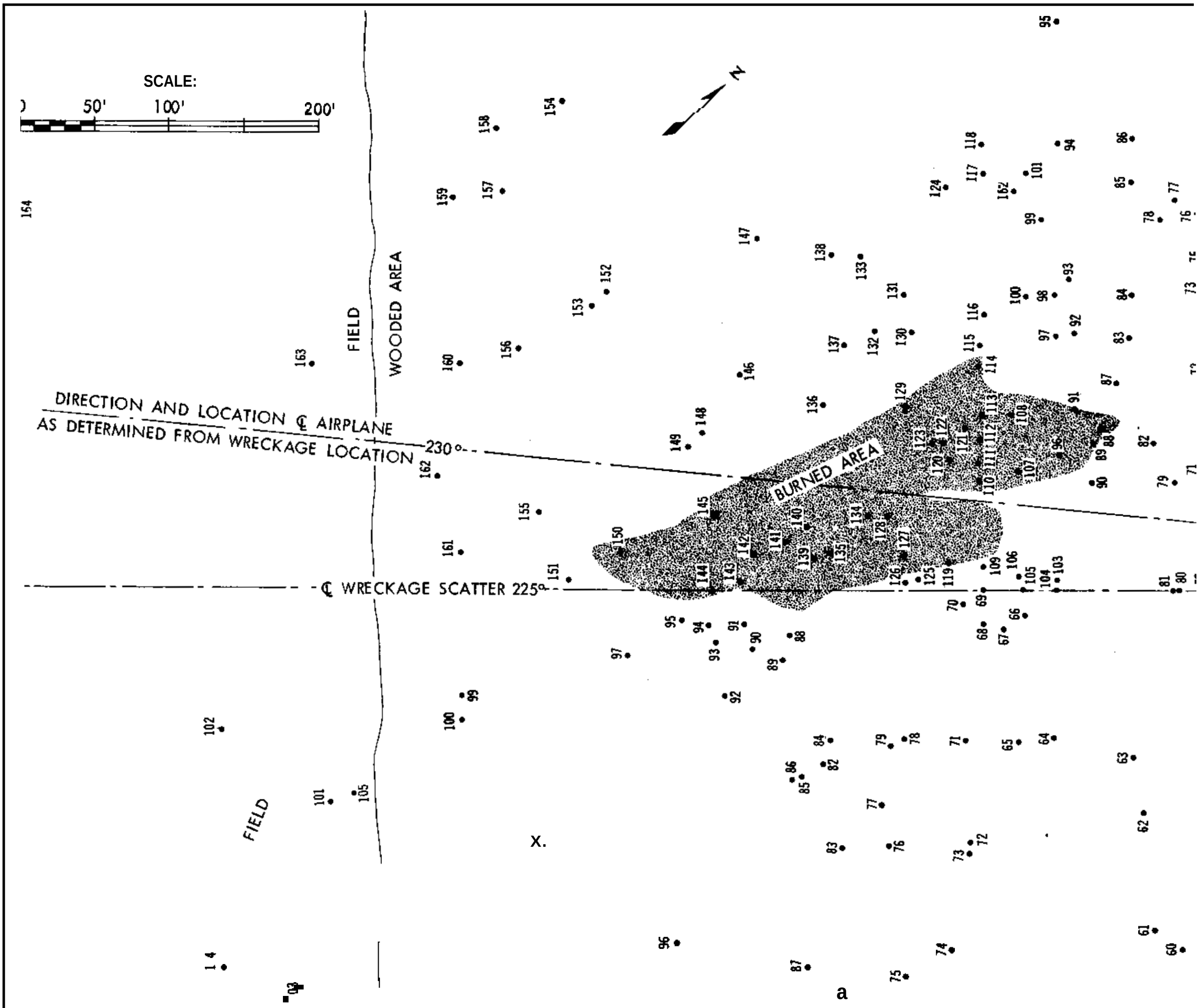
AIRCRAFT INFORMATION

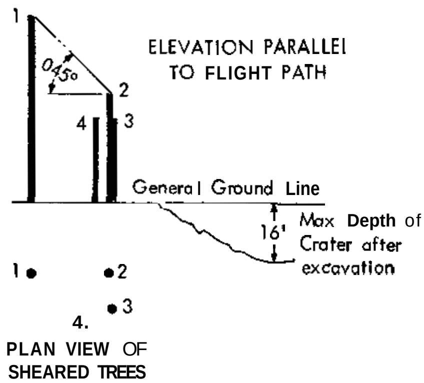
The aircraft was owned and operated by International Business Machines, Inc. N720Q was a Grumman G-1159, serial No. 58, manufactured in June, 1969, and delivered to IBM, which used it in corporate flying. The aircraft had accumulated 3,224 hours in service.

The aircraft was maintained in accordance with an approved computerized maintenance program. The last inspection, No. 4 check, was completed June 14, 1973, at an aircraft time of 3,193 hours.

The aircraft was equipped with two Rolls-Royce SPEY Mark 511-8 turbojet engines. The No. 1 engine had 3,690 hours total time with 1,242 hours since overhaul. The No. 2 engine had 3,663 hours total time with 665 hours since last overhaul.

All the applicable airworthiness directives had been incorporated on the aircraft and engines except AD 74-08-09 which required lavatory fire prevention action. Service Change 98 which authorized modification to the ground spoiler system had not been incorporated in the aircraft. This service change provided redundant ground leg switching of the ground spoiler solenoid hydraulic control valve by mdifying the wiring to the control valve. This service change was not mandatory.

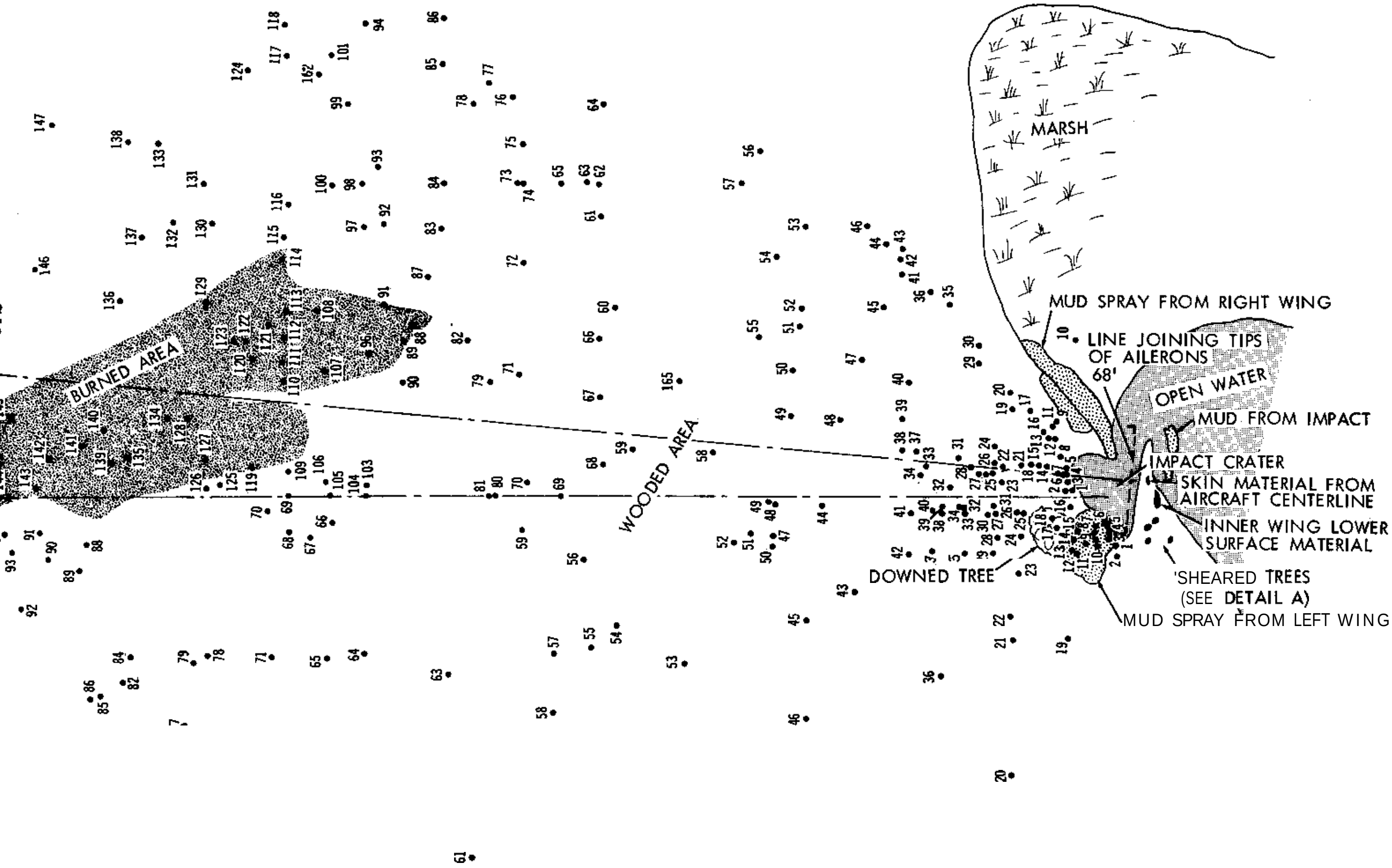




DETAIL A

PARTS LOCATED BELOW WRECKAGE SCATTER ℄

1 TGT JUNCTION BOX
2 PIECE OF WING PLANK
3 OIL SCAVENGER FILTER
4 ENGINE HP FUEL PUMP
5 ELEVATOR TRIM TAB
6 ENGINE OIL TANK
7 HP COMPRESSOR CASE
8 FLAP TRACK
9 REAR BEAM AILERON
10 LH WING TIP
11 REAR BEAM ATTACH FITTING
12 COWLING ATTACH FITTING
13 LP FUEL FILTER ELEMENT
14 LH ENGINE THRUST REVERSER OUTTER TANG
15 WING TO FUSELAGE ATTACH FITTING
16 PRESSURE FUEL SHUTOFF VALVE
17 ELEVATOR BALANCE TIP
18 ENGINE COWL
19 HP SHUTOFF COCK AND ENGINE PART
20 OXYGEN BOTTLE AND ENGINE PART
21 ENGINE PART
22 ENGINE PART
23 THRUST REVERSER ACTUATOR DOOR LINKAGE
24 ENGINE COWL
25 CENTER OVERHEAD PANEL
26 COLLINS TYPE 641D-1
27 INLET GUIDE VANE AND LPI DISC
28 ENGINE FIX COWL EDGE AND CONTROL SURFACE
29 ENGINE GEAR BOX GEAR SHAFT
30 PART OF ENGINE FUEL CONTROL
31 CABIN SEAT TRACK
32 AFT PYLON
33 SERVING TRAY
34 ENGINE COWL
35 CONTROL WHEEL-PIECE
36 LH FUEL FLOW REGULATOR, DUCT
37 PART OF ENGINE MOUNT
38 FUEL SYSTEM PART
39 FLEX HOSE
40 ENGINE OIL FILTER
41 JUNCTION BOX, REVERSE CURRENT CUTOUT RELAY, AND ENGINE MOUNT
42 ELEVATOR BALANCE WEIGHTS
43 PART OF ENGINE COWL
44 FIRE EXTINGISHER
45 SIDE WINDOW-COCKPIT
46 TUBE ENGINE BURNER CANS, AND ENGINE PART
47 BAGGAGE DOOR REEL, AND ELEVATOR BALANCE WEIGHTS
48 WATER FIRE EXTINGUISHER
49 ENGINE PART
50 NOSE GEAR LOWER SCISSOR
51 COWL AND INERTIA REEL
52 UPHOLSTERY
53 ENGINE DUCT
54 A
55 O
56 O
57 H
58 E
59 U
60 S
61 E
62 E
63 E
64 P
65 R
66 R
67 C
68 L
69 C
70 R
71 R
72 E
73 R
74 E
75 E
76 P
77 El
78 R
79 A
80 E
81 G



8.

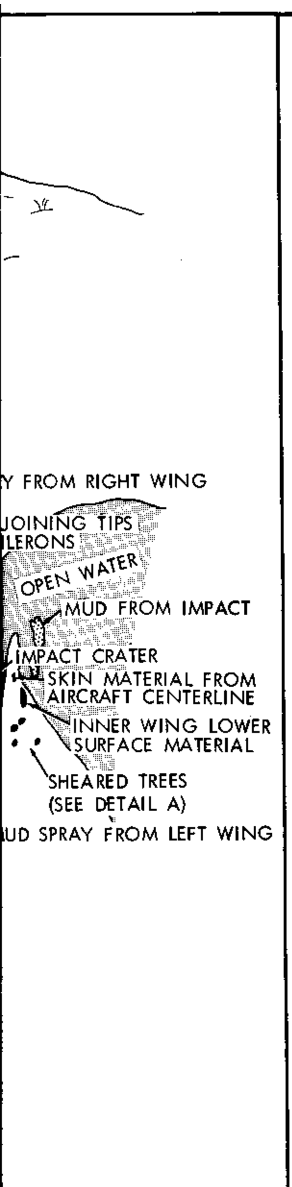
PLAN VIEW OF **WRECKAGE** DISTRIBUTION

W WRECKAGE SCATTER ℄

28 ENGINE FIX COWL EDGE AND CONTROL SURFACE
29 ENGINE GEAR BOX GEAR SHAFT
30 PART OF ENGINE FUEL CONTROL
31 CABIN SEAT TRACK
32 AFT PYLON
33 SERVING TRAY
34 ENGINE COWL
35 CONTROL WHEEL-PIECE
36 LH FUEL FLOW REGULATOR, DUCT
37 PART OF ENGINE MOUNT
38 FUEL SYSTEM PART
39 FLEX HOSE
40 ENGINE OIL FILTER
ER TANG 41 JUNCTION BOX, REVERSE CURRENT CUTOUT RELAY. AND ENGINE MOUNT
42 ELEVATOR BALANCE WEIGHTS
43 PART OF ENGINE COWL
44 FIRE EXTINGISHER
T 45 SIDE WINDOW-COCKPIT
46 TUBE ENGINE BURNER CANS. AND ENGINE PART
47 BAGGAGE DOOR REEL, AND ELEVATOR BALANCE WEIGHTS
48 WATER FIRE EXTINGUISHER
! LINKAGE 49 ENGINE PART
50 NOSE GEAR LOWER SCISSOR
51 COWL AND INERTIA REEL
52 UPHOLSTERY
53 ENGINE OUCT

54 ACTUATOR PISTONS
55 OXYGEN REGULATOR
56 OXYGEN TUBES
57 HYDLRAULIC ACCUMOTATOR
58 ELEVATOR TRIM ACTUATOR
59 UNIDENTIFIED PART
60 SECTOR
61 ENGINE PART
62 ENGINE BLADE
63 ENGINE CASE
64 PART OF COCKPIT HEAT
65 RUDDER PEDDLE
66 RADIO GEAR
67 COMPASS RACK
68 LIFE JACKET
69 COCKPIT WINDOW FRAME
70 RADIO EQUI PMENT
71 RADIO EQUIPMENT AND SUGAR CONTAINER
72 ENGINE HP CROSSOVER DUCT
73 RELAY AND JUNCTION PANEL
74 ENGINE PART
75 ENGINE PART
76 PART OF WINDSHEILD
77 EMERGENCY WINDOW RELEASE
78 RADIO EQUIP., JUNCTION BOX, PIECE OF COCKPIT SEAT
79 AIR VALVE EYE BALLS
80 ENGINE PART AND BALANCE WEIGHT
81 GYRO INDICATOR

82 RADIO EQUIPMENT
83 ENGINE CASE
84 ELEVATOR TRIM GEAR BEARING AND CIRCUIT BREAKER PANEL
85 RADIO EQUIPMENT
86 ADF ANTENNA
87 PRESSURE FUEL SENSOR AND ENGINE PARTS
88 CONTROL VALVE
89 VERTICAL SPEED INDICATOR
90 TRIM TAB ACTUATOR
91 DC-AC TV SET INVERTER
92 HYDRAULIC VALVE
93 PART OF FLIGHT CONTROL
94 TELEFLEX AND INSTRUJ ENT
95 ADF ANTENNA
96 ENGINE PART
97 WINDSHIELD PART
98 LG HYDRAULIC SELECTOR VALVE
99 LG DUMP BOTTLE
100 COLLINS EQUIPMENT
101 PART OF AIR STAIR
102 CABIN SEAT SWIVEL BASE
103 FLIGHT DIRECTOR
104 374A-4 RECEIVER TRANSMITTER UNIT
105 PART OF JUMP SEAT



RCUIT BREAKER PANEL

ARTS

PARTS LOCATED ABOVE WRECKAGE SCATTER ℄

1 AILERON ROD END
2 HALF OF ENGINE THRUST REVERSER
3 HP COMPRESSOR 7-8 STATOR- ENGINE
4 COMBINED SYSTEM RESERVOIR AND HP REGULATING VALVE
5 RH ENGINE CRANE BEAM
6 LH AILERON ACTUATOR CONTROL ARM
7 LP 1 ROTOR
8 FLUX VALVE, COWL DOOR OPEN ROD AND FLAP TRACK
9 RH ENGINE STARTER
10 BATTERY 100A - INS POWERSUPPLY
11 RH FIXED COWL
12 VOR ANTENNA
13 REGULATING VALVE
14 HALF OF THRUST REVERSER
15 THRUST STRUT ATTACH
16 ENGINE FIRE BOTTLE SQUIB
17 RH ENGINE HP COMPRESSOR
18 RUDDER AND "T" HANDLE HYDRAULIC SHUTOFF
19 FRONT BEAM FIN
20 HEAT EXCHANGER
21 OXYGEN BOTTLE
22 PRECOOLER
23 ENGINE STARTER
24 WING CAP COVER
25 RUODER HINGE
26 APU JUNCTION BOX RELAYS
27 LH LP TURBINE & REAR BEARING SUPPORT & THRUST REVERSER
28 LH HP TURBINE CASE
29 AILERON
30 PYLON COVER
31 LH WING HYDRAULIC COOLING COIL
32 FWD. ENGINE CRANE BEAM
33 B.L. 0. SPLICE
34 ENGINE INTERNAL GEAR BOX GEAR
35 OVEN
36 OVERHEAO
37 VERTICAL STABILIZER VOR ANTENNA
38 BAGGAGE OOOR
39 THROTTLE FRICTION LOCK
40 STABILIZER ACTUATOR
41 ENGINE CENTRIFICIGAL BREATHER
42 INTERIOR BAGGAGE DOOR
43 GALLEY AND LP COMPRESSOR EXTENSION SHAFT
44 INTERIOR BAGGAGEMATERIAL
45 RUDDER
46 STA. 539 BULKHEAD WEB
47 BLACK BOX
48 GALLEY WATER HEATER AND STA. 539 BULKHEAD
49 ENGINE BY-PASS
50 BLACK BOX
51 FLIGHT CONTROL
52 FLIGHT HYDRAULIC RESERVIOR
53 OVERSPEED WARNING SWITCH COVER
54 VERTICAL TAIL
55 PRINTED CIRCUIT BOARD
56 COCKPIT FWD. PRESSURE BULKHEAD, CONTROL
57 LP 2 COMPRESSOR WHEEL
58 AIR CONDITION DUCT AND CABIN WINDOW FORGING
59 NOSE GEAR TIRE
60 ELEVATOR TRIMTAB
61 WING UPPER BLO
62 WING TEOVERHANG, NOSETIRE. WINDOW MECHANISUM
63 HORIZONTAL TAIL REAR BEAM
64 OVERWING AND FLOOR LONGERON. BAGGAGE COMPARTMENT MA1ERIAL
65 ELEVATOR OVERHANG
66 MAIN GEAR TIRE
67 JUMP SEAT
68 LP COMPRESSOR DISC
69 ENGINE HP COMPRESSOR CASE
70 CABIN WINDOW FRAME AND CONTROL LINKAGE
71 STABILIZOR FIXED TRAILING EDGE
72 ELEVATOR TRIM TAB
73 RUDDER BELLCRANK AND HP COMPRESSOR STATOR
74 SUITCASE HANOLE
15 HORIZONTAL TAIL T.E. OVERHANG
76 CONTROL WHEEL
77 WING FUSELAGE TIE
18 HP COMPRESSOR7 AND 8
79 RUOOER PEDAL
80 VHF ANTENNA MOUNTING
81 RH COCKPIT WINDOW NO. 2 POST
82 TRIM TAB
83 HYDRAULIC PUMPS
84 WINDSHIELD STRUCTURE
85 RH ELEVATOR AND RUSHROD
86 CONTROL SURFACE AND HINGE
87 VERTICAL TAIL SKIN REAR BEAM
88 CONTROL SYSTEM STOP
89 BOTTOM PIECE OF ELEVATOR
90 CONTROL SURFACE HINGE
91 WINDSHIELD SLAVE-UNIT
92 WING TOP COVER BLO
91 BLACK BOX
94 BLACK SOX SHUTTLE VALVE, COMPUTER AUTO PILOT
95 STABILIZER ACTUATOR
96 COLLINS MAGNETIC AMPLIFIER
97 WING TOP COVER BLO
98 FLOAT VALVE
99 DV WINDOW LOCK TRACK
100 ENGINE FUEL CONTROL
101 BLACK BOX
102 WINDSHIELD
103 LIFE JACKET
104 LPI STATOR
105 COCKPIT MIKE WIRE
106 WINDSHIELD CENTER POST
107 LH DV WINDOW BLOCK
108 COCKPIT SEAT RAIL AND MAIN ENTRY OOOR BAYONETT
109 CABIN SEAT TRACK
110 COCKPIT WINDOW POST AND CONTROL SYSTEM STOP
111 COCKPIT WINDOW
112 LP 1 COMPRESSOR BLADE
113 ELEVATOR MAIN BOX AND TAIL BULLET
114 ENGINE ANTI-ICE SPLITTER VALVE, BAGGAGE OVERHEAO LIGHT. AND BLACK BOX
115 WING TOP SURFACE CENTER LINE OF AIRCRAFT
116 NOSE TIRE
117 STABILIZER AUG. COMPUTER
118 SPERRY UNIT
119 TAIL STINGER
120 BLACK BOX
121 BLACK BOX
122 BLACK BOX AND BATTERY TEMP. MONITOR GAUGE
123 COCKPIT OXYGEN LINE
124 RH ENGINE IN AND LPI AND 2, AND NOSE WHEEL
125 JUMP SEAT ATTACHMENT
126 COCKPIT SIDE STRUCTURE
127 HAND RAIL
128 FENCE-WING
129 BLACK BOX
130 PRESSURE LINE AND ENGINE DISC
131 RH LOWER OV WINDOW LATCH
132 CONTROL SECTION
133 HORIZONTAL STABILIZER RUBBING BLOCK
134 BLACK BOX
135 COPILOT LH CONTROL WHEEL HORN
136 ENGINE ANTI-ICE VALVE, CONTROL ROD END. ELEVATOR ATTACH AND STABILIZER PIVOT
137 CIRCUIT BREAKER
138 COCKPIT SEAT TRACK
139 PILOT SEAT
140 CENTER WINDSHIELD ATTACHMENT
141 GRAVITY FUEL CAP
142 ENGINE INSTRUMENT
143 DME
144 ENGINE INTERNAL BEARING SUPPORT
145 JUMP SEAT
146 RADIO EQUIPMENT
147 FIRE EXTINGUISHER BOTTLE
148 COCKPIT RUDDER/BRAKE CROSSOVER BAR
149 SEAT TRACK
150 ENGINE HYDRAULIC DISCONNECT
151 BLACK BOX
152 FUEL EJECTOR
151 NOSE WHEEL TIRE
154 AIR STAIR STEP
155 COCKPIT SECTION
156 COURSE INDICATOR
157 HORIZONTAL STABILIZER
158 NOSE GEAR OOOR ACTUATOR
159 COCKPIT TRIM SPOOL AND PIECE OF WINDSHIELD
160 OXYGEN BOTTLE
161 LP TACH
162 THROTTLE QUADRANT
163 CABIN INTERIOR
164 NOSE GEAR OOOR CRANK
165 COCKPIT PEDESTAL

APPENDIX D

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

WRECKAGE DISTRIBUTION CHART
INTERNATIONAL BUSINESS MACHINE CORP.
GRUMMAN GULF STREAM II, G1159, N720Q
TWO MILES SW OF KLINE, S.C.
JUNE 24, 1974

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

APPENDIX E

ISSUED: August 14, 1974

Forwarded to:

Honorable Alexander P. Butterfield
Administrator
Federal Aviation Administration
Washington, D. C. 20591

SAFETY RECOMMENDATION(S)

A-74-61

Preliminary evidence from the National Transportation Safety Board's investigation of the International Business Machines, Inc., Grumman G-1159, N720Q, aircraft accident at Kline, South Carolina, on June 24, 1974, indicates that the ground spoilers deployed in flight, which resulted in an uncontrolled crash. The three occupants of the aircraft were killed.

The ground spoiler hydraulic system includes an electrically operated solenoid control valve. The system is designed so that the following conditions must be met to energize the solenoid and deploy the ground spoilers:

1. Power must be on the main DC electrical bus.
2. Main landing gears must be on the ground with weight on them.
3. The ground spoiler switch must be in the "ARMED" position.
4. Both power levers must be in ground "IDLE."

The system does not provide the pilot with a visual or audio signal to show ground spoiler deployment, but a "NO GROUND SPOILER" light on the panel will illuminate if the solenoid-energizing conditions are met and the spoilers fail to deploy on landing.

APPENDIX E

Honorable Alexander P. Butterfield (2)

Although the aircraft was probably certificated with the belief that the design of the ground spoiler actuation system provided sufficient redundancy to prevent in-flight deployment, the Board's review of the system design has disclosed what we believe to be a potentially dangerous condition. A hot electrical short, which bypasses the redundant switches in the line to the power terminal of the solenoid, could cause the unwanted actuation of the ground spoiler system. The original configuration of the aircraft provided a switch on each main landing gear strut which completes the circuit by connecting the parer source to the ground spoiler's control valve solenoid.

On August 20, 1971, the manufacturer issued Service Change No. 98, which provided additional redundancy by breaking both the power source and the ground source to the solenoid, through the landing gear switches. This change, which was not mandatory, affected aircraft serial Nos. 1 through 90. The manufacturer advised that 39 aircraft had not been changed, including the aircraft involved in the accident. We believe that incorporation of this Service Change will eliminate the danger of a similar single failure, i.e., "hot electrical short," unwanted deployment of the ground spoilers in flight, and possible subsequent loss of control.

Although the incorporation of Service Change 98 may eliminate the possibility of in-flight ground spoiler deployment, we believe that a hot electrical short could possibly prevent the retraction of the spoilers on takeoff from a "touch and go" landing.

For this reason, the crew should have a means available to retract the spoilers at any time. In this regard, deployment of the spoilers cannot be detected visually, and some warning system may be required to alert the crew to unwanted spoiler deployment.

The Safety Board recognizes that the Federal Aviation Administration has issued an Emergency Telegraphic Airworthiness Directive to render the ground spoilers inoperative pending resolution of this problem. However, the actions we are recommending will result in modifications to the system which could permit use of the ground spoilers with a degree of reliability which will satisfy the airworthiness standards of 14 CFR 25.

In view of the above, the National Transportation Safety Board recommends that the Federal Aviation Administration issue an Airworthiness Directive which will:

(a) make Service Change 98 mandatory on Grumman G-1159 model aircraft,

APPENDIX E

Honorable Alexander P. Butterfield (3)

(b) require a device that will warn the pilot of unwanted ground spoiler deployment,

(c) require that adequate means be provided for the pilot to retract the ground spoilers in the event of an unwanted deployment.

McADAMS, THAYER, BURGESS, and HALEY, Members, concurred in the above safety recommendation. REED, Chairman, was absent, not voting.

By: John H. Reed
Chairman

APPENDIX E

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

OFFICE OF THE ADMINISTRATOR

AUG 15 1974

Honorable John H. Reed
Chairman, National Transportation Safety Board
Department of Transportation
Washington, D. C. 20591

Notation 1340A

Dear Mr. Chairman:

This replies to your Safety Recommendation A-74-61 issued August 14, relative to Grumman G-1159. N720Q, ,aircraft accident at Kline, South Carolina, on June 24, 1974.

The ground spoiler system is now being thoroughly reevaluated by Grumman with Federal Aviation Administration surveillance. We agree that another airworthiness directive will be required to define conditions which must be met prior to reactivating the ground spoilers on G-1159 airplanes.

Those conditions are expected to go beyond Grumman Service Change 98 by providing design changes to:

1. Reduce probability of failure
2. Limit effect of single failure to stay within controllability limits
3. Annunciate spoiler deployment
4. Provide means to retract spoilers in event of inadvertent deployment, and
5. Assure that information relative to system operation is available to pilot by placard and/or flight manual material.

We believe these actions will be totally responsive to your Safety Recommendation A-74-61.

Sincerely,

Alexander P. Butterfield
Alexander P. Butterfield
Administrator