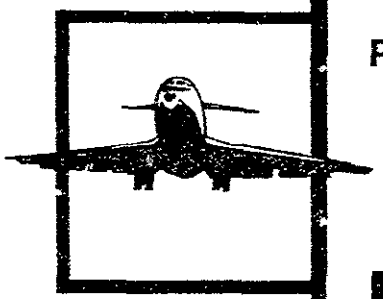

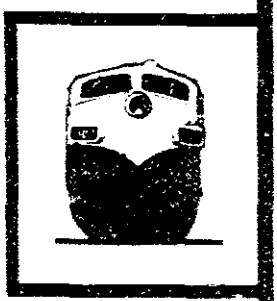

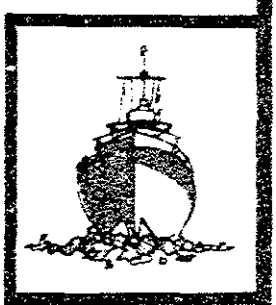

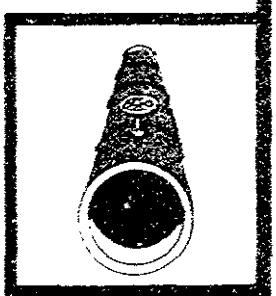

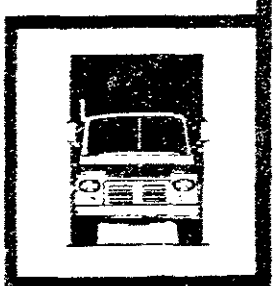

PB85-910402

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

AIR CONTINENTAL GATES LEARJET 23
BRADLEY INTERNATIONAL AIRPORT
WINDSOR LOCKS, CONNECTICUT
JUNE 4, 1984

NTSB/AAR-85/02

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

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16. Abstract

On June 4, 1984, Night Air 4, *e* Gates Learjet 23, N101PP, was being operated by Air Continental Inc. of Elyria, Ohio, on a cargo flight transporting cancelled bank checks. As Night Air 4 was on final approach to runway 33 et Bradley International Airport, Windsor Locks, Connecticut, several witnesses saw it level off over the approach iights and turn right. The right roll continued until the bank angle was about 90° and the airplane collided with the ground. The airplane was destroyed by impact and postimpact fire. Both pilots and the one passenger on board were killed.

The National Transportation Safety Board determines thst the cause of the accident was an uncommanded roll to the right which caused the airplane to roll about 90° and descend into the ground. The cause of the uncommanded roll was an asymmetric retraction of the flight spoilers wherein the left spoiler retracted and the right spoiler did not. The Safety Board could not determine the reason for the right spoiler malfunction.

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AIRCRAFT ACCIDENT REPORT

Adopted: March 5,1985

AIR CONTINENTAL GATES LEARJET 23
BRADLEY INTERNATIONAL AIRPORT
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SYNOPSIS

On June 4, 1984, Night Air 4, a Gates Learjet 23, N101PP, was being operated by Air Continental Inc. of Elyria, Ohio, on a cargo flight transporting cancelled bank checks. As Night Air 4 was on final approach to runway 33 at Bradley International Airport, Windsor Locks, Connecticut, several witnesses saw it level off over the approach lights and turn right. The right roll continued until the bank angle was about 90° and the airplane collided with the ground. The airplane was destroyed by impact and postimpact fire. Both pilots and the one passenger on board were killed.

The National Transportation Safety Board determines that the cause of the accident was an uncommanded roll to the right which caused the airplane to roll about 90° and descend into the ground. The cause of the uncommanded roll was an asymmetric retraction of the flight spoilers wherein the left spoiler retracted and the right spoiler did not. The Safety Board could not determine the reason for the right spoiler malfunction.

1. FACTUAL INFORMATION

1.1 History of the Flight

On June 4, 1984, an unmodified 1/ Gates Learjet 23, N101PP, was being operated by Air Continental, Inc., Elyria, Ohio, on a regularly scheduled cargo flight transporting cancelled bank checks under 14 CFR 135. The flight departed Cleveland Hopkins International Airport, Ohio, as Night Air 4 at 2200 eastern daylight time. 2/ After an uneventful flight, Night Air 4 arrived at Syracuse Hancock International Airport, New York, at 2245. There was routine ground cargo handling at Syracuse, the airplane was not refueled. Night Air 4 departed Syracuse at 2311, was cleared to climb to 17,000 feet, 3/ and was handed off to Boston Air Route Traffic Control Center (Boston Center) at 2314. Boston Center cleared Night Air 4 to its requested altitude of Flight Level (FL) 290 (about 29,000 feet) and the en route portion of the flight was uneventful.

1/ An unmodified Learjet has wing/lift devices that have not been changed since manufacture. A modified Learjet (for example, Century III and Howard/Raisebeck Mark II) has wing/lift devices that have been changed since manufacture to improve airplane performance.

2/ All times are eastern daylight saving time, based on the 24-hour clock.

3/ All altitudes are mean sea level, except as noted.

At 2332, Night Air 4 was handed off at 16,000 feet during its descent to Bradley International Airport, Windsor Locks, Connecticut Approach Control. Approach control identified the airplane, cleared it for a visual approach to runway 33, and at 2336 gave Night Air 4 a turn to position the airplane on final approach at 10 miles from the airport. At 2338:22, Night Air 4 reported that the airplane was on final approach for runway 33, and at 2338:25 the air traffic control tower operator cleared the flight to land. At 2341:18, the control tower operator reported to approach control that there had been an accident at the airport.

Fifteen witnesses, who either heard and/or saw the accident, were interviewed, and with the exception of a few minor points, all of the witnesses described basically the same accident sequence. The airplane was on a normal approach to runway 33 with no apparent abnormalities. When the airplane was about 200 feet over the approach Lights, an increase in engine thrust was heard and the airplane halted its rate of descent in what two pilot witnesses thought was an apparent attempt to go-around. immediately afterward, Night Air 4 began what appeared to be a level turn to the right. As the airplane went through about 90° of turn, the wings of the aircraft were nearly vertical to the ground. The airplane's nose dropped below the horizon and the airplane descended into the ground in a nose low attitude. The witnesses stated that they saw an explosion which was followed by intense ground fire.

None of the witnesses reported any significant lateral or vertical changes while the aircraft was on short final or during the 90° right turn prior to its descent into the ground. Many witnesses stated that they saw some iights illuminated on the aircraft but none repcrtea seeing the landing lights, located on the landing gear, or the landing gear in the extended position. Witnesses reported no inflight fire, smoke, or airframe separation before the crash.

The accident occurred about 2341 during hours of darkness at 41°56'N latitude and 072°41'W longitude.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others	Total
Fatal	2	1	0	3
Serious	0	0	0	0
Minor/None	0	0	0	0
Totai	2	1	0	3

1.3 Damage to Airplane

The airplane was destroyed by impact forces and postcrash fire.

1.4 other Damage

One telephone polo and a portion of chain link fence were destroyed. About 3 acres of airport property was burned and contaminated by debris and fuel.

1.5 Personnel Information

The flightcrew was properly certificated and qualified for the flight. (See appendix B.)

The captain was employed by Air Continental, Inc. on July 29, 1983, and qualified as a Learjet captain on September 27, 1983. He had last flown on June 1, 1984, and was off duty on June 2 and 3, 1984. He was returned to duty at 2100 on June 4,1984.

The first officer was employed by Air Continental, Inc. on March 23, 1984, and was assigned co-pilot duties on the Learjet. His duty schedule had been the same as the captain's since June 1, 1984.

The passenger was a former employer of the captain and was a guest on the flight.

16 Aircraft Information

The aircraft was certificated, equipped, and maintained in accordance with Federal Aviation Administration (FAA! requirements.

The basic empty airplane weight and center of gravity information for weight and balance calculations were obtained from Air Continental. The pilot, co-pilot, and passenger weights were obtained from pilot medical certificates. Before departing Cleveland Hopkins Airport, 568 gallons (3,806 pounds) of Jet A fuel was added to the airplane. To stay within the required maximum gross weight limitations, the airplane departed Cleveland with full wing and full tip tank fuel end minimum to zero fuel in the fuselage tank. Refueling was to be conducted at Bradley International Airport by Combs Gates. Typical fuel loads for Night Air 4 at Bradley on three previous trips were 410, 415, and 442 gallons. These quantities were consistent with fuel in the wing and tip tanks only upon leaving Cleveland.

The following computations reflect the most probable loading of the airplane at Cleveland and at the time of the accident.

	Cieveland (pounds)	Bradley (pounds)
Empty Weight	6,939	6,939
Crew/Passenger	449	449
Freight/Baggage	490	360
Fuel	4,718	1,518
Total Weight	12,596	9,266
Center of gravity	26.5%	24.1%

Maximum takeoff weight is 12,499 pounds.
Center of gravity limits 16% - 31.5% MAC

A second loading configuration, which placed all cargo and baggage in the baggage compartment to achieve the most aft possible center of gravity, also was computed. This configuration also was within weight and center of gravity limitations.

A weight of 9,266 pounds for landing at Bradley was used to compute the landing approach speed of about 120 knots and was consistent with the airspeed indicator "bug" (118 knots) found on the airspeed indicator in the wreckage. The approach landing speed actually flown by Night Air 4, as computed from radar data, was about 128 knots.

1.7 Meteorological Information

The surface weather observation for Bradley International Airport at 2250 (2150 e.s.t.) was:

> No ceiling, 4,000 feet scattered clouds; visibility--20 miles; temperature--65° F; dewpoint--42° F; wind--290° at 4 knots; altimeter setting--29.93 inHg.

The 2350 (2250 e.s.t.) observation was:

> No ceiling, 4,000 feet scattered clouds; visibility--20 miles; temperature--65° F; dewpoint--43° F; wind--280° at 8 knots; altimeter setting--29.94 inHg.

> At 2333, approach control gave Night Air 4 the altimeter setting of 29.94 in Hg., and at 2338 the tower controllers gave the final approach winds as 290° at 6 knots.

18 Aids *to* Navigation

A previously scheduled FAA flight check of the visual and navigational aids was conducted the day after the accident. All systems, including radio communications, were reported as being satisfactory. A maintenance certification check of the ground facilities by local airway facilities personnel indicated all systems were functioning satisfactorily.

1.9 Communications

A review of the recorded radio transmissions between approach control, the control tower, and the crew of Night Air 4 revealed normal, routine handling by air traffic control (ATC) with no discrepancies noted. The co-pilot's voice, which was identified by company personnel, was calm, and his radio transmissions were routine in nature. Air Continental's policy requires that non-flying crewmember handle the radios.

1.10 Aerodrome Information

Bradley International Airport is served by three runways. Runway 33/15 is 5,845 feet long, and 220 feet wide; runway 33 has a magnetic bearing of 328°. The touchdown zone elevation *is* 172 feet.

Runway 33 has an instrument landing system (ILS) instrument approach, runway visual approach slope indicator (VASI), and a medium intensity, or simplified short approach lighting system, 1,400 feet in length. Information supplied by tower personnel indicated that all approach and runway light systems were on low intensity settings and were operationel a: the time of the accident. The sequence flashing lights in the approach light system were off during the approach of Night Air 4.

1.11 Flight Recorders

The aircraft was not equipped with a cockpit voice recorder or a flight data recorder, and neither was required.

1.12 Wreckage and Impact Information

The initial impact point was located approximately 1,200 feet to the right of the threshold of runway 33. The airplane had disintegrated and scattered over a pattern about 400 feet long and 200 feet wide on a heading of 035° magnetic. The ground terrain was a flat, open area on the airport property. The wreckage area was scorched from heet and fire.

The airplane's initial impact damaged a chain link fence which had one post knocked down, and the cement footing of the post was pulled from the ground. About 2 feet beyond the fence post hole, there was a 5- by 3-foot gouge in the ground which contained pieces of the right airplane tip tank structure. A second gouge nark, about 18 by 10 feet in size, was located along a heading of about 035° magnetic and about 15 to 20 feet beyond the first gouge mark. Pieces of the airplane's right wing tip structure, the outboard end of the right elevator, engine blades, pieces of the cockpit windshield frame, and the encoding altimeter were recovered from within and around the second gouge mark area.

Pieces of the airplane fuselage were scattered throughout the wreckage srea. X section of the fuselage right side was recovered along the wreckage path. The largest intact portion of fuselage structure which was recovered was the tail section aft of the rear pressure bulkhead; it was heavily damaged by fire and was crushed on the left side which was upright against a telephone pole. The left wing structure was recovered in an inverted position just beyond the aft fuselage structure and was heavily burned. The left forward side of the fuselage from the main door frame forward toward the nose, including the control column, the rudder pedal assembly, the nose gear assembly, cockpit seat tracks, the throttle assembly, the nose gear door, and the lower hinge of the cabin main door, and pieces of the cockpit windshield frame lower area were attached to the wing. Located about 30 feet left of the wing structure was a portion of the left fuselage frame and skin, the left cabin window, and the upper and lower halves of the cabin main door. The lower half of the right crew seat, which was located beyond the wing st-ucture, was crushed toward an inboard direction.

The left wing was recovered in one piece with the aileron partially attached, the spoiler and flap attached, and the mid area of the left tip tank attached. The wing structure was relatively intact, except at the outboard trailing edge, which was crushed forward and burned, and the leading edge, which was crushed aft and burned. The left flap was relatively intact and retracted. The leading edge and inboard area of the left flap upper surface was sooted. A line of discontinuity in the soot deposit ran in a spanwise direction forward of the skin splice line along the spar upper cap. Aligning the discontinuity line with the wing upper surface trailing edge would correspond to a flap position of 7.5°.

The left flap push-pull rod was intact and attached between the flap and the flap sector in the wing. There was no apparent bending or elongation in the rod or distortion in the rod attachment holes. The left flap retraction cable was unbroken between the left wing sector and the center sector assemblies. The extension cable was broken approximately 4 inches from the attachment end on the left wing sector. The remaining extersion cable was continuous to the flap center sector assembly.

The center sector assembly was intact and connected to the flap actuator which also was intact on the wing structure. The actuator rod extension measured 2.25 inches from the face of the actuator housing to the centerline of the attachment bolt at the end of the rod, which corresponds to about 34° of flap extension. Full flap extension is 40°.

The left aileron trim tab was attached; the actuator motor and linkages were intact through the aileron. The trim tab deflection angle between the aileron and tab lower surfaces was about 16° trim tab trailing edge down. The alignment index between the actuator motor shaft and housing was measured at about 26°, which corresponds to 8° of trim tab deflection for left wing down. The left spoiler was intact and attached to the wing structure and spoiler actuator linkage. The spoiler was in the retracted position.

The right wing was recovered adjacent to the left wing; however, the right wing was broken apart and was damaged heavily bv fire. The right flap, spoiler, and a portion of the right aileron were recovered in the vicinity of the right wing. The right flap structure was in one piece; however, it was scorched, discolored, and partially burned away at the outboard end. The flap tracks were still attached to the right flap. The outboard flap track support assembly was separated from the wing and remained with the flap track. The position of the track support was 6.5 inches from the centerline of the aft roller on the track support to the centerline of the attachment bolt for the flap track, corresponding to a flap position of 6.5° extension.

The right flap sector was atieched to the sector brackets in the wing structure and was free to rotate. The right flap retract cable was broken about 5 inches inboard of the sector. Tne right flap extend cable was broken about 34 inches inboard of the sector. The remaining right flap cable was in one piece and was routed around the flap center sector but was not within the sector cable tracks.

The right wing spoiler was battered and partially burned away but still was attached to a remaining portion of wing structure with its hydraulic actuator attached. The actuator was intact but discolored by heat. The spoiler actuator rod was extended 1.97 inches between the face of the actuator housing and the bottom of the lock nut on the end of the extension rod. This measurement corresponded to about 39° of spoiler extension. The actuator rod could not be respositioned manually. The actuator and spoiler were recovered from an area of extensive fire damage. The spoiler actuator hydraulic lines, which were attached to the actuator, were burned in an area adjacent to the actuator and were broken where they were routed through the wing rear spar.

The right aileron was broken into two sections with the inboard section still attached to the wing structure. The right aileron control cables were attached to the outboard pully assembly and were continuous up to the aileron and rudder interconnect installation. The outboard section of the right aileron was recovered several hundred feet to the left of the remaining right wing structure. The balance tab was still attached to the outboard section of the aileron.

The empennage was broken into two major sections consisting of the horizontal stabilizer with the elevators attached and the vertical stabilizer with the rudder attached. The horizontal stabilizer, which was recovered in one piece, had separated from the top of the vertical stabilizer. The right outboard end of the horizontal stabilizer was crushed aft, and the entire right leading edge was separated from the front spar. The horizontal stabilizer actuator, which was in place, exhibited impact damage. Both the electrical drive motors were broken from their mounts. The actuator measured 14.5 inches from the center of the attachment points, which corresponds to about 6.9° airplane nose-up; full nose-up is 7°.

The vertical stabilizer was relatively intact and was attached to the tail section. The rudder was relatively undamaged and was attached with the rudder trim tab intact to the vertical stabilizer. The rudder trim tab was in the faired position, and the tab push pull tube, which appeared straight and still, was attached between the tab and trim motor. The rudder cables were attached on the rudder sector and were continuous up to where the fuselage was broken apart. The elevator cables in the tail area were continuous from the sector forward to where the fuselage was broken apart.

Both main landing gear were relatively intact and were partially attached to the wing structure. Both main landing gear actuators were in the extended position. The nose gear structure, which was broken apart, had separated from fuselage structure. The nose gear actuator was broken apart, but the down lock balls were recovered in the down and lock position.

1.13 Medical and Pathological Information

Postmortem examinations of both pilots and the passenger were performed by the Office of the Chief Medical Examiner, State of Connecticut. The examinations showed that the occupants died of multiple traumatic injuries. Injury patterns on the bodies indicated that both crewmembers were seated in their assigned seats and that the passenger was seated in the cabin. Toxicological specimens were screened for alcohol, drugs, and carbon monoxide, and the results were negative. There was no evidence of any disease or physical condition that would have affected the pilots in the performance of their duties.

1.14 Fire

The airplane exploded on impact and was involved in an intense postaccident ground fire.

1.15 Survival Aspects

The accident was not survivable because impact forces exceeded human tolerances.

The accident site was adjacent to the Bradley International Airport Fire Department station. The accident caused a power outage to the electrical gate controlling access to the site, however, the Deputy Fire Chief, who had witnessed the accident, opened the gate manually, and crash/fire/rescue (CFR) response was immediate. Five pieces of equipment manned by eight men responded to the accident. They were joined by eight off-duty firemen and by units from adjacent mutual aid fire departments. The initial fire was knocked down and controlled using aqueous film forming foam.

1.16 *Tests* and Research

1.16.1 Airplane Parts Examination

An extensive technical schedule was established to examine the powerplants and other parts of the airplane removed from the accident site.

Powerpiants.--Both airplane engines were sent to an overhaul facility in Dallas, Texas, for teardown examination and analysis. The examination was performed on July 19-20, 1984, under the supervision of a Safety Board field investigator. The examiners indicated that there was no evidence of preaccident malfunction or discrepancy on either and estimated that both engines where operating at 90 to 92 percent rpm at the time of the accident.

Light Bulbs.--A number of lightbulbs from the airplane warning panel and exterior navigation lighting system were sent to the Canadian Aviation Safety Board, Ottawa, Ontario for examination and analysis. In a report, dated October 3, 1984, the Canadian Aviation Safety Board indicated that the filaments of the right fuel pressure light and left fuel pressure light, which had been removed from the warning panel, were stretched and appeared to have been on at impact. Both empennage navigation lights and the top rotating beacon gave the appearance of having been in operation at impact. All other light bulbs, including the spoiler warning lignt, were damaged consistent with cold filaments subjected to impact. Under normal operating conditions, the spoiler warning light is on when one or both of the spoilers are extended.

System Components--The following components were examined at the manufacturer's facilities in Wichita, Kansas, on July 18-19, 1984, under Safety Board supervision.

	Component	Serial Number
1.*	Spoiler Control Valve	240
2.*	Left Spoiler Restrictor Filter	383
3.*	Right Spoiler Restrictor Filter	None
4.*	Left Spoiler Actuator	202
5.*	Right Spoiler Actuator	None
6.	Spoiler Position Switch	None
7.*	Flap Control Valve	184
8.	Flap Restrictor Filter	48
9.	Flap Relief Valve	251
10.	Flap Relief Valve	None
11.*	Flap Hydraulic Actuator	94
12.	Aileron Trim Actuator	047
13.	Pitch Trim Actuator	128
14.	Roll Autopilot Servo	384
15.	Pitch/Yaw Autopilot Servo	0580-49AA
16.	Stall Warning Vibrator	177
17.	Fuselage Fuel Pump	B6932
18.	Left Fuel Boost Pump	B1746
19.	Right Fuel Boost Pump	B4481

*Component x-rayed before examination and/or testing.

No discrepancies, other than noted in the following descriptions, were uncovered by the examinations. An X-ray of the spoiler control valve revealed no evidence of internal operating distress. The valve exhibited fire damage. The valve was tested and found operational, although it functioned slowly.

An X-ray of the right spoiler restrictor filter revealed a small "B-B" sized droplet of solder in the inlet end of the filter on the retraction side. The restrictor unit 4/ was composed of an orifice with filters on each side. The metal ball was found on the retraction side of the orifice and outside the filter screen. The hydraulic line attached to the retraction side of the orifice was partially burned away. The restrictor filter exhibited fire damage.

The O-rings seals on both sides of the restrictor were replaced before testing. The restrictor filter then was tested and found to function satisfactorily. The retraction side of the filter was removed, and foreign material was extracted and submitted to the Safety Board's laboratory where it was identified by spectral analysis as composed of tin and lead (components of solder).

An X-ray of the left spoiler restrictor filter revealed no evidence of internal operating distress. The restrictor filter did not exhibit any damage. The restrictor filter was tested and found to function satisfactorily.

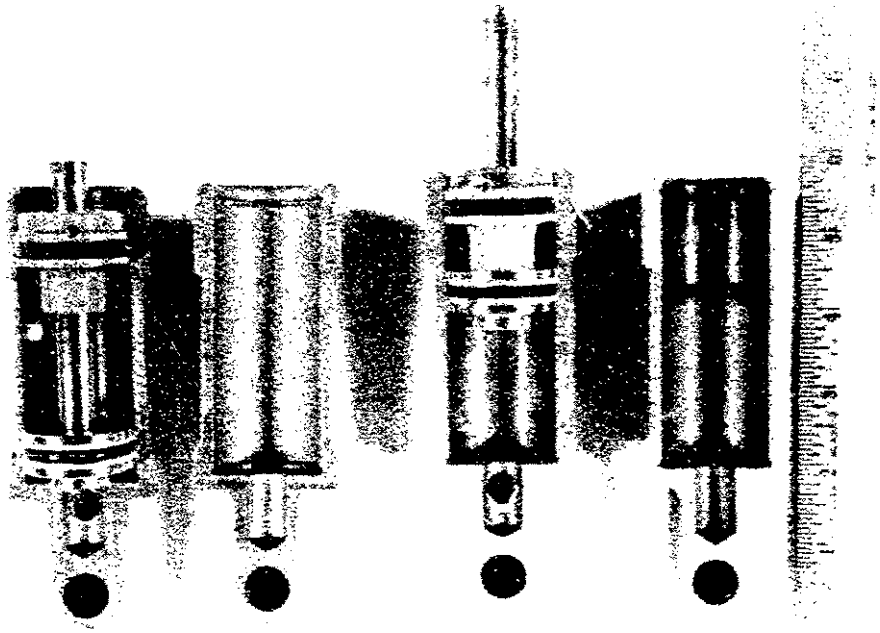
The right spoiler actuator exhibited severe fire damage; however, there was no impact damage. The actuator was extended 1.97 inches which corresponds to 39° of spoiler extension (full extension of the spoilers is 45.59. The actuator was tested and retracted at about 700 psi and extended at 500 psi. During the test, the actuator bypassed hydraulic pressure internally. Disassembly and examination of the actuator revealed that O-rings, the backup ring, and the felt wiper had been damaged by the heat of the ground fire. The right spoiler position switch was fire damaged and could not be tested eiectrically. The left spoiler actuator was not damaged. The actuator was tested and found to function satisfactorily.

The aileron trim actuator was not damaged. It was tested and found to function satisfactorilv. The pitch trim actuator exhibited impact damage. The primary and secondary drive- motors- were tested and found to function satisfactorily. The actuator was near the airplane full nose-up position. The stall warning vibrator, which exhibited impact damage, was tested electrically and found to function satisfactorily.

The left and right spoiler actuators were split in half lengthwise and examined by an engineering firm to determine if a materials trace pattern could be identified to indicate the position of the spoilers at impact or during the ground fire. (See figure 1.) The left spoiler actuator was not damaged by the ground fire; however, traces of rubber specks were found on the inside walls of the actuator, and a faint Sand was found on the actuator walls, corresponding to the piston O-ring in the extended and the retracted positions. The retract end of the left spoiler actuator barrel assembly was faintly scored; the circular scoring was aligned with the end of the piston rod. (See figure 2.) The right spoiler actuator was damaged by ground fire; heat decomposed rubber specks were found on the actuator walls and a heavy band of dark color was found on the actuator wall corresponding to the piston being in the extended position. The retract end of the barrel assembly was scored; the circular scoring was aligned with the end of the piston rod.

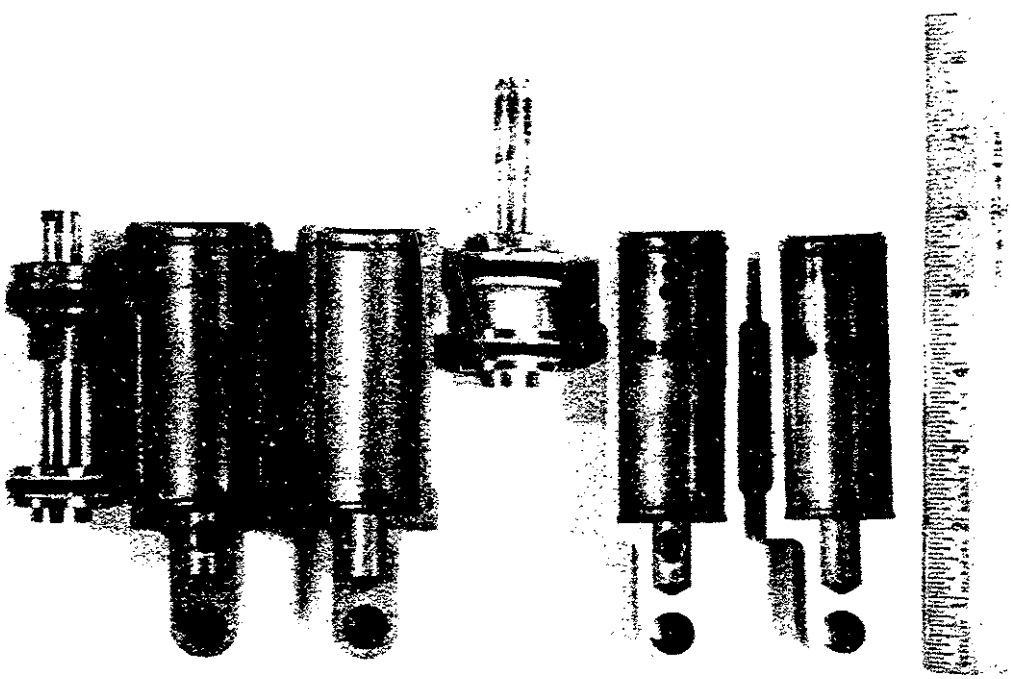
A new spoiler actuator with the piston in the retracted position was subjected to 400° F heat to determine if the heat would cause the piston to extend. The actuator piston did not extend, however, and *the* test was inconclusive since the duration and intensity of the postaccident fire could not be reproduced in the laboratory.

4/ The restrictor unit restricts hydraulic flow to the actuator so that the spoilers move at a reasonable rate during extension and retraction.



Pistons in barrel

Left **Right**



Pistons out **of barrel.**
Figure **1**

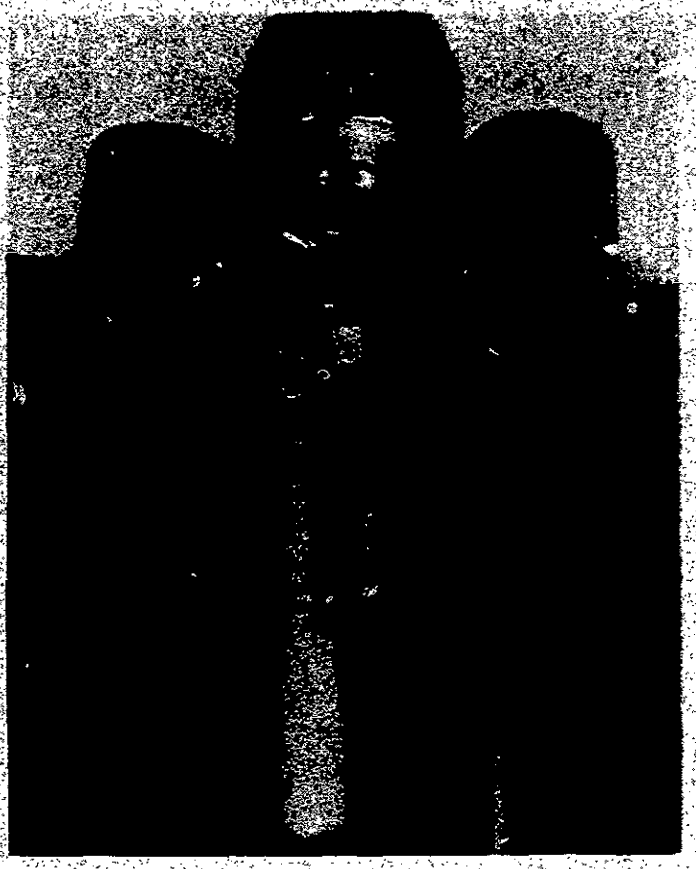


Figure 2.--Scoring at top of barrel, piston at center top.

1.16.2 Flight Tests

A flight test was flown by the FAA pilot member of the operations group at Wichita, Kansas, on July 18, 1984, using an unmodified Gates Learjet 23, N806LJ, in conjunction with the Safety Board's examination of the systems components. Its purpose was to determine airplane flight characteristics with asymmetric spoiler deployment.

The spoiler actuating system on N806LJ was modified to allow the spoilers to be split. The airplane was flown configured as closely as possible to that of the accident aircraft (airspeed-120 knots, engine rpm-90 to 92 percent, gear and flaps-extended, and spoilers-extended). During the asymmetric retraction of the spoilers, the aircraft rolled toward the direction of the extended spoiler. The roll rate initially was slow and easily correctable due to the relatively slow spoiler retraction speed. As the spoiler on the opposite wing retracted, the lateral control wheel input increased to approximately 90 percent of travel opposite the extended spoiler. The maximum airplane roll angle during the retraction was approximately 5°. A moderate amount of rudder input was used (80 to 100 pounds) with the yaw damper still engaged. There was no noticeable yaw since the pilot used the flight controls to opposition to yaw tendencies. The control inputs required were considered a normal reaction to the asymmetric maneuver.

The test pilot concluded that the airplane is controllable at V_{ref} with asymmetric spoiler extention or retraction if available roll and yaw controls are properly utilized, and that if rudder input is not used properly, lateral control will likely be insufficient to stop the rolling moment. He stated that a fuel unbalance, asymmetric power application, or any other airplane misrigging or asymmetry by itself, or in combination with an improper rudder input, could possibly result in an uncontrollable rolling moment.

A second flight test was conducted by the Safety Board's aircraft performance group and the FAA pilot member of the operations group. An unmodified Gates Learjet 23, N7200K, was flown at Bradley International Airport on October 17, 1984, to obtain radar data from the same facilities as the data for the accident aircraft. The radar data from the test airplane flight profiles and the radar data from the accident flight were obtained from Bradley Approach Controi and compared. (See appendix D.) The aircraft instrument and engine panels were videotaped to further document the flight test.

The purpose of the first two profiles was to obtain the vertical velocity performance of the airplane during the first half of the descent in spoilers extended/retracted configurations at airspeeds similar to those flown by the accident airplane as obtained from processed radar data. The difference in the vertical speeds between the spoilers extended/retracted configurations was noted and compared to the vertical speed calculated for the accident aircraft. The profiles were flown and recorded from FL200 to 10,000 feet. Since engine power settings were not known, the throttle was at idle (approximately 55 to 60 percent engine rpm) for the two descents except that a slight amount of power (5 to 10 percent) was added to maintain cabin pressurization between FL200 and 15,000 feet.

There was a marked difference in descent rates between the spoilers extended/retracted configurations. With the power at idle, spoilers retracted, and maintaining the airspeeds of the accident aircraft as closely as possible, a 4,000 to 4,200 feet per minute descent rete resulted. However, with spoilers extended, the vertical speed indicator was pegged at 6,000 feet per minute. The calculated descent rate was about 6,500 feet per minute, which compares to a descent rate of 3,500 to 3,800 feet per minute for the accident airplane (throttle setting unknown)

The third and fourth profiles were flown from the downwind position (runway 33 at Bradley) to approximately 700 feet. Since the radar data indicated that the accident airplane was about 2.5 miles abeam the radar site at 12,000 fee? at about 285 knots indicated airspeed (KIAS), these values were selected as the initial point for the profiles. The engine power was kept at idle throughout, and indicated airspeeds as predicted from radar data for the accident airplane were maintained. The flaps and landing gear were extended at the normal scheduled speeds, i.e., 200 KIAS for gear extension, 170 KIAS for approach flaps, 140 KIAS for full flaps. The third profile, flown with spoilers retracted, was similar to the accident airplane profile in ground track. Passing altitudes were higher when compared to the passing altitudes of the accident airplane.

The fourth profile was flown in a similar manner as the third profile except that the spoilers were deployed at 7,000 feet since this was the only point in the descent of the accident airplane where the descent rate was higher than that of the descent rate of the test airplane with spoilers retracted. The fourth profile required a steep descent after the final turn to maintain the desired airspeeds and track since engine power was maintained at idle. Under normal operational technique, power would be added as the landing gear and flaps were lowered to minimize changes in airplane attitude, descent rates, and airspeed. After the airplane was levelled at 1,100 feet, it required about 90 percent rpm to maintain the desired airspeed in the gear and flaps down, spoilers extended configuration.

1.17 Additional Information

1.17.1 Normal Operating Procedures

The FAA Approved Airplane Flight Manual of the Learjet 23, Section II, Normal Operating Procedures Checklist states: Taxiing --- E. Spoilers–Check operation, then retract.

1.17.2 Descent, Approach, and Landing Techniques

The Gates Learjet Flight Training Manual describes standardized procedures and maneuvers for pilots transitioning into Learjet series 20 aircraft. Those portions of the manual devoted to descent, approach, and landing state, in part;

Descent

...Both a power and pitch change is usually required when transitioning to the lower altitudes. To level off from the descent, lead the desired altitude by about 10–20 percent of vertical speed to avoid overshoot and for passenger comfort. If levelling at descent airspeed, smoothly add power while changing to level flight attitude. When levelling at a slower speed smoothly change pitch attitude to level flight and as the airspeed approaches within about 10 knots of that desired, smoothly advance power to maintain desired airspeed.

The wing spoilers are a convenient means of expediting a descent rate and/or to quickly reduce speed. Deploying the spoilers will cause a slight pitch down tendency. With a little practice, this can be anticipated, elevator pressure held against it and relieved with trim. The nose up tendency when the spoilers are retracted, may be handled in like manner. A slight buffeting will be noticed with the spoilers extended. Good planning will usually preclude the need for frequent spoiler use in flight; however, if circumstances dictate, do not hesitate to use them. Remember that the stall speed is increased with spoilers extended. Remember too, spoilers and flaps should not be used simultaneously because of the probable fatigue damage to the flap surface.

...After level off in the traffic pattern, the initial target power setting in clean configuretion to Vref plus 40 KIAS is approximately 78 percent rpm. Lowering the flaps to 8° and maintaining Vref plus 30 KIAS requires very little change of power (78 percent rpm). Lowering flaps to 20° along with extending the gear and maintaining Vref plus 20 KIAS requires an additional 4 percent (82 percent rpmi. Lowering full flaps and maintaining Vref will require additional 5 percent (87 percent rmp). These power settings are for straight and level flight and are approximate. Generally in the Learjet in a stabilized condition, I percent rpm power change will equal appzoximately 5 knots in airspeed. In the landing configuration at Vrei (speed stable), reducing the rpm 1 percent will result in approximately 100 feet per minute rate of descent.

Normal Approach for Landing

Several factors influence the requirement for utilizing a smooth, shallow power-on approach. Two of the basic factors are: First, if an approach angle is relatively shallow, airspeed control is generally improved. Secondly, by using a relatively shallow approach with adequate power, the rate of descent is held to an acceptable value. The final one-half mile of the final approach should approximate an ILS glide slope with a rate of descent of approximately 600 feet per minute. At idle or low power in a high rate descent (steep glide slope), the airplane on flare will only rotate; however rate of descent will not appreciably change. Another advantage of a shallow approach is that the high power required places the engines in the best acceleration range. . . .

Landing

Jet aircraft in general have certain landing characteristics. Deceleration is not rapid when power is reduced to idle. While in idle, the engines still produce forward thrust. In ground effect, the jet aircraft can "float" for a long distance.

The Gates Learjet in landing configuration at Vref is in a near landing attitude. Constantly trim pitch to neutral. Maintain Vref until within a few feet of the runway surface. . . .

The Operations group FAA pilot member and other Learjet pilots stated that near full nose up horizontal stabilizer trim is normal for most landings.

1.17.3 Flight Control System Malfunctions

A review of Service Difficulty Reports (SDR) since 1979 involving flight control systems on Lear 20 series airplanes disclosed three reports concerning the spoiler system: one report indicated a leaking hydraulic line due to corrosion, and the other two concerned worn and broken attachment brackets on the actuator. All three discrepancies were discovered during maintenance inspections. None of the reports indicated if spoiler operation had been affected in flight. Of the three discrepancies noted, the most likely to cause an asymmetric position between the left and right spoiler actuators would be a leaking or broken hydraulic line. Due to impact and fire damage, the preimpact integrity of the spoiler hydraulic lines of the accident airplane could not be evaluated.

2. ANALYSIS

21 General

The airplane was properly certificated and had been maintained in accordance with approved procedures. There was no evidence of preaccident failure or malfunction of the aircraft structure or powerplants.

The flightcrew of Night Air 4 were certificated and qualified for the scheduled cargo flight. The flightcrew had current medical certificates. Both crewmembers were seated in their assigned seats and the pilot was flying the airplane. Weather was not a factor; the accident occurred on a dark night, with scattered clouds, 20 miles visibility, and light winds.

2.2 The Accident

Fifteen witnesses who either heard and/or saw tine accident described basically the same accident sequence. Night Air 4 was on final approach to runway 33 at Bradley International Airport over the approach lights in a stabilized attitude configured for landing. The nose of the airplane rose and a right turn was initiated as if the pilot had decided to go-around. However, the right turn continued and the airplane descended until it struck the ground in a nose down attitude with a bank angle of 90° or more.

The Safety Board has investigated a number of Gates-Learjet takeoff and landing accidents which had similar characteristics. (See appendix E.) Certain flight maneuvers were common to all of the accidents: (1) each aircraft experienced steep banking with high roll rates immediately before the loss of control, (2) none of the flightcrews was able to recover the airplane after the rolling started, and (3) the addition of engine thrust appears to have aggravated the severity of bank attitude. During its investigations of the accidents, the Safety Board concluded that a number of factors could create a situation causing the wing roll and subsequent control loss: ice/snow accumulation on control surfaces and other aircraft structures, gusty winds, wake vortex turbulence, mistrimmed flight control surfaces, cockpit flight control interference, asymmetrical thrust application, and flightcrew failure to maintain airspeed and attitude. None of these factors, however, appear to have been present in the June 4, 1984 accident. Analysis of the radar data indicates that the airplane's speed on final approach was about 8 knots above the V_{ref} speed of 120 knots. Witnesses stated that the airplane's speed and attitude looked normal for landing. The flightcrew was rested, highly-qualified, and familiar with the airport. While this accident may have similarities to the other Learjet accidents investigated by the Safety Board, the causal factors found in the other accidents do not appear likely explanations in this accident.

2.3 The Airplane

Examination of the wreckage disclosed no evidence of an inflight fire, explosion, or component separation. The landing gears were recovered in a fully down position. Soot patterns and impact marks on the left and right flap surfaces indicated that the flaps were partially extended when exposed to postimpact fire. Examination of the flap control cables disclosed tension overload failures typical of crssh damage indicating that the flaps were extended. The flap actuator was recovered in a position corresponding to about 34° of flap extension. Full flap extension is 40. The exact flap extension before impact could not be determined; however, the flaps most likely were extended at least 34.

During the postaccident inspection, the horizontal stabilizer actuator was measured and found trimmed nearly to the full airplane nose-up position. Based on statements by pilots who fly the Learjet and Gates Learjet personnel, this is not an abnormal position for landing since it relieves back pressure on the control wheel and allows for a smooth roundout and flare for touchdown. This aiso is indicative of inflight spoiler deployment since extension of spoilers causes a nose-down pitching moment.

The right wing spoiler actuator rod was recovered in the extended position, and the left wing spoiler actuator rod in the retracted position. Because spoilers are programmed to operate in unison and because pilots are cautioned not to use them in the air when the flaps are down in order to prevent fatigue damage to the flaps, the position of the right spoilers found during the postaccident inspection was unusual.

A laboratory inspection of the right spoiler actuator revealed a heavy band of discolored metal on the interior wall that corresponded to the piston being in the extended position, indicating that the spoiler was in the extended position while exposed to the postaccident ground fire. Although circular scoring marks were found on the retract end of the spoiler actuator barrel assembly, examination of the marks was not conclusive in determining whether the scoring was caused by inservice use or by impact damage. The left spoiler actuator barrel assembly had faint scoring marks. Based upon the weight of the physical evidence and the reactions of the airplane during tne last part of the flight, the Safety Board concludes that the spoilers were asymmetrical at impact. The aileron trim actuator was recovered in a position toward full travel for left wing down which points to the possibility of a lateral control problem and indicates that the pilot attempted to counteract an uncommanded airplane roll to the right by using aileron trim.

Other components of the airplane spoilers, flaps, aileron trim, and automatic flight control systems that were recovered from the wreckage and examined at the Lear facility in Wichita did not indicate any potential source of flight control malfunctions in flight. The only discrepancy noted was a small "B-B" sized droplet of solder found in the flow restrictor of the hydraulic line for the right spoiler actuator. If the metal droplet had impeded hydraulic flow through the restrictor, the effect would have been a slightly reduced retraction capability of the right spoiler. However, flow rates through the restrictor measured during both the retraction and extension cycles were not affected by the presence of the solder.

Examination of the spoiler warning light bulbs indicated tha? the filaments were no? stretched at impact indicating a cold filament (bulb off) condition. Cnder normal conditions. if one or both of the spoilers had been extended, the bulbs would have been illuminated. However, since the right wing struck the ground first, it is possible that the impact sequence caused an electrical interruption and extinguished the light, or that the bulbs or wiring mag have been defective and that the system was not operative. If the system was inoperative, it would further explain why the flightcrew did not notice the extended spoilers on the f i i approach. Other light bulb examination evidence indicates the right and left fuel pressure warning lights were illuminated at impact. The Safety Board attributes this to the rolling maneuver of the airplane before impact during which the fuel pumps probably were uncovered in the tanks, causing the warning lights to illuminate.

The Safety Board could not determine the reason for the postulated malfunction of the spoiler system. There is no maintenance history of spoiler failure in Gates Learjets, and the flightcrew did not report a malfunction before flight when they would have checked the spoilers as part of the normal operating procedures checklist.

2.4 Accident Analysis Based on Flight Test Data

Flight tests in an unmodified Lear 23 indicated that an asymmetrical spoiler condition is controllable if prompt end correct rudder and aileron control inputs are made. Nowever, the fiight tests were made under controlled conditions at altitude with forewarning of the conditions. If an assymetrical spoiler condition were to occur at night on final approach. airplane roll rates might develop to a degree that delayed recovery inputs by an unwary pilot would not be sufficient to stop the roll.

The flight tests performed at Bradley to evaluate Lear 23 flight characteristics indicate that the first portion of the approach (from FL200 to 10,000 feet) was performed with the spoilers retracted. The flight tests also indicated that the combination of descent rate and acceleration which the accident airplane achieved as it

descended through 7,000 feet was achievable only with the spoilers extended. The Safety Board concludes that the spoilers were used to increase the rate of descent during the turn to final since the descent rate shown by the radar data of the accident flight was 'nigher than the descent rate shown by the radar data for the test flight with the spoilers retracted and was similar to the descent rate of the test flight with the spoilers extended.

After the airplane rolled out on final approach, most likely the landing gears were lowered at about 200 KIAS, the flaps were extended at about 170 KIAS, and the power was increased to maintain airspeed, attitude, and rate of descent. However, the Safety Board believes that the spoilers were still extended. It was noted during the flight test that there is little difference in cockpit total background noise level with spoilers either extended or retracted when the gear and flaps are down to alert the pilot that the spoilers are extended. The fourth profile of the test flight flown at Bradley International revealed that it took about 90 percent of power to maintain level flight with the gear and flaps down with spoilers extended. The engine teardown revealed that engines were operating at about 90 to 92 percent rpm at impact. Power required to maintain Level flight with spoilers retracted is about 87 percent. Consequently, the spoilers extended configuration only requires 3 percent more power than retracted configuration and a pilot could overlook the difference in power particularly if the spoiler warning lights were not lit. It is postulated that as the airplane passed over the approach lights, the pilot realized that the spoilers were extended and retracted them. The nose of the aircraft would have risen slightly due to spoiler retraction, but since the right spoiler did not retract the airplane started a slow roll to the right. While the pilot sdded power, he apparently did not use enough aileron and rudder control input to arrest the roll, and the airplane rolled inverted and crashed.

3. CONCLUSIONS

3.1 Findings

1. The airplane was properly certificeted and had been maintained in accordance with approved procedures.

2. There was no evidence of preaccident failure or malfunction of the sirplane's structure or powerplants.

3. The flightcrew of Sight Air 3 was certificated and qualified for the scheduled cargo flight.

4. The flightcrew of Night Air 3 held current medica! certificates.

5. Both crewmembers were seated in their assigned seats and the pilot was flying ?he airplane.

6. Weather was not a facto? in this accident.

7. There was no evidence of an inflight explosion, fire, or component separation.

8. The landing gears were fully extended at impact.

9. The flaps were extended: the actual extended position before impact could not be determined but most likely was at least 34°.

10. The aileron trim actuator was recovered in a position toward full left wing down.

11. The horizontal stabilizer actuator was in the near full airplane nose-up position.

12. The right spoiler actuator was recovered in an extended position, and the left actuator in a retracted position.

13. The right spoiler actuator was in the extended position when exposed to the postaccident ground fire.

14. There is no maintenance history of spoiler problems in Gates-Learjets.

15. Flight tests indicate that an asymmetrical spoiler condition in a Gates-Learjet 23 is controllable if prompt and correct rudder and aileron control inputs are applied. If input is not correct or applied soon enough, uncontrollable roll rates may deveiop.

16. The initial pert of Night Air 4's descent was made in a clean configuration.

17. The pilot of Night Air 4 extended spoilers during the turn to the final approach and inadvertently did not retract them until over the approach lights.

18. The spoilers did not retract symmetrically causing the airplane to roll to the right.

19. The pilot apparently did not detect the roll before the roll rate developed to the extent that the airplane could not be Controlled before it impacted the ground.

Probable Cause

The National Transportation Safety Board determines that the cause of the accident was en uncommanded roll to the right which caused the airplane to roil about 90° and descend into the ground. The *cause* of the uncommanded roll was an asymmetric retraction of the flight spoilers wherein the left spoiler retracted and the right spoiler did not. The Safety Board could not determine the reason for the right spoiler malfunction.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JIM BURNETT
Chairman

/s/ PATRICIA A. GOLDMAN
Vice Chairman

/s/ G. H. PATRICK BURSLEY
Member

March 5, 1985

4. APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The Safety Board was notified of the accident about 0030, June 5, 1984. A partial team was dispatched from the Washington, D.C., headquarters and arrived on scene about 0530. Working groups were established for operations/air traffic control/ witnesses, structures, systems/powerplants, and maintenanre records.

Parties to the investigation were the Federal Aviation Administration, Air Continental, Gates Learjet Corporation, General Electric, and the State of Connecticut.

2. Public Hearing

A public hearing was not held. Depositions were not taken.

APPENDIX B

PERSONNEL INFORMATION

Pilot Charles Russel Huffman

Mr. Huffman, 52, held Airline Transport Pilot Certificate No. 1359790, issued on April 5, 1982. He had a single and multiengine rating with a Learjet type certificate. As of June I, 1984, his total flying time was about 11,039 hours with approximately 1,130.4 hours in Learjets. He tad flown 713.4 hours while an employee with Air Continental.

Mr. Huffman had an FAR Part 135 proficiency check ride on April 29, 1984. He was assigned duty as a Captain by Air Continental on September 27, 1983.

Mr. Huffman had a first class medical certificate dated March 28,1984, with a limitation that stated, "Holder shall posses correcting glasses for near vision while exercising the privileges of his airman certificate."

According to company records, Mr. Huffman had 99.3 hours in the last 30 days and 281.9 hours in the past 90 days. He had flown into the Bradley International Airport 18 times during the last 90 days before the accident

Copilot Ronald John Dulay

Mr. Dulay, 26, held an Airline Transport Pilot No. 199388678, issued on October 29, 1982, with a single and multiengine aircraft rating. He held a first class medical certificate dated June 30,1983, with a limitation that stated, "Holder must wear corrective lenses while exercising the privileges of his airmen certificate."

His total flight time was 5,263.6 hours with 189-3 hours in Learjet, all of which was with Air continental. His last proficiency check. which was on March 23, 1984, was administered by the company's president He was assigned duties as Air Continental copilot in March 1984.

Passenger Eldridge Monroe Sheetz

Mr. Sheetz, 71, a passenger, was the holder of a Commercial Pilot's Certificate No. 244577. His second class medical certificate was issued on December 10, 1975, and it had expired.

APPENDIX C

AIRCRAFT INFORMATION

The accident aircraft was a Gates Learjet model 23A, Serial No. 23-085, Registration No. N101PP. The aircraft was owned and operated by Air Continental, Inc., of Elyria, Ohio.

The aircraft was equipped with two General Electric CJ610-4 engines, each rated at 2,850 pounds of thrust. The right engine, SN: 251-268 was a leased engine from AVIALL and, according to the engine logbook, had a total time of 2,336 hours when installed on April 7, 1984. The left engine, SX: 241-133, had a total time of 3,112.6 hours.

According to the aircraft records, the last inspection was a 150-hour check completed on April 14, 1984, at a total airframe time of 8,393.4 hours. The estimated aircraft time on the date of the *accident* was 8,489.3 *hours.*

The maximum certificated ramp weight for this aircraft is 12,749 lbs. with a maximum takeoff weight of 12,499 lbs. The maximum landing weight is 11,880 lbs. with a maximum zero fuel weight of 9,000 lbs.

On June 7, 1984, a review of the aircraft (logbooks 4 end 5) and the engine maintenance records indicate that the airplane was being maintained in accordance with applicable FAR's. No major discrepancies were noted during the review. Airworthiness Directives had been complied with. All flight control cables were replaced on February 22, 1984.

APPENDIX D

RADAR DATA

Table I.	Printout of radar data from accident flight.
Figure 1.	Plotted data of accident flight.
Table II.	Printout of radar data from first profile, descent from FL 200 to 10,000 feet, spoilers retracted.
Figure 2	Plotted data from first profile.
Table III.	Printout of radar data from second profile, descent from FL 200 to 10,000 feet, spoilers extended.
Figure 3.	Plotted data from second profile.
Table IV.	Printout of radar data from the third profile, descent from downwind to final, spoilers retracted.
Figure 4.	Plotted data from third profile.
Table V.	Printout of radar data from fourth profile, descent from down wind to final, spoilers extended.
Figure 5.	Plotted data from fourth profile.

Table 1.--Printout of Pawas data from accident flights.

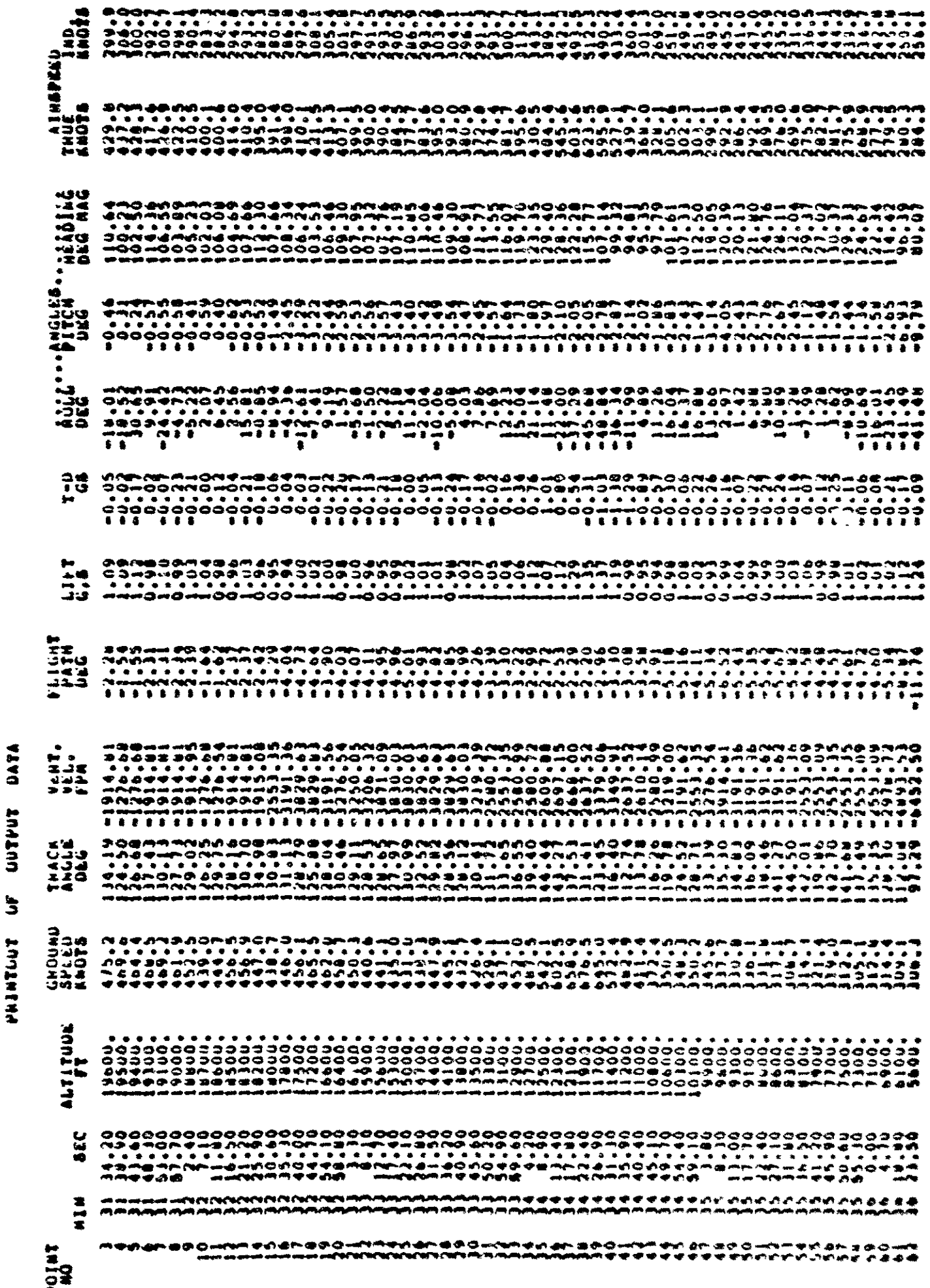


Table I.--Printout of radar data from accident flights. (cont'd)

PRINTOUT OF OUTPUT DATA

POINT NO	MIN	SEC	ALTITUDE FT	GROUND SPEED KNOTS	TRACK ANGLE DEG	VERT. VEL. FPM	FLIGHT PATH DEG	LIFT G,S	T-D GS	ANGLES... ROLL DEG	ANGLES... PITCH DEG	ANGLES... HEADING DEG MAG	AIRSPEED TRUE KNOTS	AIRSPEED IND. KNOTS
63	36	28.10	5100.	415.4	84.48	-6452.50	-11.41	1.16	-0.02	-35.75	-9.01	86.63	297.4	270.4
64	36	32.40	4600.	321.0	71.18	-5106.17	-8.90	1.39	-0.24	-33.45	-6.22	53.08	305.9	240.7
65	36	37.50	4300.	314.9	59.97	-3191.30	-5.71	1.33	-0.37	-30.27	-2.50	41.65	300.8	217.5
66	36	42.20	4100.	294.9	49.89	-1914.81	-3.68	1.26	-0.44	-30.90	-0.28	31.15	289.0	201.8
67	36	46.90	4000.	284.1	36.44	-1276.68	-2.73	1.23	-0.26	-33.72	1.35	18.92	287.8	198.7
68	36	51.60	3900.	252.2	24.21	-1276.68	-2.90	1.19	0.00	-32.60	1.38	4.37	251.7	233.6
69	36	56.30	3800.	250.9	12.29	-1290.38	-2.96	1.18	-0.11	-32.96	1.22	352.60	255.0	237.1
70	37	0.90	3700.	245.3	358.59	-1290.49	-2.96	1.27	-0.11	-35.48	1.38	339.30	255.3	237.1
71	37	5.60	3600.	238.2	342.15	-638.40	-1.51	1.26	-0.14	-34.72	2.90	323.32	252.7	235.8
72	37	10.30	3600.	224.2	328.25	-638.27	-1.61	1.27	-0.10	-41.47	2.87	310.54	242.6	226.4
73	37	15.00	3500.	222.8	304.04	-1489.36	-3.77	1.22	-0.09	-40.54	0.69	288.20	245.3	229.2
74	37	19.10	3100.	218.9	302.60	-1489.36	-3.84	1.02	-0.15	6.45	1.09	286.80	239.9	225.8
75	37	23.80	3000.	214.4	306.41	-1263.30	-3.33	1.06	-0.10	-17.99	1.79	290.27	234.4	221.1
76	37	28.60	2900.	209.8	266.32	-1263.30	-3.40	1.06	-0.15	-20.80	1.81	271.97	231.1	218.3
77	37	33.30	2800.	204.8	287.26	-1276.54	-3.52	1.01	-0.11	8.70	1.92	272.85	226.2	214.0
78	37	38.00	2700.	202.2	293.95	-1276.54	-3.56	1.04	-0.10	8.10	2.21	278.94	223.5	211.7
79	37	42.70	2600.	199.2	294.74	-638.27	-1.61	1.07	-0.03	8.11	4.19	279.83	220.1	208.9
80	37	47.40	2600.	199.9	294.25	0.00	0.00	1.00	-0.06	-1.30	5.39	279.56	220.7	209.5
81	37	52.10	2600.	196.8	293.62	-638.27	-1.86	0.96	-0.05	-0.64	3.68	278.83	217.8	206.7
82	37	56.80	2500.	194.0	293.70	-638.27	-1.86	1.02	0.00	-0.29	4.16	278.92	215.0	204.4
83	37	56.20	2500.	194.5	292.51	-638.27	-1.85	1.03	0.06	8.15	7.47	278.19	215.5	204.9
84	38	0.90	2600.	197.6	296.42	-638.27	-1.83	0.98	0.03	9.99	4.96	281.67	218.4	207.5
85	38	5.60	2600.	197.7	300.27	0.00	0.00	0.94	-0.03	8.24	3.11	285.90	218.2	207.1
86	38	10.30	2600.	194.8	301.40	-638.27	-1.85	0.97	-0.05	4.57	3.80	287.66	215.5	204.8
87	38	15.00	2500.	194.0	305.35	-638.27	-1.86	1.06	-0.05	11.72	4.27	289.44	214.7	204.1
88	38	19.70	2500.	191.0	316.75	0.00	0.00	1.06	-0.17	12.58	6.25	299.95	209.6	199.1
89	38	24.40	2500.	182.1	318.11	0.00	0.00	1.00	-0.13	-0.94	6.63	301.05	200.5	190.9
90	38	29.10	2500.	173.5	316.22	0.00	0.00	1.00	-0.10	2.19	7.26	299.21	192.2	182.7
91	38	33.80	2500.	166.5	320.67	0.00	0.00	0.96	-0.02	-0.09	7.65	303.10	184.4	175.3
92	38	38.50	2500.	169.5	316.20	-638.27	-2.13	0.97	-0.03	-4.47	5.42	298.08	188.2	178.9
93	38	43.20	2400.	176.9	315.91	-638.27	-2.04	1.00	-0.09	-7.05	5.10	298.80	195.8	186.4
94	38	47.80	2400.	170.3	314.42	-638.27	-2.12	0.95	-0.21	-5.29	5.15	297.35	189.4	180.1
95	38	52.50	2300.	162.4	311.25	-1276.54	-4.43	0.95	-0.26	-2.89	5.70	294.16	182.3	173.4
96	38	57.20	2200.	146.6	311.93	-1276.54	-4.91	1.00	-0.10	0.15	5.39	294.36	166.3	158.1
97	39	1.90	2100.	147.6	311.15	-1276.54	-5.07	0.98	-0.09	0.60	5.07	293.78	167.8	160.6
98	39	6.60	2000.	152.8	312.10	-1595.78	-5.88	0.97	-0.15	2.90	4.43	295.20	173.1	165.9
99	39	11.30	1900.	150.2	316.96	-1595.78	-5.98	1.01	-0.15	1.92	4.44	298.98	168.8	161.6
100	39	16.00	1800.	145.2	317.80	-1276.54	-4.95	1.01	-0.11	-0.38	5.73	299.81	163.9	157.4
101	39	20.70	1700.	143.3	316.61	-1276.54	-5.02	1.00	-0.09	-2.31	5.76	298.76	162.0	155.5
102	39	25.40	1600.	144.1	314.98	-1276.68	-4.99	0.96	-0.09	-2.75	5.28	297.42	160.9	154.5
103	39	30.10	1500.	140.6	313.38	-1914.95	-7.65	0.94	-0.25	-1.45	5.07	295.55	158.6	153.7
104	39	34.80	1400.	132.1	311.69	-1914.81	-8.12	1.05	-0.26	-0.15	5.16	295.38	149.6	145.5
105	39	39.50	1300.	124.7	313.62	-638.27	-2.69	1.07	-0.14	-3.05	5.80	296.18	140.5	136.9
106	39	44.20	1200.	118.5	312.49	-638.27	-3.04	0.97	-0.04	-3.62	6.51	295.04	134.6	131.1
107	39	48.90	1100.	122.9	308.43	-1276.68	-5.45	1.01	0.05	-2.62	6.74	290.92	138.6	135.1
108	39	53.60	1000.	129.5	306.20	-638.40	-2.78	1.07	-0.08	0.77	11.19	291.50	143.5	140.4
109	40	27.80	800.	129.5	309.64	0.00	0.00	1.00	-0.02	1.87	12.86	293.41	143.2	140.1
110	40	32.50	800.	127.3	310.77	-638.27	-2.83	0.96	-0.13	1.63	10.16	293.82	141.1	138.1
111	40	37.20	700.	116.5	312.09	-638.27	-3.04	1.00	-0.09	-0.04	12.63	294.73	131.0	128.5
112	40	41.90	700.	119.6	310.86	-638.40	-3.01	1.00	-0.07	-0.56	12.38	293.66	132.3	129.7
113	40	46.60	600.	117.9	311.35	-638.40	-3.06	1.00	-0.03	-0.85	13.00	294.10	129.4	127.1
114	40	51.50	600.	114.4	309.72	-638.27	-3.02	0.97	0.01	-1.87	12.08	292.70	131.0	128.4
115	40	56.20	500.	124.4	306.50	-1276.54	-5.78	1.02	0.07	5.85	9.17	291.04	135.4	133.3
116	41	0.90	400.	138.9	317.72	-638.27	-2.60	1.21	0.37	10.43	10.17	300.69	147.5	145.5
117	41	5.40	400.	162.4	351.92	-666.67	-2.71	1.39	0.24	46.23	6.78	333.99	166.8	164.6
118	41	10.10	300.	185.9	18.51	-1333.33	-4.05	1.10	0.11	28.30	3.09	1.08	185.5	183.4

* SMOOTHED VALUES ARE APPROXIMATE NEAR END POINTS

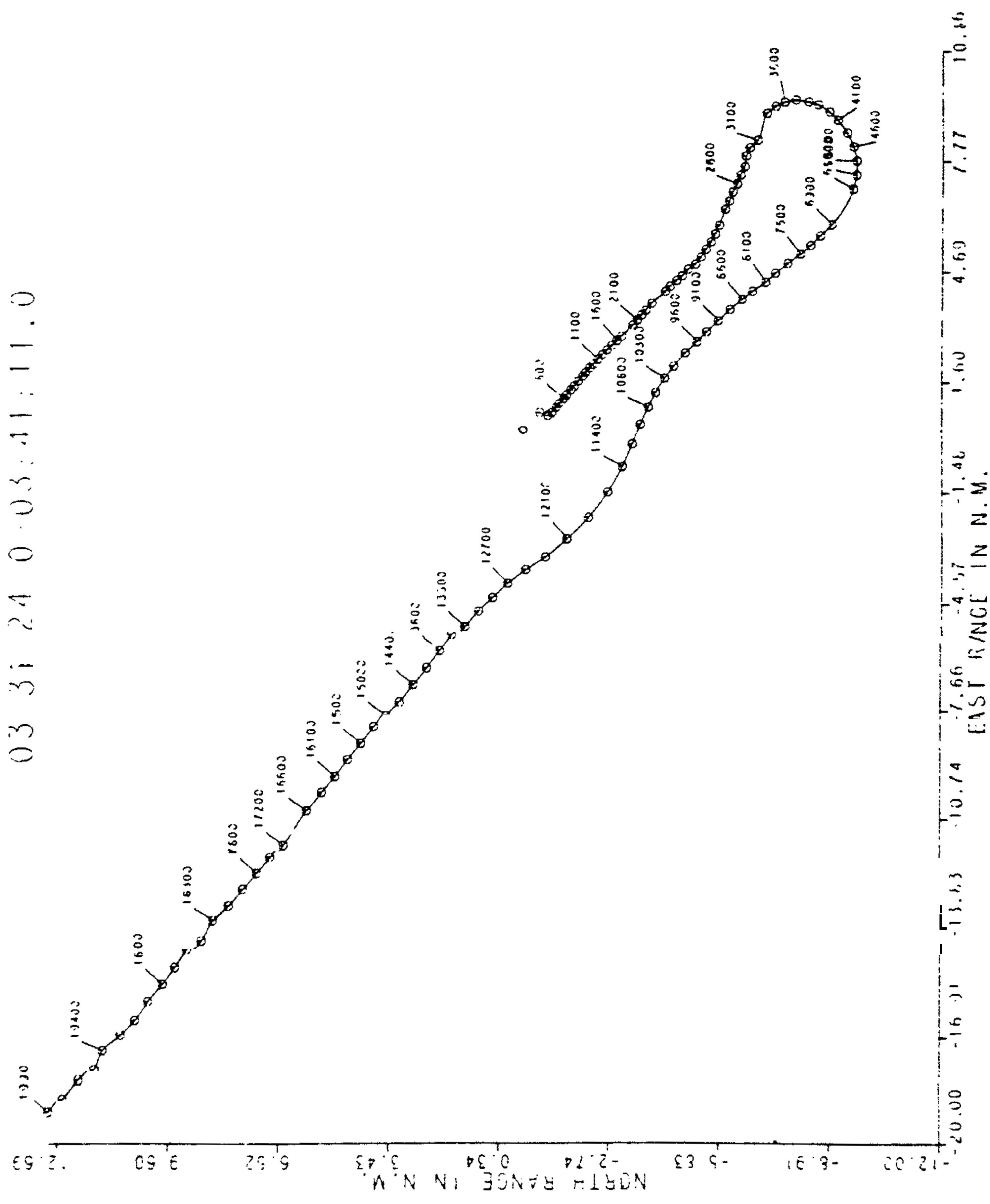

03 31 24 0 03:41:11.0
EAST RANGE IN N.M.
NORTH RANGE IN N.M.

Table II.--Printout of radar data from first profile, descent from FL200 to 10,000 feet, spoiler retraction

PRINTOUT OF OUTPUT DATA

POINT NO	TIME MIN	TIME SEC	ALTITUDE FT	GROUND SPEED KNOTS	TRACK ANGLE DEG	VERT. VEL. FPM	FLIGHT PATH DEG.	LIFT G,S	T-D GS	ANGLES ROLL DEG	ANGLES PITCH DEG	HEADING DEG MAG	AIRSPEED TRUE KNOTS	AIRSPEED IND. KNOTS
3	3	47.24	19200.	406.4	134.70	-5131.92	-7.10	1.07	-0.12	4.99	-4.83	146.71	368.0	275.7
4	3	51.95	18900.	411.9	132.29	-3805.18	-5.21	1.03	-0.09	-3.69	-2.94	144.18	373.3	281.1
5	3	56.70	18600.	406.9	133.04	-4487.14	-6.21	0.96	-0.19	7.45	-4.27	144.94	369.7	279.6
6	4	1.33	18200.	396.5	135.44	-4482.48	-6.36	1.08	-0.30	-5.23	-3.89	147.45	360.1	273.7
7	4	6.09	17900.	392.1	130.40	-2523.21	-3.63	1.15	-0.20	-11.26	-0.60	141.99	355.8	271.9
8	4	10.85	17800.	383.9	129.59	-1928.25	-2.84	0.98	0.03	10.69	-0.13	141.12	347.8	265.7
9	4	15.46	17600.	386.4	135.01	-3216.71	-4.69	0.92	-0.05	14.11	-2.50	147.03	350.5	268.7
10	4	20.14	17300.	393.6	135.44	-3840.00	-5.50	0.97	-0.13	-18.27	-3.44	147.49	359.0	276.7
11	4	24.84	17000.	392.6	127.06	-4448.88	-6.38	1.04	-0.12	-23.34	-4.31	138.24	361.6	280.1
12	4	29.58	16600.	383.5	124.62	-4474.78	-6.56	0.98	-0.25	2.06	-4.37	135.52	354.5	276.1
13	4	34.21	16300.	379.6	128.02	-4466.47	-6.62	1.01	-0.18	11.40	-4.34	139.19	350.5	274.1
14	4	38.96	15900.	378.0	130.04	-4420.03	-6.58	0.98	-0.20	3.14	-4.34	141.42	349.5	274.9
15	4	43.71	15600.	372.4	129.59	-4494.65	-6.79	0.97	-0.02	-0.69	-4.55	140.90	345.0	272.5
16	4	48.33	15200.	381.8	129.59	-5121.03	-7.54	0.97	-0.05	6.38	-5.57	140.98	356.2	283.4
17	4	53.08	14800.	385.9	132.50	-5116.65	-7.45	1.06	-0.19	16.87	-5.41	144.14	360.6	288.8
18	4	57.71	14400.	384.8	137.46	-4484.03	-6.56	1.09	-0.22	14.89	-4.35	149.56	358.9	289.0
19	5	2.47	14100.	375.2	139.98	-3816.44	-5.73	1.01	-0.29	-4.77	-3.45	152.29	348.9	282.1
20	5	7.14	13800.	364.8	135.39	-3843.21	-5.93	1.10	-0.16	-25.61	-3.53	147.24	340.3	276.2
21	5	11.84	13500.	364.1	126.66	-3810.03	-5.89	1.04	-0.06	-6.67	-3.40	137.92	342.5	279.2
22	5	16.59	13200.	363.9	132.08	-3191.12	-4.94	1.10	-0.18	15.38	-2.31	143.78	341.1	279.3
23	5	21.21	13000.	362.1	135.01	-2563.69	-3.99	1.02	-0.23	0.13	-1.39	147.00	338.7	278.2
24	5	25.96	12800.	352.2	132.11	-2528.40	-4.05	1.04	-0.21	-10.56	-1.27	143.85	330.0	271.7
25	5	30.70	12600.	340.4	129.53	-1907.95	-3.16	1.03	-0.10	-5.61	-0.06	141.05	318.9	263.1
26	5	35.36	12500.	337.0	129.08	-1916.33	-3.21	0.96	-0.28	10.08	-0.33	140.58	315.9	260.9
27	5	40.08	12300.	330.2	135.01	-2570.97	-4.39	0.98	-0.06	11.93	-1.40	146.81	308.9	255.8
28	5	44.70	12100.	332.5	135.46	-2560.51	-4.34	0.99	0.17	-8.44	-1.36	147.35	311.5	258.8
29	5	49.45	11900.	340.4	130.09	-3185.33	-5.27	0.97	-0.15	-10.45	-2.68	141.68	321.6	266.2
30	5	54.13	11600.	343.2	130.09	-3202.14	-5.26	1.00	-0.42	14.78	-2.72	141.75	324.8	272.3
31	5	58.82	11400.	319.2	138.07	-3173.67	-5.60	0.99	-0.46	14.00	-2.57	150.06	299.8	251.8
32	6	3.57	11100.	292.8	138.07	-3190.94	-6.13	1.07	-0.10	0.73	-1.91	149.78	274.2	231.0
33	6	8.20	10900.	297.4	138.51	-1928.30	-3.66	1.07	-0.13	0.61	0.58	150.55	277.9	235.0
34	6	12.95	10800.	300.5	138.51	-1895.26	-3.56	1.00	-0.09	0.60	0.25	150.62	281.1	238.2
35	6	17.70	10600.	300.7	138.89	-1911.81	-3.59	1.00	-0.04	0.66	0.18	151.07	281.7	239.4
36	6	22.32	10500.	296.9	138.89	-1943.76	-3.70	0.97	0.02	5.10	0.03	151.05	278.0	236.7
37	6	26.96	10300.	310.1	141.76	-2592.41	-4.71	0.99	0.16	6.20	-1.42	154.17	291.7	249.3
* 38	6	31.58	10100.	324.6	142.21	-2561.49	-4.45	1.03	0.07	-9.87	-1.43	154.78	306.5	263.0
* 39	6	36.33	9900.	332.0	135.92	-2528.40	-4.30	1.03	0.04	-11.07	-1.49	148.20	315.0	271.3

* SMOOTHED VALUES ARE APPROXIMATE NEAR END POINTS

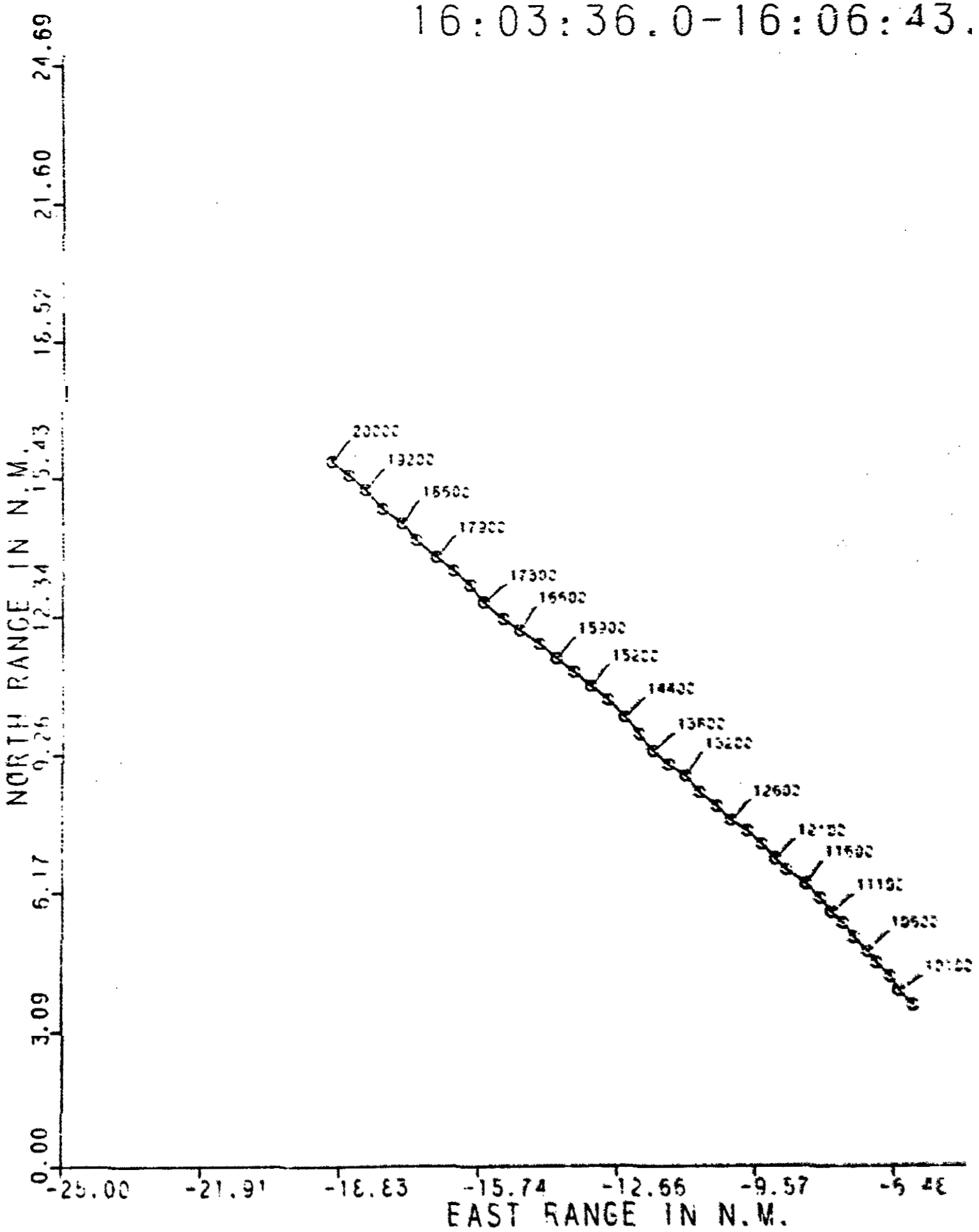


Figure 2.--Plotted data from first profile, spoilers retracted.

Table III.--Printout of radar data from second profile, descent from FL200 to 10,000 feet, spoilers extended.

PRINTOUT Ut OUTPUT DATA

POINT YO	MIN	SEC	ALTITUDE FT	GROUND SPEED KNOTS	TRACK ANGLE DEG	VERT. VEL. FPM	FLIGHT PATH DEG	LIFT G,S	T-U GS	ANGLES ROLL DEG	ANGLES PITCH DEG	HEADING DEG MAG	AIRSPEED TRUE KNOTS	AIRSPEED IND. KNOTS
3	16	33.36	19100.	402.2	159.71	-5108.06	-7.14	0.75	-0.11	-24.61	-6.02	174.96	362.4	269.2
4	16	30.09	I9200.	YU1.6	154.81	-7580.11	-10.55	0.04	-0.11	-13.12	-9.47	169.14	366.4	274.4
5	16	42.85	I8500.	400.8	154.81	-8311.64	-11.56	1.11	-0.33	9.19	-9.77	160.74	368.9	279.4
6	16	41.45	I7900.	401.3	159.20	-5181.89	-7.26	1.21	-0.12	b.95	-4.60	173.70	365.7	219.5
7	16	52.16	17700.	403.6	158.48	-4490.20	-b.26	0.90	-0.02	0.73	-4.51	173.05	367.5	281.0
8	16	56.8)	I7200.	4u4.2	159.52	-6993.54	-9.68	U.91	-0.15	21.69	-8.52	173.92	373.2	288.5
9	17	1.59	16600.	408.5	167.22	-7034.39	-9.64	1.03	-0.28	14.36	-8.12	182.19	379.9	296.6
10	17	6.20	16100.	397.9	166.19	-6412.13	-9.04	1.04	-0.42	-19.45	-7.37	180.98	369.4	290.3
11	17	10.95	15600.	384.4	157.93	-6401.14	-9.33	1.05	-0.13	-19.42	-7.49	171.80	356.5	281.9
12	17	15.57	I5100.	387.6	156.66	-6483.75	-9.37	1.00	-0.14	9.49	-7.64	170.35	361.1	287.8
13	17	0.20	I4600.	389.8	162.29	-6401.00	-9.20	1.04	-0.24	19.49	-7.54	176.40	364.6	293.0
14	17	34.95	14100.	391.7	165.73	-6403.74	-9.16	1.03	-0.16	5.60	-7.45	180.06	367.9	297.9
15	17	29.57	13600.	383.8	165.03	-5765.41	-0.43	1.07	-0.32	0.47	-6.41	179.22	360.3	293.8
16	17	34.31	13200.	375.4	165.98	-4466.47	-6.69	1.08	-0.30	-0.22	-4.39	180.24	351.2	287.8
17	17	38.96	12900.	368.6	164.93	-3840.60	-5.87	1.01	-0.31	-3.98	-3.61	179.13	344.5	283.4
18	17	43.71	12600.	351.6	163.99	-3892.83	-0.23	*0.98*	-*0.29*	6.64	-3.02	178.03	328.4	271.1
19	17	48.21	I2300.	344.9	167.90	-3891.27	-6.35	0.98	-0.14	9.43	-3.86	182.18	322.7	261.5
20	17	52.96	12000.	345.7	168.50	-4404.54	-7.16	0.97	-0.10	-7.62	-4.79	182.74	324.9	270.5
21	17	57.15	11600.	345.4	163.97	-4465.66	-7.21	1.02	-0.21	-8.21	-4.70	177.85	325.2	272.6
23	18	2.35	11JOU.	343.3	163.97	-3908.40	-6.41	1.01	-0.25	-1.95	-3.84	177.89	323.1	272.1
23	18	6.96	11000.	334.4	162.94	-3900.13	-6.56	0.98	-0.24	-2.29	-3.95	176.77	314.8	266.3
24	18	11.58	10700.	325.2	162.77	-3842.33	-6.65	1.03	-0.16	-0.30	-3.69	176.54	306.2	260.2
25	18	16.33	10400.	325.3	162.77	-3189.85	-5.52	1.07	-0.12	6.81	-2.38	176.59	306.2	261.5
26	18	20.96	I0200.	314.1	166.69	-2592.41	-4.51	1.10	-0.22	6.19	-1.111	180.83	305.0	261.3
* 27	18	25.59	10000.	317.0	166.45	-1297.30	-2.31	1.15	-0.17	-9.39	1.55	180.71	297.4	255.5
* 28	18	30.21	10000.	308.4	160.65	0.00	0.00	1.09	-0.09	-9.46	4.04	174.70	288.4	241.6

* SMOOTHED VALUES ARE APPROXIMATE NEAR END POINTS

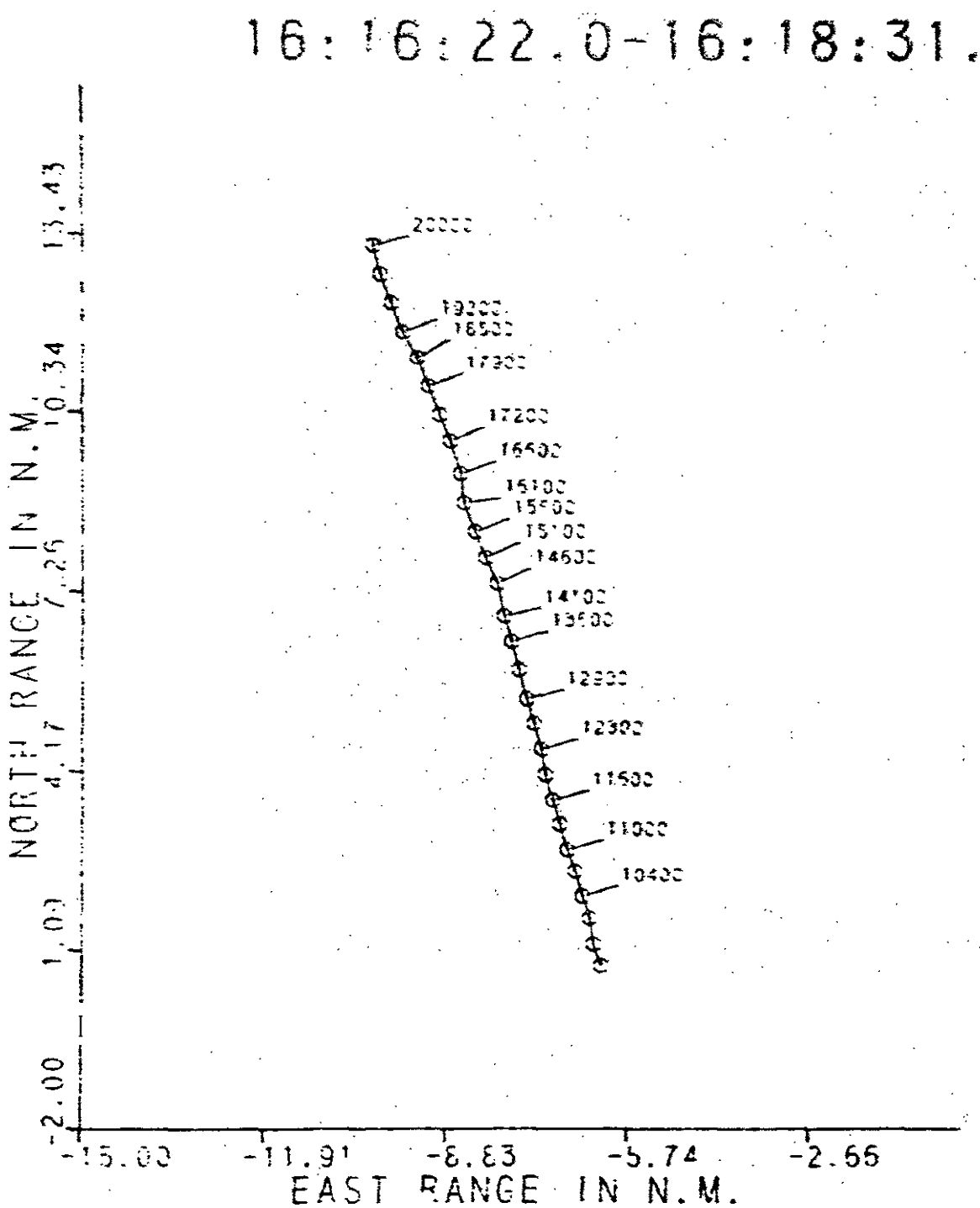


Figure 3.--Plotted data from second profile, spoilers extended.

Table IV.--Printout of rndnr dntn from the thrid profile, descent from downward to final, spoilers retracted.

PRINTOUT OF OUTPUT DATA

POINT NO	TIME MIN	TIME SEC	ALTITUDE FT	GROUND SPEED KNOTS	TRACK ANGLE DEG	VERT. VEL. FPM	FLIGHT PATH DEL	LIFT G,S	T-D GS	ANGLES ROLL DEG	ANGLES PITCH DEG	HEADING DEG MAG	AIRSPEED TRUE KNOTS	AIRSPEED IND. KNOTS
3	38	19.07	12000.	466.4	156.58	-432.31	-0.52	0.97	-0.01	8.19	0.67	170.38	442.4	371.6
4	38	32.95	11800.	460.8	146.63	-1114.37	-1.37	1.43	-0.26	-50.52	-0.13	159.87	438.0	368.9
5	38	37.34	11700.	445.5	132.56	-2025.89	-2.51	1.05	-0.58	-32.33	-1.40	145.04	425.3	358.5
6	38	41.82	11500.	405.2	135.01	-2637.85	-3.67	1.00	-0.56	15.39	-2.03	147.43	385.4	324.9
7	38	46.45	11300.	375.8	139.47	-1942.12	-2.91	1.01	-0.58	-6.02	-0.72	152.07	355.3	299.8
8	38	51.08	11200.	341.4	132.48	-1946.50	-3.21	0.92	-0.65	-15.07	-0.79	144.48	322.7	272.3
9	38	55.70	11000.	311.3	132.94	-3239.42	-5.86	0.88	-0.37	8.21	-3.05	144.62	293.6	248.1
10	39	0.34	10700.	289.0	136.92	-3542.36	-6.89	0.99	-0.21	10.33	-3.12	148.56	211.7	230.5
11	39	9.11	10200.	286.5	139.98	-2898.63	-5.70	1.03	-0.09	-2.41	-1.52	151.99	26Y.0	230.0
12	39	14.33	10000.	292.9	138.07	-2562.54	-4.93	1.02	-0.05	-3.06	-1.02	150.12	275.6	236.5
13	39	19.07	9800.	290.7	138.07	-2554.91	-4.95	1.01	-0.15	11.67	-1.14	150.13	373.0	235.7
14	39	23.73	9600.	290.0	145.22	-2594.69	-5.04	1.00	-0.10	6.52	-1.22	157.79	272.6	235.3
15	3Y	28.32	9400.	284.7	142.16	-2597.94	-5.14	0.95	-0.43	-12.61	-1.47	154.53	268.0	232.2
16	39	32.96	9200.	264.9	138.07	-3190.79	-6.78	0.98	-0.23	1.35	-2.21	149.85	249.9	217.0
17	39	37.71	8900.	265.1	143.36	-2529.44	-5.38	1.11	0.21	10.53	-0.19	155.60	249.3	217.6
18	39	42.46	8800.	277.3	145.80	-1931.07	-3.93	1.01	0.12	0.24	0.37	158.47	261.1	228.3
19	39	41.07	8600.	299.0	143.55	-2562.65	-4.83	1.00	-0.07	-0.04	-1.42	156.15	283.8	249.2
20	39	51.82	8400.	298.0	145.89	-1910.71	-3.62	1.02	-0.21	-1.58	-0.04	158.69	282.5	248.1
21	39	56.46	8 300.	275.2	142.83	-1928.62	-3.95	0.96	-0.18	-6.83	0.07	155.30	260.3	229.5
22	40	1.14	8100.	273.2	141.76	-2528.83	-5.22	0.96	-0.06	-1.67	-1.11	154.04	259.3	229.3
23	40	5.95	7900.	276.1	141.76	-2545.06	-5.20	0.99	-0.12	-3.13	-1.21	154.06	2b2.1	233.0
24	40	10.57	7700.	270.7	139.83	-2577.30	-5.36	0.98	-0.27	-2.32	-1.10	151.97	258.0	229.6
25	40	19.95	7300.	263.7	143.71	-2543.16	-5.43	1.11	-0.18	-20.98	-1.05	155.96	251.5	225.1
2b	40	24.70	7100.	256.0	127.77	-2526.32	-5.56	1.19	0.03	-40.79	-1.37	139.14	246.3	221.1
27	40	29.45	6900.	266.7	111.96	-4596.49	-9.65	1.09	0.27	-39.26	-h.39	122.70	203.0	237.0
28	40	33.95	6400.	293.1	100.59	-6488.63	-14.32	1.26	0.11	-41.33	-9.49	111.37	295.6	268.8
29	40	38.70	5900.	309.8	82.21	-6401.28	-11.52	1.46	-0.10	-43.98	-8.68	93.24	316.0	289.8
30	40	43.32	5400.	303.2	66.66	-5804.92	-10.69	1.2Y	-0.33	-36.45	-7.74	78.00	311.7	288.0
31	40	52.70	4600.	290.5	51.96	-3855.14	-7.46	1.48	-n.30	-38.71	-3.87	63.76	298.6	279.2
32	40	57.33	4400.	277.8	31.49	-1944.85	-3.95	1.43	-0.14	-37.33	-0.13	44.02	286.5	268.7
33	41	1.96	4300.	278.4	20.36	-1280.23	-2.60	1.14	-0.09	-28.71	0.64	33.40	287.5	270.1
34	41	6.71	4200.	271.4	11.38	-1895.78	-3.94	1.24	-0.19	-42.04	-0.14	24.59	281.3	264.6
35	41	11.45	4000.	266.2	348.62	-2562.59	-5.42	1.2Y	-0.11	-41.71	-1.93	2.51	276.6	261.0
36	41	16.07	3800.	265.0	338.04	-2561.55	-5.45	1.21	-0.12	-37.21	-1.95	352.30	274.1	260.0
37	41	20.82	3600.	262.1	320.17	-3207.46	-6.88	1.56	-0.15	-50.34	-3.10	334.70	271.0	257.3
38	41	25.45	3300.	264.3	291.06	-2582.18	-5.50	1.36	-0.18	-33.97	-1.34	306.27	268.8	256.4
39	41	30.16	3200.	256.5	291.06	-637.87	-1.40	1.11	-0.21	-6.30	2.83	306.65	25Y.B	248.1
40	41	34.95	3200.	242.9	285.75	-648.65	-1.51	0.97	-0.20	-9.74	2.64	301.49	245.4	234.3
41	41	39.58	3100.	231.7	283.73	-1265.52	-3.08	0.96	-0.15	4.31	1.52	299.42	234.1	223.9
42	41	44.44	3000.	224.9	289.21	-1264.42	-3.17	1.04	-0.15	11.82	2.03	304.81	228.0	218.4
43	41	49.07	2900.	224.0	293.44	-860.06	-2.17	1.0b	-0.02	12.72	3.11	308.94	228.2	218.9
44	42	3.19	2800.	221.0	319.22	-843.05	-2.15	1.03	-0.16	21.97	2.76	333.93	228.0	219.0
45	42	7.95	2100.	210.1	328.38	-1279.19	-3.44	1.U0	-0.36	6.43	2.10	342.48	217.9	209.6
46	42	12.57	2600.	196.1	324.93	-648.65	-1.87	1.07	-0.19	-2.58	5.01	339.05	203.6	196.1
41	42	17.32	2600.	181.6	325.96	0.00	0.00	1.00	-0.12	-4.28	7.56	340.29	189.0	182.0
48	42	22.07	2600.	172.8	320.65	-647.55	-2.12	0.96	-0.25	3.28	5.96	334.92	180.2	173.5
4Y	42	26.71	2500.	167.3	328.73	-647.55	-2.19	1.04	-0.18	6.53	7.09	342.35	114.7	168.5
50	42	31.45	2500.	156.6	327.59	0.00	0.00	1.01	0.02	-7.64	10.20	341.60	1b3.9	158.0
51	42	36.11	2500.	155.2	320.21	-635.24	-2.31	0.69	-0.04	-1.09	7.04	334.20	lb2.5	156.7
52	42	40.83	2400.	160.2	326.67	-1902.56	-6.66	U.95	-0.19	0.10	2.70	339.42	168.4	162.6
53	42	45.51	2200.	154.4	320.31	-1267.33	-4.63	1.02	-0.18	0.79	6.23	332.97	161.6	156.5
54	42	50.20	2200.	143.5	327.39	-1265.24	-4.97	0.96	-0.15	6.95	6.78	339.53	150.5	145.8
55	42	54.95	2000.	140.4	328.53	-1913.89	-7.66	0.94	-0.23	1.53	4.50	339.57	147.2	143.0
56	42	59.57	1900.	136.U	329.43	-1911.81	-7.85	0.99	-0.16	6.05	5.62	339.91	143.0	139.1
57	43	4.32	1700.	132.8	336.63	-1890.61	-7.99	1.02	-0.21	1.24	6.86	346.31	137.3	133.9
58	43	9.10	1600.	121.1	331.36	-1269.06	-5.90	1.03	-0.22	-6.40	12.29	341.10	124.7	121.8
5Y	43	23.13	1300.	123.5	323.01	-1919.47	-8.72	1.01	-0.04	-8.93	8.25	332.05	126.7	124.3
60	43	27.82	1100.	120.7	315.00	-1909.97	-8.87	1.03	-0.11	3.69	9.42	323.60	123.5	121.6
61	43	32.57	1000.	128.9	328.73	-1280.20	-5.59	1.08	-0.01	15.93	11.11	338.53	129.0	127.2
62	43	37.20	900.	138.4	337.95	-1279.68	-5.21	1.05	0.04	4.04	9.48	348.59	137.1	135.3

Table IV.--Printout of radar dnta **from the thrid** profile, descent from downwind to final, spoilers retracted (cont'd).

PRINTOUT OF OUTPUT DATA

POINT NO	TIME MIN	TIME SEC	ALTITUDE FT	GROUND SPEED KNOTS	TRACK ANGLE DEG	VERT. VEL. FPM	FLIGHT PATH DEG	LIFT G,S	T-D GS	ANGLES ROLL DEG	ANGLES PITCH DEG	HEADING DEG MAG	AIRSPEED TRUE KNOTS	AIRSPEED IND. KNOTS
63	43	41.95	800.	139.5	333.43	-631.58	-2.56	1.06	-0.14	-5.53	12.14	344.93	137.7	136.1
64	43	51.33	800.	129.4	329.87	0.00	0.00	0.98	-0.36	-11.02	15.74	341.84	127.7	126.3
* 65	43	56.08	800.	112.2	320.65	-648.10	-3.26	0.92	-0.43	-11.59	16.24	331.09	111.4	110.2
* 66	44	0.71	700.	81.0	315.00	-1296.20	-8.97	0.92	-0.36	-4.05	28.73	318.96	81.1	80.3

* SMOOTHED VALUES ARE APPROXIMATE NEAR END POINTS

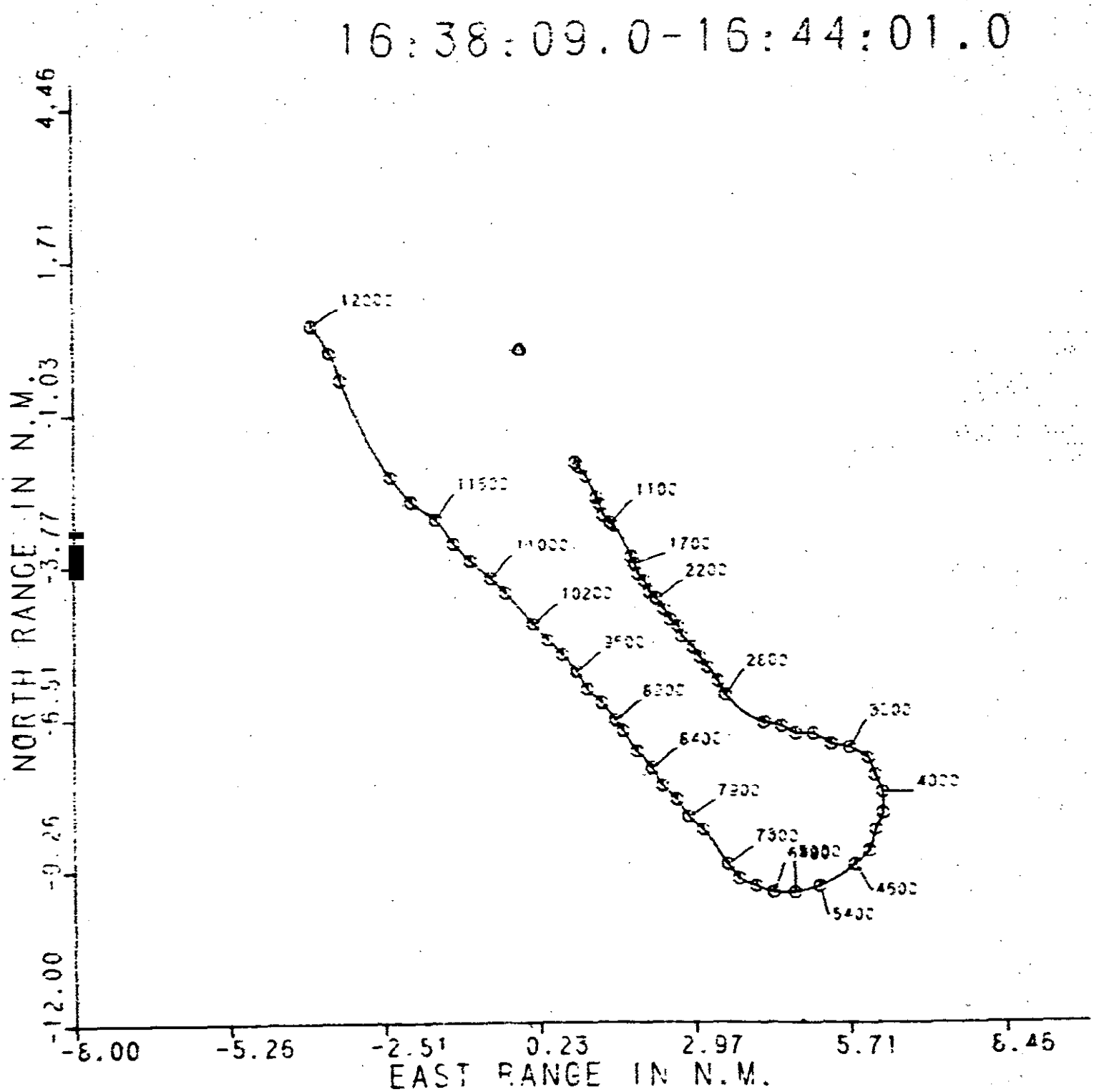


Figure 4.--Plotted data from *third* profile, spoilers retracted.

Table V.--Printout of radar data from fourth profile, descent from downwind to final, spoilers extended.

PRINTOUT OF OUTPUT DATA

POINT NO	TIME MIN	TIME SEC	ALTITUDE FT	GROUND SPEED KNOTS	TRACK ANGLE DEG	VERT. VEL. FPM	FLIGHT PATH DEG	LIFT G,S	T-D GS	ANGLES ROLL DEG	ANGLES PITCH DEG	HEADING DEG MAG	AIRSPEED TRUE KNOTS	AIRSPEED IND. KNOTS
3	35	49.10	12000.	456.3	239.21	0.00	0.00	1.02	-0.02	-14.37	1.20	256.20	452.4	380.J
4	35	58.97	12000.	452.1	233.72	-669.57	-0.84	0.96	-0.28	-13.42	0.31	250.66	446.0	314.1
5	36	3.45	11900.	436.7	231.21	-1318.22	-1.71	1.05	-0.40	-20.00	-0.32	248.17	429.9	361.3
6	36	8.08	11800.	404.7	224.99	-648.65	-0.91	1.04	-0.61	-17.65	0.86	242.06	395.4	311.9
7	36	12.70	11800.	374.9	222.48	-1333.33	-2.01	0.93	-0.51	-12.30	-0.01	239.69	364.8	105.6
8	36	11.20	11600.	348.7	219.04	-1964.91	-3.18	0.96	-0.37	-11.41	-0.16	236.27	337.9	283.5
9	36	21.95	11500.	327.7	216.45	-1966.07	-3.39	0.95	-0.29	-4.85	-0.55	233.76	316.2	665.3
10	36	26.415	11300.	319.4	216.01	-2615.56	-0.62	0.94	-0.34	4.59	-1.70	231.25	308.4	259.5
11	36	31.11	11100.	306.0	218.43	-2593.89	-4.78	0.91	-0.30	12.64	-1.52	235.80	29b. I	249.8
12	36	35.70	10900.	290.4	222.52	-3206.00	-6.21	0.93	-0.16	7.13	-2.74	740.04	282.8	239.2
13	36	40.45	10600.	288.6	222.52	-3840.77	-7.41	I.02	-0.10	-12.75	-3.70	239.83	282.2	239.9
14	36	45.01	10300.	296.7	214.78	-3211.75	-6.09	1.08	0.01	-3.47	-2.20	231.71	287.1	245.3
15	36	49.82	10100.	301.0	220.90	-2597.65	-4.86	1.10	-0.23	16.35	-1.17	238.01	292.9	251.1
16	36	54.32	9900.	291.5	224.99	-1966.07	-3.81	1.04	-0.22	8.67	0.06	242.34	284.4	244.6
17	36	59.07	9800.	280.6	225.81	-1926.69	-3.87	0.99	-0.22	1.85	0.16	243.20	273.9	235.8
18	37	1.70	9600.	268.5	225.81	-1925.65	-4.05	1.00	-0.09	0.01	0.43	243.33	261.9	226.1
19	31	8.46	9500.	272.3	22 .81	-1915.90	-3.97	0.96	-0.01	0.02	0.18	243.26	265.8	225.9
20	37	13.13	9300.	270.6	225. 1	-2564.29	-5.34	0.97	-0.20	-11.72	-1.27	243.10	264.8	229.7
21	37	17.82	9100.	267.0	218.05	-2542.09	-5.36	1.01	-0.07	-7.23	-0.92	235.03	259. I	225.5
22	37	22.51	8900.	265.5	221.11	-2560.46	-5.43	1.05	-0.17	20.23	-1.01	238.07	258.5	225.7
23	37	27.20	8700.	261.1	231.74	-2560.46	-5.53	1.07	-0.06	21.38	-0.95	248.09	257.1	225.2
24	37	31.95	8500.	262.6	236.36	-2526.32	-5.42	1.06	-0.15	-2.73	-0.68	253.53	259.9	220.4
as	37	36.70	8300.	256.8	229.61	-1263.16	-2.78	1.01	-0.06	-10.36	I.96	246.87	251.2	221.3
26	37	41.14	8300.	262.2	228.87	-2493.51	-5.36	0.68	0.01	8.56	-1.54	245.90	257.2	226.7
21	37	45.95	7900.	268.5	235.62	-3789.71	-7.93	1.03	-0.09	14.19	-3.87	252.26	266.6	236.6
28	31	50.58	7700.	270.1	238.89	-2561.44	-5.34	1.08	-0.18	12.04	-1.04	255.65	267.6	238.2
29	37	55.32	1500,	266.4	244.06	-2561.44	-5.42	0.99	-0.19	1.79	-1.36	760.86	265.2	236.11
30	37	59.95	7300.	257.0	240.08	-2560.40	-5.61	1.14	-0.06	-28.75	-1.10	256.76	254.8	228.1
31	38	4.70	7100.	260.5	221.83	-2527.36	-5.47	1.15	-0.04	-38.94	-1.51	231.99	254.0	228.1
32	38	9.45	6930.	270.2	211.25	-4506.40	-9.34	0.84	0.00	-29.60	-6.74	226.79	364.3	238.2
33	38	14.07	6400.	280.1	206.11	-7660.66	-15.09	1.14	-0.06	-44.60	-12.15	220.60	80.5	254.9
34	38	18.82	5100.	288.3	181.36	-8312.60	-15.87	1.26	-0.11	-41.57	-13.40	194.62	288.8	265.4
35	38	23.45	5100.	297.7	175.53	-9006.66	-16.61	1.00	-0.37	-15.11	-14.18	188.69	300.4	278.8
36	39	28.14	4300.	292.8	171.64	-6359.25	-12.09	1.58	-0.50	-28.75	-8.09	184.43	289.9	272.4
37	38	33.95	4100.	279.9	147.78	-581.60	-1.17	1.62	-0.14	-14.40	3.69	160.73	211.7	256.0
38	38	37.45	4200.	270.6	137.79	25.55	0.05	I.07	0.00	-29.94	3.62	150.50	263.1	247.4
39	38	42.14	4100.	271.5	128.02	-1916.28	-3.98	1.13	-0.08	-40.99	-0.81	140.21	266.0	250.6
40	38	46.84	3900.	270.2	109.63	-2542.03	-5.30	I.24	-0.22	-44.72	-2.13	121.40	268.0	253.2
41	38	51.58	3700.	259.5	94.86	-3858.69	-8.34	1.11	-0.26	-39.62	-5.04	106.28	261.4	247.7
42	38	56.21	3300.	246.2	81.27	-4488.70	-10.20	1.41	-0.311	-44.96	-5.96	92.35	251.4	239.7
43	39	0.95	1000.	234.2	53.04	-3159.45	-7.58	1.41	-0.22	-37.81	-2.09	64.68	241.1	231.0
44	39	5.10	2800.	234.2	41.12	-1263.16	-3.04	I.27	0.15	-20.79	2.46	53.33	239.2	229.8
45	39	10.33	2800.	239.7	33.08	0.00	0.00	1.06	-0.11	-19.77	4.31	45.79	245.2	235.5
4b	39	15.08	2800.	233.6	25.93	-1298.39	-3.14	0.89	-0.50	-12.94	0.80	3b.57	240.0	230.5
47	39	19.70	2600.	206.5	24.57	-1929.97	-5.27	1.03	-0.50	-0.17	0.90	36.41	212.2	204.4
48	39	14.45	2500.	172.9	26.41	8.42	0.03	1.15	-0.15	16.93	9.68	38.40	176.8	170.5
49	39	29.14	2600.	167.8	44.27	0.53	0.00	0.117	-0.06	9.15	8.05	55.93	170.5	164.2
S0	39	33.83	2500.	174.7	34.90	-2524.90	-8.11	0.85	-0.10	-15.98	-1.14	45.77	179.4	173.0
51	39	38.61	2200.	175.9	30.32	-3188.23	-10.14	1.00	-0.04	5.45	-1.84	40.63	179.8	174.1
52	39	43.21	2000.	177.4	39.69	-2859.03	-9.03	I.02	-0.12	-4.10	-0.58	50.15	178.2	173.1
53	39	47.07	1800.	178.3	30.01	-2620.68	-8.25	1.06	-11.23	-18.75	0.09	40.81	178.5	173.9
54	39	52.10	1600.	169.9	21.58	-2178.65	-7.10	1.00	-0.34	-1.26	1.48	32.40	169.3	165.5
55	39	57.45	1400.	157.3	26.66	-1900.49	-6.79	1.14	0.01	13.94	5.16	37.38	154.9	151.8
50	40	2.16	1300.	165.6	39.28	-636.29	-2.17	I.06	-0.16	1.15	0.66	51.81	161.0	158.I
57	40	6.96	1300.	160.2	27.72	-648.65	-2.29	0.98	-0.21	12.18	8.03	39.87	15b.J	153.4
58	40	11.59	1200.	155.8	51.37	-1281.27	-4.64	1.10	-0.03	25.08	6.89	63.69	151.1	148.5
59	40	16.33	1100.	149.6	57.82	-632.62	-2.39	1.10	0.04	-13.12	11.24	71.24	144.5	142.2
60	40	20.95	1100.	164.5	35.32	0.00	0.00	I.0b	0.24	-11.42	10.72	48.60	159.6	157.2
61	40	25.71	1100.	180.0	45.78	0.00	0.00	I.03	-0.01	14.75	8.53	59.42	174.9	172.2
62	40	10.46	1100.	169.8	50.36	0.00	0.00	1.04	-0.12	16.67	9.10	64.12	164.6	162.0

Table V.--Printout of radar data from fourth profile, **descent** from downwind tu final, spoilers extended. (cont'd)

PRINTOUT OF OUTPUT DATA

POINT NO	MIN	SEC	ALTITUDE FT	GROUND SPEED KNOTS	TRACK ANGLE DEG	VERT. VEL. FPM	FLIGHT PATH DEG	LIFT G.S	T-D GS	ANGLES ROLL DEG	ANGLES PITCH DEG	ANGLES HEADING DEG MAG	AIRSPEED TRUE KNOTS	AIRSPEED IND. KNOTS
63	40	35.08	1100.	169.1	63.32	0.00	0.00	1.07	0.21	20.45	9.80	77.50	163.8	161.3
64	40	39.83	1100.	173.7	72.48	0.00	0.00	1.01	0.05	6.09	9.21	86.93	168.5	165.9
65	40	44.46	1100.	176.5	69.87	0.00	0.00	1.01	-0.31	6.15	8.90	84.24	171.3	168.7
66	40	49.15	1100.	162.7	78.63	0.00	0.00	1.00	-0.24	-1.96	10.00	93.31	157.7	155.3
67	40	53.85	1100.	137.4	67.50	0.00	0.00	1.01	-0.07	-16.92	14.80	81.89	132.4	130.1
68	40	58.58	1100.	137.8	57.39	-631.58	-2.59	0.98	0.24	2.80	12.17	70.65	132.7	130.6
69	41	3.33	1000.	162.0	71.13	-631.58	-1.20	1.04	*0.00*	-0.17	8.76	85.32	157.3	155.1
70	41	7.95	1000.	161.9	57.97	0.00	0.00	1.07	-0.09	-14.88	11.10	72.18	156.8	154.6
71	41	12.70	1000.	157.6	54.34	0.00	0.00	1.00	0.04	3.11	11.35	68.44	152.5	150.3
72	41	17.45	1000.	153.9	61.48	0.00	0.00	1.00	0.02	1.10	11.94	75.83	148.8	146.7
73	41	22.07	1000.	160.3	55.95	*0.00*	0.00	1.00	0.10	1.27	10.94	70.10	155.2	153.0
74	41	26.85	1000.	165.5	63.32	*0.00*	*0.00*	1.01	-0.17	7.42	10.19	77.70	160.5	158.2
75	41	31.46	1000.	151.9	64.05	0.00	0.00	0.97	-0.14	-3.32	11.85	78.49	146.8	144.8
76	41	36.13	1000.	144.5	59.53	-622.37	-2.43	0.96	-0.12	-3.06	10.59	73.25	139.5	137.6
77	41	40.95	900.	135.6	60.58	-622.37	-2.59	1.03	-0.18	0.15	13.31	74.40	130.9	129.3
78	41	45.57	900.	135.4	59.72	0.00	0.00	1.01	-0.11	-5.61	15.66	74.27	130.5	128.9
79	41	50.33	900.	140.5	53.35	-649.20	-2.61	0.98	0.02	-7.68	11.25	67.00	135.7	134.0
80	41	54.95	800.	143.3	50.31	-649.20	-2.56	1.00	0.00	-2.56	11.13	64.08	138.7	137.2
81	41	59.70	800.	154.1	50.31	-630.02	-2.31	1.02	0.16	7.07	9.48	64.18	149.5	147.8
82	42	4.46	700.	161.3	58.74	-630.02	-1.21	1.02	0.18	7.18	8.37	73.07	157.2	155.7
83	42	9.07	700.	174.2	58.74	-631.58	-2.05	1.01	*0.07*	-9.04	6.85	73.13	170.1	168.5
* 84	42	13.82	600.	184.0	50.31	-631.58	-1.94	1.03	-0.05	-3.07	6.18	64.64	180.0	178.5
* 85	42	18.57	600.	178.0	55.62	0.00	0.00	1.04	-0.05	5.11	8.70	70.37	174.1	172.6

* SMOOTHED VALUES ARE APPROXIMATE NEAR END POINTS

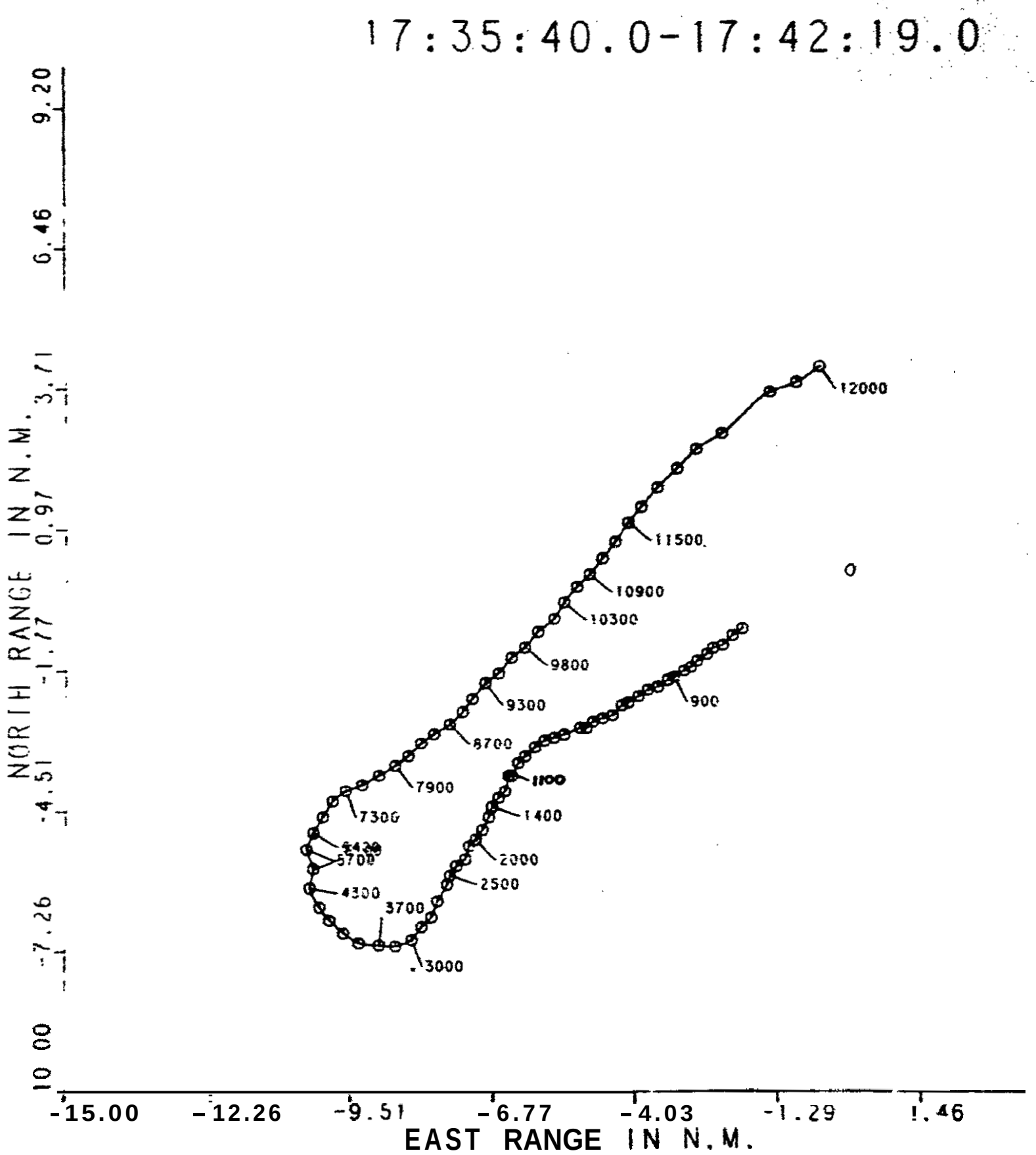


Figure 5.--Plotted data from fourth profile, spoilers extended.

APPENDIX E

ACCIDENT HISTORY

In Lancaster, California, on October 17, 1978. an unmodified Learjet 24, crashed duping a training flight. The training schedule for Learjet type rating required the introduction of single-engine approaches and simulated engine faiiure on takeoff at or after V_1 speed during this series of planned touch-and-go landings. One witness said the airplane made a circling approach to the runway and touched down about 600 feet beyond the threshold and that the airplane rolled to the center taxiway before he heard a power increase for takeoff. Another witness saw the airplane bank sharply to the left upon becoming airborne, and then bank 90° to the right. From a point about 550 feet from the end of the runway, the airplane veered off to the right at an angle of 38°. The right wingtip made initial contact about 360 feet from the side of the runway. One pilot was killed, the other was seriously injured. and the airplane was destroyed. The Safety Board concluded that the pilot did not maintain directionai control of the aircraft. (NTSB Accident Docket No. 3-3022)

On December 4, 1978, a Learjet 25, with *e* Century III wing modification, crashed in Anchorage, Alaska, during the landing phase of flight following a visual approach. Light-to-moderate icing was forecast in clouds below 12.000 feet in the Anchorage area, and turbulence accompanied by gusting winds was reported in the airport vicinity. The flightpath was normal almost to touchdown when the airplane suddenly pitched up and began to bank steeply from side to side. The airplane rolled to the right end continued over until the right wing struck the ground. *Of* the sever: persons aboard the airplane. both pilots and three passengers were killed, and two passengers suffered serious injury: the airplane was destroyed.

The Safety Board determined that the probable cause of the accident was en encounter with strong, gusting crosswinds during the landing attempt, which caused ?he ai-craft to roll abruptly and unexpectedly. The ensuing loss of control resulted from inappropriate pilot techniques during the attempt to regain control of the aircraft. Suspected light ice accumulations on the aerodynamic surfaces may have contributed to a stall and loss of control. (Aircraft Accident Report--"Inlet Marine, Inc., Gates iearjet N77RS, Century III, Model 25C, Anchorage International Airport, Anchorage, Alaska, December 4, 1978" (NTSB-AAR-79-18))

On December 20, 1978, a Learjet 25, Howard/Raisbeck Mark II Conversion, airplane, with a crew of two and five passengers aboard, crashed during takeoff. in Minneapolis, Minnesota. Witnesses staled that after liftoff, the Learjet rolled *to* a 45° right bank, then to an 80° to 90° left bank, and finally *to* an 80" to 90° right bank. They estimated that the airplane reached a maximum aititude of 100 to 150 feet. The airplane struck ?he ground approximately 5,300 feet beyond the approach end of the runway in a nose-high attitude and then bounced and skidded about 803 feet before coming to a stop. All five occupants received serious injuries, and the airplane was destroyed. Causai factors related to this accident involved pilot preflight preparation, snow/ice on the airplane, improper flap setting, and improper pitch trim setting. (NTSB Accident Docket No. 3-4353)

On January 19, 1979, *e* Learjet 25D, equipped with a Century III wing modification to improve siow-speed performance and to permit operations on shorter runways crashed during a night, nonprecision approach. During descent, the airplane, which was piloted by two pilots who held Learjet type ratings, flew in light to moderate,

occasionally severe ice conditions. Shortly before the Learjet was to land, a McDonnell Douglas DC-9 took off. Witnesses saw the Learjet cross the threshold in a normal landing attitude. and seconds later, begin a series of left and right rolls. The aircraft was in a steep right bank when the right wingtip fuel tank struck the runway 2,640 feet beyond the threshold, and the airplane burst into flames. All six occupants of the aircraft were killed, and the airplane was destroyed.

The Safety Board determined that the probable cause of the accident was the pilot's loss of control of the airplane. Tne loss of control may have been initiated by wake turbulence of a departing aircraft, by a premature stall caused by an accumulation of wing ice, by delayed application of engine thrust during an attempted go-around, or by a combination of all these factors. (Aircraft Accident Report--"Massey-Ferguson, Inc., Gates Learjet 25D, N137GL, Detroit, Michigan, Jsnuary 19, 1979" (NTSB-AAR-80-4))

On July 6, 1979, an unmodified Ultra Air Learjet 25B crashed on landing at Pueblo, Colorado. The purpose of the flight was an FAA checkride for the two-well qualified crewmembers. After 40 minutes of routine airwork, the aircraft was configured for a single-engine ILS approach and landing. When the aircraft was stabilized on the final approach, the FAA inspector said he left the cockpit and belted himself down and that the airplane then went through severe yawing and rolling oscillations. Witnesses recalled seeing the airplane nose-high with the wings rocking through several cycles. The aircraft, with high engine power applied, climbed steeply to 50 feet, rolled inverted, and crashed. Both pilots were killed, the FAA inspector was seriously injured. and the airplane was destroyed.

The postaccident inspection revealed that the rudder trim was set ai zero. The pilot apparently was holding rudder to compensate for the retarded engine during ?he approach rather than trimming off the pressure. Causal factors included the improper rudder trim setting and the possibility that the heei of the pilot's cowboy boot may have jammed between the bottom of the rudder pedal and the cockpit floor scuff plate. (NTSB Accident Docket No. 3-3982)

On Mav 5, 1980, an unmodified Gates Learjet Model 23 was being operated by Kennedy Flite Center, Richmond, Virginia, on a flight from Richmond to Louisville, Kentucky, continuing to Gainesville, Florida, and returning to Richmond. Upon arrival in the Richmond area, the flightcrew requested an instrument ianding system (ILS) approach to runway *33* at Byrd International Airport. The flightcrew were cleared for the approach and landing. Witnesses stated that the airplane crossed the runway threshold "a bit high," started to rock. and rolled inverted as engine thrust increased. The airplane crashed adjacent to the runway at 0312 and burst into flame. Both pilots were killed.

The Safety Board determined that the probable cause of the accident was the pilot's failure to maintain proper airspeed and aircraft attitude while transitioning from final approach through flare to touchdown. The low-speed/high angle-of-attack flight condition precipitated wing rolloff, wingtip strikes, and ultimate loss of aircraft control. The pilot's improper technique during roundout may have been due to fatigue, his limited knowledge, training. and experience regarding the flight characteristics of the Leerjet aircraft, and distraction caused by concern over the intensity of the approach lighting. {Aircraft Accident Report--"Kennedy Flite Center Gates Learjet 23, N866JS, Byrd Internations! Airport, Richmond, Virginia, May 6, 1980." (NTSB-AAR-80-12))