?/?/2000

V-22

V-22: Testing IS BELIEVING

Only the exhaustive flight testing currently under way on the troubled tilt-rotor aircraft will determine if its flaws have been corrected

by James W. Canan
Contributing writer

The Pentagon's controversial V-22 program appears to be making a comeback from a pair of fatal crashes in 2000 that threatened to put it out of business. Flight tests of the Bell-Boeing Osprey tilt-rotor aircraft reportedly have gone well since their resumption last May, following a 15-month lull in which the program was stringently reviewed and the aircraft partially redesigned.

"We've made a big turnaround in the V-22 program," Marine Corps Col. Daniel Schultz, program manager for Naval Air Systems Command (Navair), asserted recently. "We're fixing everything that needs to be fixed, and we're right on schedule in the flight tests."

Time will tell. The overarching purpose of the flight test program is to demonstrate that the tilt-rotor aircraft can perform to specifications and expectations while being flown safely as well. Even though flight tests got off to a good start, they have a long way to go and a lot to prove. The test program will not end until late 2004 or early 2005.

The DOD intends to let flight testing run its course before deciding the fate of the aircraft. Defense Secretary Donald Rumsfeld said as much late last year when asked whether the program might be discontinued, sooner or later, with flight tests still in progress. Remarking on the V-22's "interesting capability," Rumsfeld replied, "Why in the world would you put in place a test program if you didn't want to know what the outcome will be?"

A transforming role

Current and contemplated changes in the operations and weapons requirements of U.S. armed forces may make the V-22 more appealing. Champions of the tilt-rotor transport plane contend that it fits nicely into military transformation plans, and that it is especially well suited to the far-ranging, swift-striking special operations missions and expeditionary campaigns that lie ahead.

Bell Helicopter Textron and Boeing Helicopters are teamed as prime contractor. Bell manufactures the wings, overwing fairings, empennage, nacelles, and counterrotating, three-blade prop-rotors. Boeing is responsible for the aircraft's flying qualities and builds the fuselage, landing gear, avionics, and electrical and hydraulic systems.

The Marine Corps plans to buy 360 MV-22s; the Air Force wants 50 CV-22s for its component of the U.S. Special Operations Command (USSOCOM). The Osprey is coveted for

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over the program and renamed the aircraft. Prominent among the early doubters was Richard Cheney, now vice president. As secretary of defense, he moved to kill the V-22 in 1989, three years into its full-scale engineering development, but Congress stayed his hand.

The program endured three crashes of prototype aircraft in the early 1990s. Investigators concluded that tilt-rotor technology had been blameless in all of them, and the program survived. The V-22 was cleared for engineering and manufacturing development (EMD) in 1994, and for low-rate initial production (LRIP) in 1997.

The Marines are interested in using the V-22 for both sea- and land-based operations.

In 2000, two more fatal crashes once again imperiled the program. Early that year, a Marine MV-22 nose-dived into the ground, killing four crewmembers and 15 passengers. The accident was attributed to human error. Investigators concluded that the crew had allowed the aircraft to fall prey to vortex ring state (VRS), an aerodynamic phenomenon induced by the combination of low airspeed and rapid rate of descent, resulting in prop-rotor blade stall, unbalanced lift, and loss of control.

The second crash occurred eight months later, taking the lives of four crewmembers. It was attributed to hydraulic system failure and faulty software. As a result, DOD grounded the V-22 and assembled a blue-ribbon panel of defense and industry experts to review and critique the program.

Corrective measures

The panel identified a number of design problems, notably the crowded routing of hydraulic and electrical lines. It recommended continuing with V-22 production, but only at the minimal rate necessary to preserve the Bell-Boeing industrial base, until the problems were corrected. Several other independent review panels weighed in with similar conclusions and recommendations.

Near the end of 2001, Edward C. (Pete) Aldridge Jr., undersecretary of defense for acquisition, technology, and logistics, approved a V-22 recovery plan devised by Navair and the Marine Corps. The plan included aircraft modifications and a rigorous flight test program to prove them out.

At the time, Aldridge expressed "serious doubts about the safety, reliability, and operational suitability of the V-22" and declared that "the only way to prove the case one way or the other is to put the airplane back into flight test." He emphasized that the testing would have to determine why the Osprey seemed susceptible to VRS, and that it "must explore low-speed hover, including the conditions of landing where there's dust and debris blown up by the props." The testing should also explore the aircraft's "combat maneuverability," and should involve "formation flying, including refueling," Aldridge said.

"We will not be driven by trying to accomplish something within a certain period of time," the acquisitions chief declared.

The hydraulic failure that contributed to the December 2000 crash was the result of hydraulic lines rubbing against each other, inducing friction and heat that caused one of the lines to rupture. As a result, Navair and its contractor team redesigned the hydraulic system, providing ample clearance between lines in order to eliminate chafing and facilitate maintenance. Hydraulic line clamps have been redesigned to keep the lines from vibrating, and have been treated with abrasion-resistance coating. Some hydraulic lines have been thickened and strengthened.

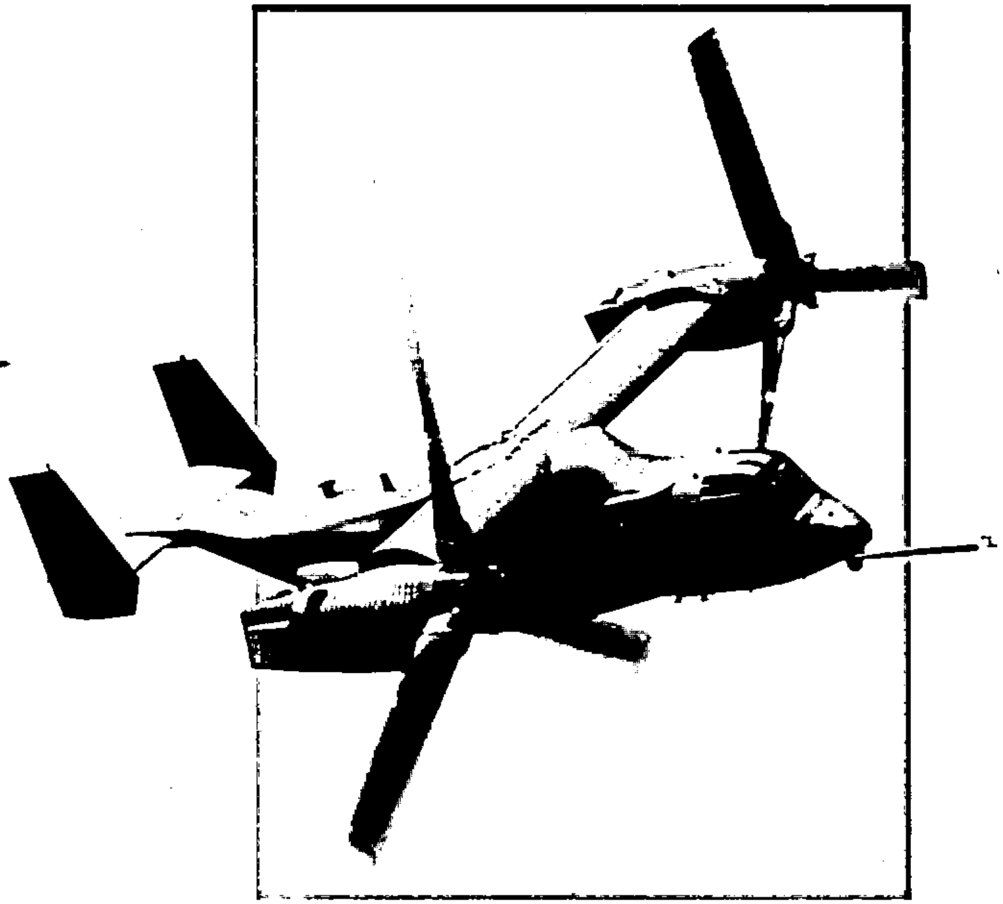
All Marine Corps MV-22s and Air Force CV-22s in the flight test program now incorporate the redesigned hydraulic systems, as well as electric wiring repositioned for greater clearance. In those aircraft, "nothing touches or rubs against anything else," Schultz asserts.

Navair and its contractors plan to manufacture operational Ospreys in three successive production blocks. Aircraft in each block will embody all software upgrades and flight-safety additions and modifications, including the redesigned hydraulic and electrical systems and new devices to warn pilots that they are descending too rapidly and risking VRS. Such devices could include a seat shaker, color changes in cockpit displays, and aural alarms, Schultz explains.

The Osprey's rotating nacelles, linchpins of dual-mode flight, have been redesigned to facilitate inspection and maintenance. Modifications include a greater number of nacelle access doors and rerouted prop-rotor gearbox lines.

Return to flight

The first V-22 test aircraft produced in the EMD phase of the program returned to the air last May at Patuxent River NAS (known as Pax



capabilities that improve upon those of conventional helicopters: It can be flown great distances at night and in bad weather, and at low, terrain-following altitudes to avoid radar detection. It can also be refueled in flight.

"This airplane is going to transform the way the Marine Corps and the Air Force fly," Schultz declares.

The Marines would fly the Osprey from sea or land bases as a troop or cargo carrier on combat-assault and assault-support missions. The Air Force would use it for insertion and extraction of special operations forces, most notably on long-range missions that must be carried out within a single overnight period of darkness. The V-22 is said to be tailor-made for such time-urgent missions; it can fly twice as fast and twice as high as existing special operations aircraft, and three to five times farther.

"We need tilt-rotor technology," declares Air Force Gen. Charles Holland, commander-in-chief of USSOCOM. The war in Afghanistan left him "even more convinced of why the CV-22 would best fit" special ops requirements, Holland says.

V-22 procurement could exceed that of the Marines and the Air Force if the program finally passes muster. The Navy has said it would like to buy 48 HV-22s for sea rescue and replenishment missions, but has put off funding procurement until 2009 at the earliest.

NASA, which has long been interested in developing a nonmilitary variant of the Osprey, took part in reviewing and critiquing the V-22 program and has a leading role, as Navair's partner, in the collection and analysis of flight test data.

Powered by a pair of Rolls-Royce T406 engines at its wingtips, the high-wing Osprey takes off and lands vertically like a helicopter, with engine nacelles perpendicular to the ground and propellers operating as rotors. Once the Osprey is airborne, its nacelles rotate 90° forward, turning it into a turboprop aircraft. Much of Osprey pilot training is focused on managing the transition from helicopter mode to full aircraft and back again.

"We're not training helicopter pilots or fixed-wing pilots," Schultz notes. "The V-22 pilot is a very different kind of pilot."

A problematic history

Critics of tilt-rotor technology have had misgivings about the flight safety and operational utility of the V-22 ever since its inception as the Army JVX in 1982, a year before the Navy took

River). Equipped with redesigned flight-control and mission software, that Osprey will be transferred to the aircraft carrier Iwo Jima for additional testing later this year.

Last October, two more redesigned planes—an EMD V-22 and an LRIP MV-22—joined the test fleet at Pax River. The EMD model is being used exclusively to test and verify tilt-rotor aircraft behavior at low airspeeds and high rates of descent conducive to VRS. It is expected to demonstrate that the V-22 can descend as rapidly as a helicopter without inducing VRS and blade stall, Schultz explains.

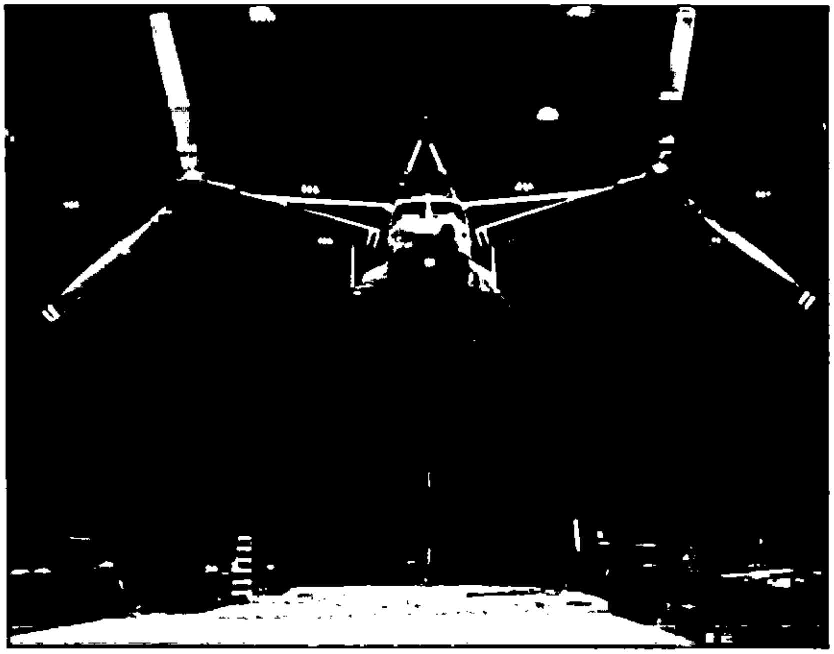
Michael Tkach, vice president and director of the Bell Boeing V-22 joint program office, notes that the VRS-oriented flight tests will engender an "exhaustive evaluation" of V-22 performance "on the basis of actual flight data instead of theoretical models and computer simulations."

The first LRIP MV-22—a so-called "fleet representative" aircraft—at Pax River is configured for parachute delivery of troops and cargo, and is being tested in that mode. It is also being used for V-22 pilot training and as a testbed for new mission software. Marine test pilots praised the craft's performance after flying it to Pax River from the Bell Boeing V-22 final assembly plant in Amarillo, Texas, on a 5-hr flight at altitudes up to 15,000 ft and at a true airspeed of 300 kt. By midsummer, four more LRIP MV-22s will have entered the Pax River test program.

At Edwards AFB, Calif., one of the first two CV-22 special ops prototypes resumed flight testing last September. The other prototype is undergoing anechoic-chamber testing of the CV-22's integrated electronic warfare (EW) suite, and is scheduled to begin test flights next summer. Two additional CV-22s, both production models, are scheduled to be delivered in FY05 for initial operational test and evaluation at Edwards.

The CV-22 weighs more and can fly farther than the MV-22, and has been modified more extensively. The vertical stabilizer of the Air Force Osprey had to be rebuilt and strengthened to accommodate both the transmitter and receiver antennas of the aircraft's suite of integrated radio frequency countermeasures. Both had to be repositioned at the aft section of the tail to eliminate interference and enhance performance.

In addition, radar-absorbent material has been applied to areas around other antennas, and the aircraft's original 16-ft fixed refueling probe has been replaced by an 18-ft retractable probe that sits flush with the nose when not in use. The Marine MV-22, which does not contain an EW suite, also will be equipped with the retractable probe.



The CV-22 is suspended in the anechoic chamber at Edwards AFB for electronic warfare testing. Photo by Rob Bardua.

Both the MV-22 and the CV-22 will carry chaff and flare dispensers. Each variant is designed to embody a turreted, rapid-fire gun system for self-defense, but program officials have not decided when, or whether, to factor it into procurement plans. The gun system would add considerable weight, and weight translates into cost.

Counting the cost

The flyaway unit cost of V-22s in the first production block is projected at $68.4 million. The program's FY03 budget includes funds for cost-cutting initiatives as part of a long-term effort to make the Osprey more affordable and more appealing to those who will decide its fate. Additional modifications to cut weight and cost, without compromising capability, are expected throughout the production process, officials say.

"Affordability is very important," asserts Air Force Col. Craig Olson, deputy V-22 program manager. "We're always looking for ways to take weight out of the aircraft."

For now, though, the Osprey's cost is of less concern to Pentagon decision makers than its performance and flight safety. After flight tests resumed last year, Aldridge told reporters that he had "some real problems with this airplane" and was "skeptical" of their resolution. Later on, the acquisitions chief let it be known that he had not changed his view, despite reports to the contrary. ▲

Major new thrust for MEMS engines

by J.R. Wilson
Contributing writer

Microelectromechanical systems (MEMS) continue to find new applications in virtually all areas of technology, including aerospace engine control. They even serve as miniature propulsion systems in their own right. While much of this activity remains in the realm of R&D, the prospects already are seen as revolutionary.

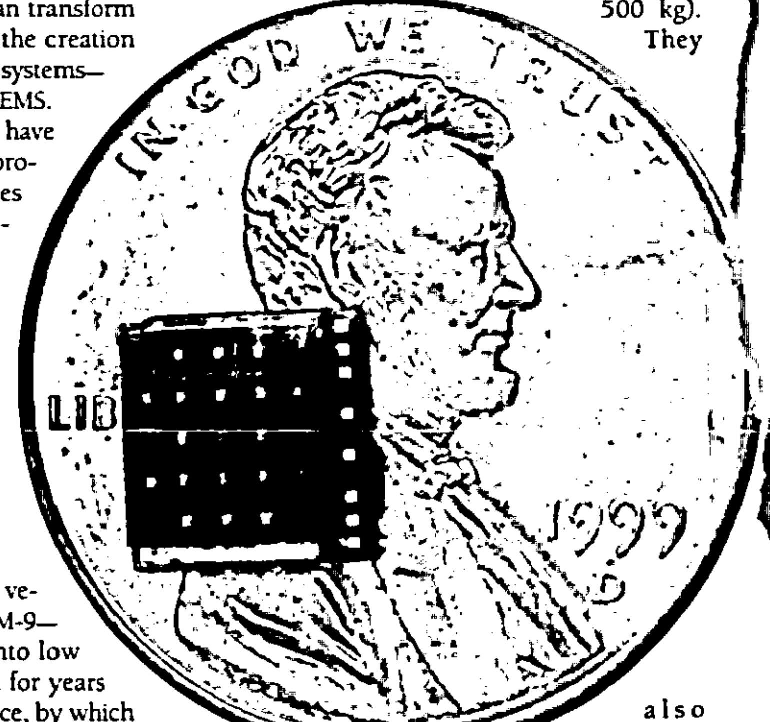
"Given the potential of this technology, it ranks as high in priority as any other for DARPA," says Clark Nguyen, the agency's MEMS program manager. "Its potential to take us places well beyond where we are today is just too large to ignore."

Alan Epstein, who has been heavily involved in MEMS development as a professor in MIT's Dept. of Aeronautics and Astronautics, agrees with Nguyen: "I think it can transform aerospace. Technology will allow the creation of smaller and smaller aerospace systems—and one of those technologies is MEMS.

"I think in five years you will have microturbines for microairplane propulsion, and microrocket engines available for either space propulsion on orbit or very small launch vehicles—perhaps the size of an AIM-9—that could put a pound or two into low Earth orbit," says Epstein. "NASA for years has pursued low-cost access to space, by which they mean low cost per pound to orbit. MEMS lets you expand that definition to low cost per mission. So MEMS propulsion, combined with MEMS gyros and GPS guidance and all the other microdevices, could put a couple of pounds into orbit for around $50,000. The cost per pound isn't lower, but you can redefine the sorts of missions you have in space."

The first preliminary test of a digital propulsion microthruster in space was conducted by TRW Space & Electronics, teamed with The Aerospace Corporation and the California Institute of Technology, during the second phase of a DARPA-sponsored digital micropropulsion project.

"We put two arrays of digital propulsion microthrusters in a can, put the can on a rocket, and at the apogee of the rocket fired the thrusters and proved their function in a ballistic free-flight trajectory," says David Lewis, TRW's project manager. "We fired more than 20 individual microthrusters during that test. We did not make performance measurements; we were simply confirming the functionality in space. To the extent that they impart impulse or momentum to a body in space, we believe the Earth-based tests we've done have proven that."



Satellites and more exotic uses

Lewis says such microthrusters eventually will be extremely important to the development of femto (less than 100 g), pico (up to 1 kg), nano (up to 10 kg), micro (up to 100 kg), and minisatellites (up to 500 kg). They also could be adapted for use on medium (500-1,000 kg) and large (1,000 kg and up) satellites. But satellites are not the only potential application.

"Right now, the diameter of the thrust chamber of our unit is around 100-200 µm," says Lewis. "The Z-axis direction can be anywhere up to 2 mm, depending on the total propellant mass you want to incorporate. There are emerging DOD missions where small volume is desirable or essential. Missile defense is one of those. We believe these microtechnologies serve those mission needs. The small total volumes available for satellites using MEMS technology provide real advantages to boost and midcourse interceptors."

V-22 Osprey's record comparable to other aircraft

By Robert Charles
Former staff director to the U.S. House of Representatives' National Security Subcommittee

Before Congress prematurely amputates V-22 Osprey's technology from the body of U.S. defense, the flight test performance of other visionary prototypes should be considered. In historical context, the record of the V-22—four accidents in nine years of development—appears neither better nor worse than many parallel projects of lasting value to the nation's defense.

In light of recent events, that comparison is understandably hard to accept, especially for families of the 23 brave Marines who perished in last year's Osprey crash. Those families have a point—flight testing should continue until there is widespread confidence that this unique asset is prepared to safely take brave Marines into combat.

In a broader sense however, innovative aeronautical design and flight testing is always risky. The more humans involved, the riskier it is.

By way of example, in 1948, the U.S. lost 13 brave pilots in military flight-testing accidents, most flying traditional fixed-wing aircraft. That was also the year Capt. Glen Edwards died crash-landing his YB-49 Flying Wing. Today—due in part to his effort—we have a highly capable, state-of-the-art B-2 Stealth Bomber.

We also have Edwards Air Force Base to remind us of the price paid by those who wring out prototypes on their way to operational success.

In the years immediately thereafter, the U.S. tested increasingly innovative airframes, including the X-15 and X-2, paving the way for the SR-71 Blackbird, a plane capable of Mach 3, as well as other supersonic aircraft part of today's standard air arsenal. These developments, too, came at sobering cost.

In 1956, Capt. Iven Kincheloe soared in the Bell X-2 to a record-setting 126,200 feet. Just weeks later, in the exact same plane, Capt. Mel Apt exceeded Mach 3, but promptly perished when his X-2 tumbled out of control. Novel technologies carry disproportionate risk. In fact, despite remarkable flights in the X-15 by pilots like Chuck Yeager, Scott Crossfield and Neil Armstrong, there were also wincing X-15 crashes.

Mr. Armstrong puts one in mind of the Apollo Program that began in the 1960s, and aeronautical innovations in multi-stage rocketry. Today, Americans go to the Space Station by Shuttle, but not without painful memories of Apollo One, which ended the lives of three superb aviators and astronauts, Ed White, Gus Grissom and Roger Chaffee, or more recently the Challenger crew. In both cases, technology was advancing rapidly, and an unforeseeable glitch among thousands of mission-critical parts precipitated sudden catastrophe.

And in both cases, the program was strengthened by the unforgettable starkness of the event. A deep reality was the same then and now—progress in aviation is necessarily hazardous; those who press the envelope for the sake of the program are, by absolute definition, heroes. In fact, while practicing moon landings on Earth, Neil Armstrong's own vertical take-off platform malfunctioned. He barely escaped with his life, as the platform crashed and burned.

On a more mundane level, military flight training—largely underfunded in presidential budgets over the past half decade—carries its own costs. Between 1997 and 2001, for example, the U.S. Army experienced 26 class A aviation accidents, each one costing at least a million dollars or causing a fatality. In the same period, Army class B aviation accidents—more than $200,000 in damage or placing five or more people in the hospital—totaled 13.

Between 1999 and 2000 alone, Army aviation accidents in class A rose by 75 percent, while Army aviation class B accidents rose 600 percent. Why? Inherent risk, together with how many dollars are dedicated to pilot training and op-temp, both affect the ultimate price of progress.

Finally, the opportunity cost of not getting back up—painfully perfecting and methodically pressing forward the Osprey—is high. Alternative rotor and fixed-wing airframes are less capable, more costly to maintain and fast aging. The Osprey requires complete wringing out—that much is self-evident. But that is precisely the conclusion reached when the F-18 E/F fighter had to re-prove itself after discovery late in development of serious wing drop and wing baffle problems.

The realities that should govern the Osprey debate now are timeless. First, every life is precious, indeed priceless. Second, aerodynamic engineering is uncertain and cannot be completed in wind tunnels or on computer simulators. Test piloting is required, and crashes are a tragic, sometimes unavoidable, part of that noble profession.

Neither war-fighting nor flight-testing is for the faint of heart. In the shadow of these stark facts is one final, quiet truth.

To abandon the future in the name of caution is an illusion more dangerous than embracing the uncertainty in progress, no matter how frightening that uncertainty is.

Here, as elsewhere, the Marine Corps Hymn is the final word: "In many a strife, we've fought for life, and never lost our nerve." That spirit embodies the men who died in the Osprey—and it should embody our approach to the Osprey's future.

Top Marine speaks on V-22

By Linda DeFrance

Although Gen. James L. Jones, the Marine Corps' senior leader, believes a decade of studies has shown the V-22 tiltrotor Osprey to be the best solution to meet Marine Corps mission requirements, he said his service is not blinded by its love of it.

"I would resist, with all my moral fiber, the idea that we would willingly or knowingly try to bring aboard a program—V-22 or anything else—and so fall in love with the program that we would put people at risk to ride in those vehicles," Jones said at a forum Tuesday night. "We just simply wouldn't do that. And I don't think we've done that."

Top Marine Corps officials have been criticized for wanting the V-22 at any cost, following two fatal accidents last year that killed a total of 23 Marines. Currently, the program is under several simultaneous reviews: a program-wide Defense Dept. independent review panel; a DOD inspector general looking into maintenance record falsification charges; accident investigations into the Dec. 11 crash; and also likely Secretary of Defense Donald Rumsfeld's sweeping review encompassing all military programs.

While some reports in the press have said Jones ordered his own review seeking alternatives to the Osprey in light of its

——Top Marine Cont. on Page 4

07/21/2000

Bombardier BD-700

7/21/00

Transportation Safety Board
Aviation Safety Information System (ASIS)
Data Printout - Aviation Occurrence A00O0150

This printout is issued to provide information on the general circumstances of this occurrence. The information is based upon details provided by participants and other data uncovered to date by the investigation staff. The Transportation Safety Board of Canada (TSB) gathered this information for the purpose of advancing transportation safety. It is not the function of the TSB to assign fault or to determine civil or criminal liability.

A word of caution, some of the information in this document is as provided to the TSB and has not been subjected to further confirmation. Also, the investigation may still be in progress, and therefore, the information is subject to change.

Occurrence Type: INCIDENT REPORTABLE **Class:** CLASS 5
Reportable Incident Type: D. DIFFICULT TO CONTROL
Location: CYYZ TORONTO/LESTER B. PEARSON INTL
Country: CANADA **Province:** ONTARIO
Date: 21-JUL-2000 **Time:** 14:50

Aircraft Operator	Aircraft Model	Registration
BOMBARDIER INC.	BD-700-1A10	C-GGKA

Injuries	Fatal	Serious	Minor	None	Total
Crew	0	0	0	2	2
Passenger	0	0	0	0	0
Ground	0	0	0	N/A	0
Total	0	0	0	2	2

Transportation Safety Board
Aviation Safety Information System (ASIS)
Data Printout - Aviation Occurrence A00O0150

Aircraft Data

Registration: C-GGKA

Operator: BOMBARDIER INC.
Type of Operator: MANUFACTURER
Type of Operation: EXPERIMENTAL/TEST
Make: BOMBARDIER INC.
Model: BD-700-1A10 **Category:** AEROPLANE
Common Name: GLOBAL EXPRESS **Damage:** NONE

Injuries	Fatal	Serious	Minor	None	Total
Crew	0	0	0	2	2
Passenger	0	0	0	0	0
Total	0	0	0	2	2

Individual Information

			Crew Hours			
			All Types		This Type	
Individual Type	Licence Type	Seat No	Total	Last 90	Total	Last 90
PILOT-IN-COMMAND			0	0	0	0

Occurrence Summary

A00O0150: C-GGKA, A GLOBAL EXPRESS AIRCRAFT, WAS RETURNING TO DOWNSVIEW AIRPORT FOLLOWING ITS FIRST PRODUCTION TEST FLIGHT WHEN THE FLIGHT CREW FOUND THAT BOTH ELEVATORS WERE JAMMED. THE FLIGHT CREW WERE NOT ABLE TO DISCONNECT THE ELEVATORS SO THE LANDING WAS ABORTED AND THE FLIGHT WAS DIVERTED TO TORONTO, LBPIA SINCE BETTER ERS WAS AVAILABLE. THE CREW DECLARED AN EMERGENCY AND WERE CLEARED TO LAND AT LBPIA. DURING THIS TIME THE ELEVATOR TRAVEL WAS LIMITED TO 1 TO 2 DEGREES IN EITHER DIRECTION, AND THE STABILATOR TRIM DID NOT PROVIDE THE AMOUNT OF TRAVEL REQUIRED FOR LANDING. THE FLIGHT CREW USED A COMBINATION OF THRUST AND PITCH TRIM TO MAINTAIN CONTROL OF THE AIRCRAFT. AT SOME POINT PRIOR TO LANDING, THE CREW MANAGED TO BREAK LOOSE THE RIGHT HAND (R/H) ELEVATOR ALLOWING THE AIRCRAFT TO TOUCH DOWN AT A HIGHER THAN NORMAL SPEED (APPROXIMATELY 140 KNOTS) WITHOUT FURTHER INCIDENT. IT WAS REPORTED THAT THE TOUCHDOWN WAS FIRM.

AN COMPANY CONDUCTED INVESTIGATION REVEALED THAT AN UNFLAGGED RIGGING PIN, WHICH IS ROUTINELY ONLY PARTIALLY REMOVED DURING ELEVATOR RIGGING (BECAUSE IT IS VERY DIFFICULT TO INSERT IN THE QUADRANT HOLE AGAIN) WAS NEVER REMOVED BEFORE FLIGHT FROM THE QUADRANT UNDER THE FLIGHT COMPARTMENT FLOOR. DURING THE PILOTS' COMBINED EFFORTS TO BREAK LOOSE THE JAMMED ELEVATORS, THE END OF THE PIN WAS SHEARED OFF ALLOWING CONTROL OF THE R/H ELEVATOR. IT IS BELIEVED THAT THIS PIN VIBRATED INTO THE ELEVATOR CONTROL MECHANISM DURING FLIGHT, PREVENTING NORMAL ELEVATOR TRAVEL. THE REASON WHY THE ELEVATOR DISCONNECT DID NOT FUNCTION WHEN SELECTED IS STILL UNDER INVESTIGATION BY THE COMPANY.

ALL AIRCRAFT IN FLIGHT STATUS AT ALL BOMBARDIER TORONTO FACILITIES ARE GROUNDED PENDING A FULL INSPECTION OF THESE AIRCRAFT FOR FULL FLIGHT CONTROL TRAVEL AND THE REMOVAL OF ALL RIGGING PINS BEFORE BEING RELEASED FOR FURTHER FLIGHTS.

Late Sept, 2000

C-27J

From: Kart & Erin Berg
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To:

Subject: The exciting world of flight test

Ciao, Tutti - Hello, Everyone!

If you haven't heard through the grapevine, two weeks ago the 1st C·27 J prototype crashed while performing a test during landing in Turin. Both Pilots and the FTE (onboard only for ballast) walked away with no injuries and no one on the ground was injured. The past 2 weeks I have been assisting in the investigation of the accident, and though the final analysis is not complete from vendors etc., I plan on giving you the information on the accident to get your opinions and to give you all something to think about. It has been great learning experience investigating this accident.

Working in Flight Test/Aviation, none of us look forward to accidents of any kind. but they give everyone the opportunity to evaluate what happened and learn from the mistakes/misfortune of others. In this email, I will explain the circumstances of the accident. The aircraft. the test, and the pilot comments. I look forward to hearing your thoughts on the situation and ideas of what the problem was and how it was handled. On Friday I will email the findings of the investigation and what actually happened. Enjoy!

The Aircraft:

The C·27J is a small 2 engine (turboprop) military tactical transport with a MTOW of 60,000 lb. and MLW of 54,000 lb. It is a variation of the G-222 or C·27A. The main differences are new landing gear, APU, ECS, flight control system, avionics suite, and engines -- very similar to the DC-9 vs. 717. The first prototype (the one that crashed) however, only incorporated the engines and flight control system modifications. The engine control was provided via an independent engine control system. While the data bus architecture was not the same as the production standard, it provided identical engine control. This was not a factor in the accident. The flight control modifications primarily incorporated an increase in rudder authority to counteract the increased thrust of the engines and a q-feel system. The engines are Allison AE2100Ds with 6 blade propellers that produce 4700 hp at takeoff. These are the same engines used on the

SAAB 2000 and similar to those used on the C· l 30J.

Up until the accident. all systems were functioning properly with no anomalies noted in many flights. All of the FTI was in good condition and calibrations were up to date.

The Test:

The test to be performed was an Engine Throttle Transient. The requirement was an RTO at 135 kts. It had been agreed among design, flight test, and the pilots that this test point could be accomplished during landing. The purpose of the test was to demonstrate FADEC power management and engine response characteristics. This test point was being performed after build-ups at 120, 125, and 130 kts. The procedure was as follows:

1. Perform a normal landing.

2. After touchdown, select Flaps 1 (takeoff flap selling. to decrease lift and thus increase wheel loading).

3. Select takeoff power and accelerate to 130 kts.

4. At 130 kts, chop the power to ground Idle.

(In earlier testing, an acceleration of about 5 kls. occurred after reducing power from MTO so the target chop speed was thus 130 not 135.)

5. Wait 3 sec. then select MAX REV and stop.

As far as the aircraft systems and engine performance/operation were concerned, this was considered a low risk test. As Pat Nightingale pointed out to me any test that is above **taxi** speed isn't really considered low risk from the test execution point of view. Turin airport is generally not busy and has a 10,000 ft. runway (I think 60 m wide) which is plenty long and wide enough for this test with this aircraft.

Pilot Comments:

The pilot in command had the following comments:

The landing was normal. After landing, flaps 1 was selected end then takeoff power. They accelerated to 130 kts., chopped the throttles to ground idle, and began counting to 3. Everything seemed normal. After counting to 3, the throttles were chopped to max reverse. At this point, the pilot said he felt a strong tendency for the aircraft to veer/yaw to the right. He said he applied full left rudder and increased power, and felt he was recovering the aircraft. He then reduced power again and the aircraft again began yawing/veering to the right. With full rudder, the aircraft continued to the right. He increased power again, but the aircraft was still going right. At this point, I think the aircraft departed the runway and he began using crash procedures -- one of which Is to put the throttles to ground idle. When the aircraft stopped, he pulled all three fire handles (engines 1,2 and APU) and egressed the aircraft.

It was a clear *day,* and they landed with a 5 kt. tailwind. The aircraft ended up outside of the airport fence in a cornfield 100m off the right side of the runway. The copilot added no comments.

Think about what the problems could have been and how you would have handled the situation. I will send the failure and timeline of events in a couple days. I look forward to hearing your thoughts on/analysis of the events and what you would have been looking for during the test.

Fly/Test Safe!

Ciao,

Karl

From: Karl & Erin Berg
Sent: ~oy. October I'll. 200) 1 :A., YM
To:

SubJect; 1h11 scoon

OK, so this message didn't go out on Friday. What can I say? I'm In Italy and it's effecting my mind ...

So what happened?

Everything was normal through touchdown. When the pilot increased the throttles to takeoff power, both FADECs on the left engine received a "left power lever angle sensor fault." When this happens, the FADEC takes the last good PLA received, which in this case was takeoff power. At this point the ·PWR LEVEL 1 FAIL· message appeared on the engine display. The power was at takeoff for a total of 10 seconds to accelerate to 130 knots before chopping to ground idle. When the throttles were chopped to ground idle. the left engine remained at takeoff power. The pilot counted to 3 (ssc.) and then selected max reverse. Three seconds was how long it took for the engine (propeller) to bleed off enough thrust to make the asymmetric power noticeable. The data shows that at the same time the pilot was selecting max reverse, the left rudder deflection was increasing to full pedal. This is why the pilot associated the yaw with max reverse. He stayed in max reverse for 2 sec., then Increased power to flight idle, then to takeoff power to recover the aircraft. Four seconds later the amount of rudder was decreasing and the - pilot seemed to have recovered the aircraft. (This is confirmed on the cockpit tape.) They were now at about 110 kts. At this point the pilot selected max reverse again. We lost data here for 7 seconds…convenient, huh? When the data came back they were at about 90 kts. (Vmcg approx. 83 kts.) Throttles were again at takeoff power; there was full left rudder with decreasing sideslip, and the left engine was still pegged at takeoff power. Shortly after this point we believe the aircraft left the runway and they were basically along for the ride. As one would expect, when they decreased below Vmcg the slideslip began increasing. The voice tape shows they applied the brakes. but what *I* think really stopped them was a muddy field. The left engine remained at takeoff power until they had a propeller strike. All of the propellers were lost on both engines (including an instrumented prop. for propeller blade strain testing). The nose gear collapsed and they struck one wing tip, if not both. When the aircraft left the runway, there was more than 2,000 ft remaining.

There was more damage to the aircraft, but I have neither seen the plane nor been Involved in that part of the Investigation. From a flight test standpoint, the aircraft is a loss and all remaining testing has been rescheduled on the other 2 airplanes. I don't know whether they will be able to repair the aircraft to fly again.

Why did the FADECs receive the power lever angle sensor faults? We are still waiting for this answer. It has been determined that the throttle quadrant was the problem, and the vendor was supposed to have analyzed the quadrant at the end of last week. At this point we are sure that the logic in the FADEC and the tolerances of the throttle quadrant and FADEC complement each other in such a way that the fault was not because a tolerance was too tight or there was a software glitch. This was a hardware problem.

The preflight brief did not really contain any test-specific safety brief. I don't know Lockheed's procedures for safety briefings (this test was requested by them), but I know Alenia's is VERY relaxed and this is something that Madelene and I have discussed many times.

So we know what happened and where the problem was, but was the loss of the aircraft avoidable? This is the question that I've been asking myself. After an accident, it's easy to be critical when looking at the data. Since I am not a pilot, I hesitate to criticize the crew's actions, and state should haves. With that said, I think that a huge factor in this accident It that neither pilot said anything about the engines during the post-flight brief. Is this because they forgot, or is It because neither of them looked at the engines during the accident? After the pilot increased the throttles to takeoff power, they were there for 10 seconds. More than half of that time they had a failure message. If they did not have this failure message, wouldn't the engines be something that a pilot would at least glance at when he notices a strong tendency for the aircraft to yaw? Also, the pilot said he associated the yawing tendency with reverse thrust. Then why, after he recovered the aircraft, did he select reverse thrust again?

My personal opinion is that the aircraft could have been recovered had the pilots realized the problem. Do you (pilots especially) think that I am simplifying the problem here or could the accident have been avoided by a quick scan of the cockpit? As with before, I look forward to hearing any comments/questions you have regarding this.

Regards,

Karlo

10/10/2000

Bomberdier Challenger 604

Biz Jet

Prototype? built 1994

Jet crash kills 2

Oct 10, 2000

3rd crew member hurt in ill-fated test flight

9-f-4

Wichita Eagle staff

Two members of a Bombardier test-flight crew became the first aircraft casualties at Wichita's airport in 27 years when their Challenger 604 jet crashed Tuesday on Tyler Road shortly after takeoff.

The men's names were not released Tuesday night, and a third crew member was in critical condition at Via Christi Regional Medical Center-St. Francis Campus.

The crew of two pilots and a test-flight technician departed from Mid-Continent Airport on what Bombardier described as a routine high altitude test. The plane took off on Runway 19 Right northwest of the terminal at 2:49 p.m.

"They weren't in the air but a matter of a few seconds," said Bailis Bell, director of airports for the Wichita Airport Authority.

The plane crashed on Tyler Road, tethering a chain-link fence from the east side of the road that tangled around the jet as it burst into flames.

Nearby airport rescue squads hurried to the scene, where they fought to extinguish the burning wreckage. They found the three trapped inside by a jammed main entryway, said Capt. Paul Moore of the airport police and fire unit.

"You could hear the screaming inside," said Moore, who was among the first to arrive.

The city airport last saw death in 1973, when three perished in two separate crashes.

Commercial flights were not interrupted Tuesday, said airport spokeswoman Angie Prather. A grass fire shut down the west side of the runway, but the east side remained open.

Rush-hour traffic snarled on West Kellogg between Ridge and Maize roads and shut down the southbound lanes on Tyler from Maple just as workers from the Bombardier plant were ending their shifts. Police plan to block off traffic on Tyler today from Harry Street to Yosemite Drive. "People need to avoid Tyler," Deputy Chief Stephen Cole said Tuesday night. "We won't let them through until they get that aircraft moved."

Police expected to guard the road throughout the night, Cole said, because officials need to determine if there's any damage to the street from the fire. The crash left the plane's engine in the middle of the street and charred grass on both sides of Tyler. Only local traffic will be allowed through the area.

The initial crash rocked the nearby office of the National Weather Service, quaking the lights overhead. "Basically, the last time the building shook like that was when the DeBruce elevator exploded. So we knew something like that had happened," said Chance Hayes, warning coordination meteorologist.

The rumble sent rescuers racing toward the billowing smoke.

"They were burning alive," Moore said. Moore grabbed an ax off a fire truck and broke out the windshield so firefighters could spray water and foam inside. "I just kept yelling back for them to just hang on, hang on," Moore said. The firefighters quickly extinguished the flames, Moore said, but they had to cut through the fuselage to reach the men inside.

"It's a well-built plane.... It's a tough one to crack open," he said. "There's no doubt in my mind we did everything we could."

Wichita police provided traffic control to help the 72 emergency vehicles summoned with the first call at 2:52 p.m. and the later rush from Bombardier employees leaving work.

"We let people out from Bombardier at 4 and blocked off to the south at Yosemite and Tyler," Cole said. Police detectives began interviewing witnesses to collect names for the Federal Aviation Administration.

Officials from the National Transportation Safety Board arrived to begin investigating the accident Tuesday night.

Felix Lococo, manager of the Federal Aviation Administration Flight Standards District office, said he expected help from Transport Canada -- the Canadian equivalent of the FAA -- because it licensed the plane.

Bombardier Aerospace executives also arrived in Wichita on Tuesday night from the Business Aviation Association's annual trade show in New Orleans.

"We will not speculate on its cause or circumstances," said Jim Ziegler, vice president and general manager of Bombardier Aviation Services and Learjet Operations.

The plane operated as Challenger Test One. Each area test pilot receives a test flight number. Because they fly so many different airplanes, having a call sign helps cut down on confusion for pilots and flight controllers.

Company executives said the plane flew exclusively for altitude testing in the Challenger 604 development program and had been in service since 1994 with 1,227 hours during pre- and post-certification testing.

The Challenger series has a safety record better than industry standards, said Robert E. Breiling, owner of Breiling & Associates of Boca Raton, Fla. His company tracks crashes of turbine engine airplanes and helicopters.

Still, those who fly know the risks and many were touched by Tuesday's tragedy.

"There is a high level of danger involved," said Lt. Ben Frankenfield, a spokesman for McConnell Air Force Base. "As for those who have lost their lives, it's tragic. We feel for them and we're praying for their families."

Bombardier plans to suspend test flights today in memory of the crash victims.

Reporting: Deb Gruver, Stan Finger, Hurst Laviana, Molly McMillin, Dennis Pearce, Tim Potter, Novelda Sommers, Ron Sylvester, Beccy Tanner, Roy Wenzl.

BOMBARDIER AEROSPACE

STATEMENT | PROGRAM OVERVIEW | SPECIFICATIONS SHEET | FRANÇAIS

Challenger 604 Backgrounder Statement

Statement for October 11, 2000, 4:40 p.m. EDT

Statement for October 10, 2000, 8:50 p.m. EDT

Challenger Accident Briefing October 10, 2000

Date and time:	October 10, 2000, 9:30 p.m. CDT
Location:	Media Centre Airport Hilton in Wichita
Participants:	Jim Ziegler Vice President and General Manager Business Aviation Services and Learjet Operations David Franson Director Public Relations and Communication Learjet

Thank you all for joining us here at this late hour. While we don't have a great deal of new information, let me start by saying that all of us at Bombardier want to express our sympathy and concern to the loved ones of the victims. The members of this crew are our colleagues and our friends and this accident touches all of us deeply. Upon being notified of the accident in New Orleans at approximately 3:45 p.m. CDT, senior managers from both Wichita and Bombardier Aerospace headquarters in Montreal immediately departed for Wichita. We are currently meeting with our Bombardier Flight Test Center employees.

As you already know, the aircraft involved in this afternoon's accident was a Challenger 604 flight development aircraft. It was, in fact, built in 1994 as the prototype and had accumulated 1227 hours during pre and post-certification testing for that program. It was equipped with both a Flight Data Recorder and a Cockpit Voice Recorder. We expect them to be recovered in the near future, when a team from the National Transportation Safety Board arrives. Our accident investigators are standing by to assist them.

Needless to say, we are still in the very early stages of reviewing the facts of this accident. We will not speculate on its cause and circumstances. In closing, on

Publications

Aircraft Accident Brief

NTSB/AAB-04/01 [PDF version]

Accident Number:	CHI01MA006
Aircraft and Registration:	Bombardier CL-600-2B16 (CL-604), C-FTBZ
Location:	Mid-Continent Airport, Wichita, Kansas
Date:	October 10, 2000
Adopted On:	April 14, 2004

HISTORY OF FLIGHT

On October 10, 2000, at 1452 central daylight time, [1] a Canadair Challenger CL-600-2B16 (CL-604) (Canadian registration C-FTBZ and operated by Bombardier Incorporated) was destroyed on impact with terrain and postimpact fire during initial climb from runway 19R at Wichita Mid-Continent Airport (ICT), Wichita, Kansas. The flight was operating under the provisions of 14 *Code of Federal Regulations* (CFR) Part 91 as an experimental test flight. [2] The pilot and flight test engineer were killed. The copilot was seriously injured and died 36 days later. [3]

A review of air traffic control (ATC) and cockpit voice recorder (CVR) transcripts from the accident flight indicated that the pilot in the left seat was performing the pilot-in-command (PIC) and pilot-flying (PF) duties and that the copilot was performing the radio communications and other related pilot-not-flying (PNF) duties. [4] The flight test engineer was to perform test flight configuration and monitoring duties at his workstation in the cabin. The flight crew was to initiate a standard takeoff and climb and conduct flight testing of modified pitch feel simulator (PFS) units [5] above 8,000 feet above ground level (agl). [6] The test required that the airplane be configured with an aft center of gravity (c.g.). [7]

The accident flight was the second flight to collect data to obtain certification by the United Kingdom's Civil Aviation Authority (CAA) for two customer airplanes in the United Kingdom. Following the first flight in 1999, the CAA provided a list of unacceptable items that Bombardier needed to correct before the Challenger 604 could obtain CAA certification, including modification of the PFS units. [8]

On September 29, 2000, about 1806, the airplane returned to Wichita from other flight test operations in Fairbanks, Alaska, and was not flown for about 1 week in preparation for the flight testing of the modified PFS units. On October 6, 2000, the production PFS units were removed and the modified PFS units were installed. The airplane was loaded with 1,100 pounds of water ballast and 734 pounds of tail ballast for an aft c.g. test configuration.

A ground test with the modified PFS units was performed to determine the control column travel needed for full elevator travel in both directions. The test also repeated the baseline tests that were previously conducted with the production PFS units. The ground tests were designed to measure and record force at the control column in pitch at different column positions and at different stabilizer positions. Two systems engineers from company headquarters in Montreal (who also attended the preflight briefing for the accident flight) were present during the static ground tests. Documentation indicated that no anomalies were noted with the PFS installations.

About 1330 on October 10, 2000, a preflight briefing was held at the Bombardier Flight Test Center (BFTC) for the first flight with a modified PFS aboard the airplane. The preflight briefing was attended by the three flight crewmembers, a BFTC aircraft controller, a systems engineer, an avionics engineer, the project engineer, and the two systems engineers from Montreal. The BFTC aircraft controller stated that the briefing had been postponed several times because the airplane was not ready. However, he added that there was no rush to fly that day and that the airplane had no outstanding maintenance items when it was released about 1330.

Statements from briefing participants indicated that several minutes before the briefing, the accident pilot asked the accident flight test engineer to obtain a risk analysis from BFTC's manager of flight test operations and safety. The manager of flight test operations and safety stated that he first learned about the test flight at this time. He stated that he assessed the flight's risk level as low because the airplane was operating within its c.g. range and because "the modification was stabilizing."

The briefing began with a description of the airplane's configuration and the presentation of load sheet information. The accident copilot reportedly asked, "why are we so far aft?". The flight test engineer responded that this configuration (with the production PFS units) was previously flown on airplane number 5991 (the accident airplane) with the CAA test pilot during the 1999 flight test. The flight crew reportedly responded, "okay." The briefing continued with a presentation comparing the characteristics of the production PFS and modified PFS units. The pilot reportedly stated that the airplane was going to "handle like a pig." According to briefing participants, flight test maneuvers and procedures to address potential anomalies in the modified units were not discussed. The briefing concluded about 1400 and flight crewmembers boarded the airplane about 1415.

At 1420:33, the CVR recorded a sound similar to several warning systems being checked, followed by the "before engine start" checklist items and conversations about the airplane's systems. The right engine was started at 1432:07. The PIC performed two flight control sweeps at 1434:24. The first sweep included the aileron, rudder, and elevators. The second sweep was a slow control sweep of the elevators. [9]

At 1448:45, the tower issued a takeoff clearance and instructed the flight crew to fly a heading of 230°. [10] At 1449:21, the pilot stated, "okay, here we go," and a sound similar to an increase in engine RPM was recorded 2 seconds later. At 1449:29, the pilot stated, "set thrust," and the copilot responded, "thrust set" 6 seconds later. At 1449:37, the copilot called out "airspeed's alive eighty knots." At 1449:48 the copilot called out "V one" (takeoff decision speed) and "rotate". The pilot responded, "okay, we're flying," followed by the copilot calling out "V two" (takeoff safety speed).

At 1449:51, the CVR recorded a sound similar to stick shaker [11] for 2.2 seconds, during which time the pilot stated "whew," and the flight test engineer stated "what are you doing?". The CVR then recorded the mechanical voice warning "bank angle" [12] and a sound similar to stall aural warning for 1.1 seconds at 1449:53. "Bank angle" was recorded at 1449:54 and again at 1449:55. A sound similar to stick shaker was recorded for 0.15 seconds beginning at 1449:57, followed by "bank angle" again at 1449:57.36.

At 1449:58, and for the next 2 seconds, a sound similar to stick shaker was recorded for 0.22 second, and the pilot stated, "hang on." A sound similar to stick shaker" was recorded again for 0.3 seconds; the flight test engineer repeated "what are you doing?" followed by a sound similar to stall aural warning for 0.82 seconds, and "bank angle" again. At 1449:59.59, the pilot stated, "hang on." The recording ended at 1450:00.

Witnesses reported seeing the airplane bank to the right after takeoff. They stated that the airplane's right wing rolled and impacted the ground first and that the airplane exploded on impact. The airplane crashed through an airport perimeter fence and came to rest adjacent to a two-lane, north-south road.

PILOT INFORMATION

The pilots were certificated under Federal Aviation Administration (FAA) certification requirements and held Transport Canada exemptions from holding Canadian pilot certificates.

The Pilot Flying

The PF, age 33, was hired by Bombardier Aviation Services in Tucson, Arizona, in July 24, 1995, as a flight test pilot, where he performed airplane modification and supplemental type certificate (STC) [13] test flights on Learjet 31A, Learjet 60, and Challenger 604 aircraft. He also performed aerodynamic stall testing and system evaluation flights on Learjet customer service aircraft. He was hired at BFTC as an experimental test pilot on May 5, 1999.

From August 1989 to October 1990, he performed avionics certification testing as a flight test engineer for an avionics manufacturer. He was employed as a captain on an Aero Commander 500 for 14 CFR Part 135 cargo operations from October 1990 to September 1993. From October 1993 to September 1995, he was employed as a captain on a Beechcraft Baron and Piper Chieftain and as a first officer on a North American Saberliner for an unscheduled Part 135 cargo and passenger operator.

He held an airline transport pilot (ATP) certificate issued on August 25, 1991, with type ratings in the CL-65 (Canadair Regional Jet), CL-604, Learjet-60, and Bombardier BD-700 (Global Express). In addition, he was a certified flight and ground instructor. His first-class medical certificate was issued on May 16, 2000, with the limitation "holder shall wear corrective lenses."

According to FAA documents, the pilot received an order of suspension of his ATP certificate on July 19, 1996, for failure, as PIC, to ensure that cargo aboard a Part 135 cargo flight was secured to prevent shifting under anticipated flight and ground conditions. The suspension was later withdrawn and replaced with an order of assessment on September 27, 1996, fining the pilot $750.

According to company records, he had logged 6,159.3 hours flying time, including 1,187 hours at Tucson Production Flight Test; 359.3 hours engineering flight test flying time at BFTC; 557.2 hours of production flight test PIC time at Tucson; and 126.4 hours of engineering flight test as PIC at BFTC. He had logged 189 flying hours in the Challenger 604, of which 94.6 hours were as PIC. He received his initial type rating in the Challenger 604 on October 15, 1998. His last proficiency check was accomplished on March 24, 2000. [14] According to BFTC's manager of flight test operations and safety, there was no record that the pilot flying had received formal test pilot training. Bombardier's vice president of flight tests stated that the PF was assigned to entry-level flying assignments as an experimental test pilot and flights typical of normal flight operations. The PF had a bachelor of science degree in aviation technology.

The PF had flown a total of 95.7 hours, 55.2 hours, 4.6 hours and 1.9 hours in the last 90 days, 30 days, 7 days and 24 hours, respectively. The pilot was off duty on October 8, 2000. He worked from 0800 to 1800 on October 9 and returned to work on the day of the accident at 0800.

The Copilot

The copilot, age 43, was hired by Bombardier on February 1, 1999. He was a former U.S. Air Force F-15 fighter pilot and instructor pilot. He was employed as a test pilot by Swearingen Aircraft Company, where he performed development and certification test flights on Metroliner airplane systems from August 1991 to January 1994. In addition, he was employed as an engineering test pilot on high-performance jet prototypes at Cessna Aircraft Company. He performed developmental and certification test flights involving performance and handling qualities, stalls, and envelope expansion on Cessna Citation and Excel airplanes in Wichita from January 12, 1994, to January 29, 1999. He was also an FAA-designated engineering representative.

He held an ATP certificate issued on June 10, 1990, with type ratings in the Cessna CE-500, CE-525S, CE-560XL, CE-650, CE-750, Bombardier CL-65 (Regional Jet), CL-604, and SA-227 Metro III. He was a certified flight instructor and held an airframe and powerplant certificate issued on January 4, 1979. His first class medical certificate was issued on September 27, 2000, with no limitations.

According to company records, he had logged 6,540.7 hours of flying time, [15] including 463.7 hours at BFTC; of which 254.4 hours were as PIC at BFTC. He had logged 6,076 flying hours when he was hired by Bombardier, of which 2,123 hours were flight test. He had attended a 2-week test pilot short course, according to company records. He had 1.2 hours flying time in the Challenger 604, of which 0.4 hours were as second in command. He received his type rating in the CL-604 on June 23, 2000. This was also his last proficiency check. He had flown a total of 88.1 hours and 17.1 hours in the last 90 and 30 days, respectively. He had logged no flying hours in the last 7 days or 24 hours.

The copilot had returned from Amsterdam, Holland, on October 8, 2000, about 2230. On October 9, 2000, he worked from 0715 to 1630 and returned to work on the day of the accident at 0730.

AIRPLANE INFORMATION

The accident airplane, serial number 5991, was registered and owned by Bombardier Inc., Canadair, and was equipped with two General Electric CF34 turbofan engines. Manufactured in 1994, the airplane was used exclusively as an engineering development and sustaining program test airplane. The airplane was operated on a Canadian flight permit (experimental type certificate) and was not issued an airworthiness certificate. A special flight authorization (SFA) [16] was issued by the FAA's Wichita Manufacturing Inspection District Office (MIDO) on September 5, 2000. The SFA was issued to conduct flight test(s) required to obtain a U.S. type certificate. The SFA stipulated the operational conduct and limitations for the flight crew and airplane.

The airplane fuel tank system comprised a left wing tank, right wing tank, auxiliary fuel tank and tail fuel tank (see figure 1). The auxiliary fuel tank system beneath the center cabin had a forward, center, and aft tank that were interconnected by pipes and that were not isolated from each other by shutoff valves or check valves. The tail fuel tank system had two saddle tanks and a third tank at the rear of the tail cone. (see figure 1).

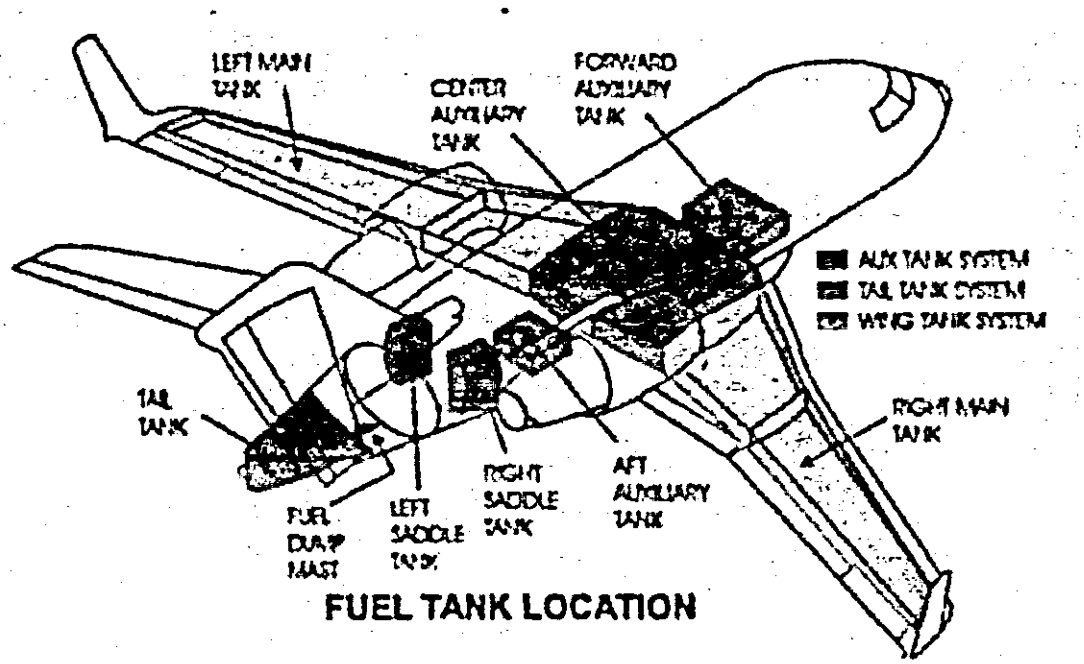

Figure 1. Airplane Fuel System Diagram

The airplane was equipped with a ground proximity warning system, which provided voice message alerts. The "bank angle" voice message is based on the airplane's roll attitude and radio altitude. The roll angle limit ranges linearly from 10° at 30 feet agl to 40° at 150 feet agl. It ranges from 40° at 150 feet agl to 55° at 2,450 feet agl. When the airplane's roll angle exceeds the alert threshold, the "bank angle, bank angle" aural alert activates. An additional "bank angle" alert is generated if the roll angle increases by another 20 percent of the threshold. If the roll angle exceeds 140 percent of the threshold, an aural alert is issued every 3 seconds.

The airplane's stall warning system provided aural, visual, and tactile warning of an approaching stall. As the airplane's vane angle of attack (AOA) [17] increases, tactile warning is provided by a stick shaker. A further increase in vane AOA activates a stick pusher. Visual stall warnings are provided by flashing red "STALL" annunciators on the left and right glareshield and by a low-speed indicator on each of the primary flight displays. An aural warbler warning begins when either stall channel signals the pusher to fire. Both channels are required to activate the pusher. In addition to the warnings, the autopilot disconnects and continuous ignition is activated.

The stick pusher forces the control columns forward to lower the nose (AOA) and are designed to prevent an aerodynamic stall. The system's dual (left and right) channel stall protection computer (SPC) monitors the following inputs to calculate the AOA trip points:

- AOA
- Lateral acceleration
- Flap position
- Weight on wheels
- Altitude
- Weight on wheels fail

In the event of an AOA rate increase greater than 1° per second, the SPC lowers the AOA trip points (phase advance) to prevent the airplane's pitching momentum from carrying it through the stall warning/stick pusher sequence into the stall. An acceleration switch disconnects the stick pusher mechanism if less than 0.5 G is reached during the stick pusher activation. The stick pusher can also be de-activated by pressing and holding the autopilot/stick pusher disconnect switch located on the pilot's and copilot's control wheel. The stick pusher is capable of operating immediately once the autopilot/stick pusher switch is released. In case of malfunction, the stick pusher can be disabled by selecting the "PUSHER" switch to "OFF" on the pilot's or copilot's stall protection panel. Both the pilot's and copilot's switches must be in the "ON" position for stick pusher activation.

The accident airplane's SPC actuation could be modified for flight test purposes. After takeoff, and the removal of weight from the landing gear, the nominal design provides for a 2-second interruption (time out) of the phase advance for shaker and pusher activation. During this time, the SPC activation angles for the shaker and pusher are not phase advanced, and will activate only if the AOA threshold is exceeded. The accident airplane's SPC could be adjusted to interrupt the phase advance to the AOA threshold. Examination of flight test data indicated that of the two SPC channels, the left timed out at 5.5 seconds on the airplane's three previous flights and the right channel timed out at 2.0 seconds, which is the production standard. [18] According to Bombardier documents included in a November 5, 2001, letter to the National Transportation Safety Board, there was insufficient data to determine the timeouts for the accident flight. The letter stated that although the left shaker activation may have been delayed, the increased timeout would not have affected stick pusher activation.

The following are normal production shaker and pusher activation vane angles: [19]

Shaker 19.2° with a tolerance of +/- 0.35°
Pusher 23.1° with a tolerance of +/- 0.35°

Recorded test flight data indicated that the activation vane angles for the accident airplane were set at the following values:

Shaker Channel	Left	19.7°
Shaker Channel	Right	19.3°
Pusher Channel	Left	23.6°
Pusher Channel	Right	23.2°

[20]

No mechanical flight control system discrepancies were reported during the 30-day period before the accident.

Airplane Limitations

The *Challenger 604 Operating Manual* contains weight and balance information for a normal category, certificated CL-604. According to a restriction and/or special instruction, the accident airplane had an expanded weight and balance envelope for takeoff and landing. The c.g. range changes based on airplane configuration. According to the CL-604's type certificate data sheet (No. A21EA), the airplane's aft c.g. limit was 38 percent mean aerodynamic chord (MAC) between airplane weights of 43,000 and 47,700 pounds. The accident airplane's weight at takeoff was 44,849 pounds.

AftLim is 35%@Lower weights !!

Weight and Balance and Performance Calculations

The preflight weight and balance data for the accident flight were as follows:

Zero Fuel Weight		29,254 lbs.	
Left Wing Fuel		4,850 lbs.	4909 max
Right Wing Fuel		4,850 lbs.	
Center Fuel	7222 lbs/1062g	3,800 lbs.	563 gal
Aft Fuel	3169 " /466gal	2,500 lbs.	370 gal
Ramp Weight		45,254 lbs.	
c.g.		37.4 percent MAC	

Fwd Lim CG: 16 to 20 % MAC

MAC = 92.644 inches

Flight test tolerances for the accident flight were as follows:

- Stick Shaker/pusher set to nominal
- Test weight tolerance: +5 percent to –1 percent
- c.g. position tolerance: 7 percent of total travel
- Airspeed tolerances are 3 knots
- Non-turbulent conditions

Postaccident Fuel Weight Calculations and Weight and Balance

The CL-604 fuel computer uses a fixed constant fuel weight (density) [21] of 6.75 pounds per U.S. gallon (variability of density due to nonstandard temperature was not considered in the equation). [22] After the accident, Bombardier recalculated the airplane's weight and balance based on a takeoff weight of 44,849 pounds and a fuel weight value of 6.75 pounds per gallon. [23] In a December 13, 2000, memorandum to the Safety Board, Bombardier's calculations indicated that the airplane's c.g. was 37.9 percent MAC at the start of the takeoff roll.

In addition, Bombardier recalculated the airplane's c.g. estimating both the shift within the tanks and the amount of fuel transfer between fuel tanks during the takeoff roll and initial rotation. The transfer rates calculated between fuel tanks were as follows:

Forward auxiliary tank to center auxiliary tank	0.735 gallons per second
Center auxiliary tank to aft auxiliary tank	0.875 gallons per second
Saddle tanks to tail cone tank	0.484 gallons per second

The following table compares fuel tank quantity and transfer changes between the start of the airplane's takeoff roll (zero pitch angle as the airplane accelerated down the runway before rotation) and 20 seconds later with an airplane pitch angle of 13.8°at rotation: [24]

Table 2. Comparison of Fuel Tank Quantity and Transfer Changes

Tank	Before Acceleration, at Zero Pitch Angle	13.8° Pitch Angle, at Rotation
Forward Auxiliary	41.5 gallons	26.8 gallons
Center	491 gallons 558.5 gal	488.2 gallons
Aft Auxiliary	26 gallons	43.5 gallons
Saddle Tanks	212.5 gallons	202.8 gallons
Tail Cone	165 gallons 377.5 gal	174.7 gallons

In addition, Bombardier stated that fuel could also shift between rib bays in the airplane's wing fuel tanks. Based on Bombardier fuel shift calculations evaluated by the Safety Board staff, the airplane's c.g. increased to 40.5 percent MAC by the time it reached a 13.8° pitch angle 20 seconds later. [25]

Postaccident Center-of-Gravity Related Airworthiness Directives

The fuel shift/c.g. issue was addressed by Bombardier, Transport Canada and the FAA following the accident. On February 1, 2001, Bombardier issued a temporary revision to the Challenger flight manual changing the airplane's aft c.g. limit from 38 percent MAC to 34.5 or 35.0 percent, depending on airplane weight. The same day, Transport Canada issued Airworthiness Directive (AD) CF-2001-07 to make the revision permanent. The FAA issued emergency AD 2001-03-52 on February 2. The FAA's AD stated that the Challenger's "fuel tanks are not baffled, which allows fuel to migrate when the airplane pitches up." The AD added that "fuel migration under conditions of acceleration and/or climb, if not corrected, could result in the airplane exceeding the aft center of gravity limit, and consequent loss of control of the airplane." The AD stated that the revision was intended to "prevent fuel migration from resulting in a rearward shift of the c.g. to the degree that will result in controllability problems."

METEOROLOGICAL INFORMATION

The ICT automated surface observing system (located 4,500 feet from the approach end of runway 19R) recorded the following information at 1450:

> Wind 190° at 20 knots gusting to 26 knots; 10 statute mile visibility; few clouds at 12,000 feet agl; scattered clouds at 20,000 feet agl; temperature 17° Celsius (C) ; dew point of –11° C; altimeter 30.21 inches of mercury. Peak wind of 29 knots from 170°occurred at 1400.

No microburst or gust front activity was recorded between 1250 and 1450. According to the low-level wind shear alert system, centerfield winds were generally from the south/southwest with speeds from 15 to 22 knots.

AIRPORT INFORMATION

ICT is located about 5 miles southwest of Wichita. The airport has three concrete runways: 01L/19R (10,300 feet by 150 feet, grooved concrete), runway 01R/19L (7,302 feet by 150 feet) and runway 14/32 (6,301 feet by 150 feet). The airport is equipped with aircraft rescue and firefighting (ARFF) units under provisions of 14 CFR Section 139.317 Index C. [26]

Twelve air carriers and three fixed base operators serve the airport. In addition to Bombardier, two other airplane manufacturers use the airport for flight test operations. The air traffic count from September 1999 to September 2000 was 180,878 flights.

FLIGHT RECORDERS

The airplane was equipped with an airborne data acquisition system (ADAS) capable of recording 1,780 flight test data parameters. The magnetic flight test data tape and the digital flight data recorder (FDR) tape, which recorded additional parameters, were recovered from the wreckage. Thermal damage destroyed ADAS flight test data recorded after takeoff rotation. Safety Board staff synchronized the instrumented data with the recovered FDR data. [27]

The airplane was equipped with a Fairchild model A-100A CVR. The CVR exterior received some structural and fire damage. The interior and the tape were not damaged. The recording comprised four channels of good quality audio information. [28] A transcript was prepared from the entire 31-minute recording.

WRECKAGE AND IMPACT INFORMATION

The airplane first impacted the ground 437 feet from the intersection of runway 19R's centerline and the extended centerline of taxiway B. The airplane came to rest upright about 1,174 feet from the initial ground impact scars and 850 feet to the right of the runway centerline. Wreckage was found along the entire path. Parts of the right wing, radome, and nose structure were found within the first 300 feet of the wreckage path. A large concentration of right engine structure was found just past the wreckage path's midway point. The left wing was found largely intact and attached to the fuselage. The right wing was consumed by fire. The empennage separated from the fuselage and was heavily damaged by fire. It came to rest in a drainage ditch near the fuselage. Flight control cables were found in their approximate correct locations throughout the wreckage, but complete cable continuity could not be determined because of extensive right wing and empennage damage. Fuel system components in the fuselage and right wing were consumed by fire.

Wreckage of both engines was recovered in the debris field. The left engine was found attached to the fuselage. The right engine was located on the road, about 30 feet behind the fuselage. An external examination did not reveal evidence of pre-impact anomalies.

The flight spoiler power control units were found in the stowed position. The extensions of the flap actuator jackscrews were replicated on a similar airplane in the Challenger Service Center, and the flap setting was calculated to be about 20°.

The cockpit's left side was heavily sooted close to the floor and the multifunction displays (MFD) in the instrument panel were damaged by heat. The instrument panel was displaced aft and downward. The outboard edge of the instrument panel was separated from its structure and displaced aft, inboard, and downward. The control yoke was turned to the right. Both rudder pedals were jammed against the forward bulkhead. The windshield was crazed and sooted.

The cockpit's right side was crushed into the copilot's seat. The outboard corner of the instrument panel was separated from the structure and displaced inboard about 3 inches. The floor beneath the copilot's station was displaced upward about 6 inches and rearward about 14 inches. The copilot's MFDs were heat damaged. The floor forward of the seat was destroyed and displaced rearward with the rudder pedals visible from outside the airplane. The outboard lower side panel was displaced inboard and separated from the structure. The upper panel was displaced rearward. The circuit breaker panel bulkhead was displaced downward about 9 inches at its forward side and was free of its upper attachments.

The right side wall and outer cabin floor structure in the forward-to-mid cabin, forward of the flight test engineer's station, were destroyed by fire. [29]

MEDICAL AND PATHOLOGICAL INFORMATION

Autopsies of the PF and flight test engineer were conducted by the Sedgwick County Regional Forensic Science Center in Wichita, Kansas. According to the autopsy report, the pilot died at the scene of the accident after suffering blunt force trauma, smoke inhalation and burns. The cause of death was listed as "carbon monoxide toxicity and smoke inhalation." The flight test engineer died at the scene of "blunt force trauma of head and neck." The report added that he also suffered "postmortem thermal burns," fractured vertebrae and cervical spinal cord lacerations. There was no evidence of carbon monoxide or soot in his airways or lungs, according to the autopsy report. The copilot, who sustained blunt force trauma and burns, was removed from the cockpit by rescuers and transported by ambulance to a local hospital, where he arrived about 1548 hours. He died on November 15, 2000, of "complications from thermal burns."

The Regional Forensic Science Center and the FAA's Civil Aerospace Medical Institute performed toxicological testing of the pilot and flight test engineer. The tissue and blood specimens tested negative for a wide range of drugs, including major drugs of abuse. [30]

EMERGENCY RESPONSE

Two ARFF vehicles arrived at the accident site within 90 seconds, according to ARFF dispatch logs and personnel statements. [31] Wichita Fire Department (WFD) was notified about 1452 and the first unit arrived about 1458, according to WFD dispatch logs. WFD responded with 48 personnel and 23 vehicles. Both pilots were reported to be conscious when the initial ARFF units arrived at the accident site.

Access to the crash site from the airport was hampered by the damaged fence and by a ditch along the road. ARFF vehicles Safety 1 (S-1) and Safety 3 (S-3) [32] responded first with three firefighters, all of who were wearing protective gear. S-3, manned by one driver, was first to arrive. ARFF vehicle S-1 arrived with a driver and the airport police captain. The ARFF training captain and the ARFF deputy chief followed in an airport pickup truck, along with ARFF vehicle S-2, which was manned by one driver. The ARFF chief arrived in his car.

The drivers of vehicles S-1 and S-3 initially remained in their trucks and used foam to extinguish the fuselage fire and burning fuel under the airplane. The S-3 driver stated that, when he arrived, the fuselage was "engulfed in flames, even the roof." He stated that he first used his roof turret to extinguish fires on the left wing and the airplane's left side and top before moving into position to put out fires on the right wing and fuselage.

After the S-2 vehicle arrived, the driver of S-3 exited his vehicle and assisted the training captain, who was attempting to break holes in the cockpit side windows to direct water from hand-held hoses into the cockpit and onto the pilots. [33] ARFF personnel used fire axes, sledgehammers, and crowbars to break holes in the left and right side cockpit windows. A hole was first made in the cockpit's left side window, and water was directed into the cockpit to suppress the fires and protect the flight crew. A second hole was also punched through the copilot's window. [34]

Upon their arrival, firefighters observed an impact-related hole on the top of the fuselage's left side (located aft of the main passenger door and forward of the left wing) and directed fire extinguishing agent through the hole. After WFD personnel arrived, forced entry tools (hydraulic cutters and spreaders) were used in an unsuccessful attempt to force the passenger door open. According to ARFF personnel statements, no attempts were made to open the emergency hatch over the right wing. ARFF personnel stated that they were aware of the hatch's location and operation. ARFF personnel reported that the hole on the left side of the airplane provided sufficient access to the cabin and that entry through the hatch was not necessary.

WFD assisted with additional forced entry tools to enlarge the holes in the side cockpit windows, and to enlarge another hole located on the left side of the fuselage and forward of the wing. Additional water spray was used to protect the WFD firefighters who entered this hole to rescue the flight crew. The copilot was extricated from the cockpit about 20 minutes after ARFF units arrived and was transported to a hospital about 1541. The PF died before he could be extricated. The flight test engineer was found dead in the cabin near the cockpit bulkhead.

The ARFF S-2 truck was equipped with a penetrator nozzle, which can be used to pierce an airplane's fuselage to deliver water or foam inside the airplane. ARFF personnel stated that two firefighters were needed to prepare and operate the nozzle and hose. The ARFF chief stated that "only three ARFF personnel [were] on scene in first arrivals and they concentrated on knocking down the fire that was on both sides of the airplane." The chief stated that additional firefighters would have aided rescue efforts.

An ARFF captain/supervisor stated that the "tower provided us with no information... in the first three, four, five minutes at the scene. We knew nothing that was on there. We didn't even know if this was a commercial airplane, test airplane or whatever."

A fuel-fed vegetation fire was also extinguished. One ARFF officer was treated for smoke inhalation.

Emergency Response Training

At the time of the accident, multiagency drills at ICT were held quarterly and involved ARFF and law enforcement personnel, the Sedgwick County Fire and Sheriff's departments, and the Wichita fire and police departments.

ARFF personnel had received familiarization training on air carrier and military airplanes that use the airport. No similar training was provided for flight test airplanes based at the airport, which are frequently equipped with special features including ballistic-initiated spin recovery parachutes, forced entry locations, and pyrotechnic-operated emergency hatches.

At the time of the accident the Airport Authority's Airport Safety Division employed 24 people, who received law enforcement and ARFF initial and yearly recurrent training. Four people were assigned to ARFF duties and two were assigned to airport law enforcement duties for each 8-hour shift.

The Safety Board addressed ARFF staffing concerns when it issued Safety Recommendation A-01-65 to the FAA. Safety Recommendation A-01-65, issued on October 23, 2001, asked the FAA to "amend 14 *Code of Federal Regulations* 139.319 (j) to require a minimum Aircraft Rescue and Fire Fighting staffing level that would allow exterior firefighting and rapid entry into an airplane to perform interior firefighting and rescue of passengers and crewmembers." In a February 19, 2002, letter to the Safety Board, the FAA stated that it had asked the Aviation Rulemaking Advisory Committee (ARAC) Airports Issue Group to create an ARFF Requirements Working Group to examine ARFF staffing levels as part of an overall ARAC review of 14 CFR Part 139. On October 17, 2002, Safety Recommendation A-01-65 was classified "Open—Acceptable Response," pending results of the ARAC working group and implementation of the recommendation.

SURVIVAL ASPECTS

The airplane's configuration comprised pilot and copilot seats, a cockpit jump seat, and a flight test engineer station in the airplane cabin. The flight test engineer's station was located on the right side of the cabin. The seat was located adjacent to the emergency exit over the right wing. All crew seats were equipped with 5-point adjustable restraints. The pilots survived the impact sequence, but injuries and damage to the forward fuselage and cockpit prevented them from escaping unaided.

A manually operated, downward-opening main passenger door (with integral stairs) was located on the left side of the fuselage, aft of the cockpit. The main passenger door was found fully closed and latched. Safety Board staff examination revealed that the fuselage had buckled into the door, with evidence of shear and/or compression overload (skin wrinkles) on the forward fuselage and cabin door. Attempts by Safety Board investigators to open the door manually (with the inside and outside releases) were unsuccessful. The exterior handle was found out of its stowed position in a horizontal position; the handle could be moved 1.5 inches counterclockwise from the horizontal. Further investigation revealed that the mechanical fasteners that attach the aft center latch cam to the torque tube were sheared. The door's interior and latching mechanism exhibited evidence of a compressive overload to the door's lower tension rod and buckling damage to the door intercostals. An internal inspection of the door structure revealed damage to the forward part of the door stairs.

The airplane was equipped with an inward-opening, plug-type emergency exit hatch over the right wing. The exit can be opened from either inside or outside the airplane. The hatch was found in the closed and secured position. Postaccident examination determined that the exit was operational from the outside and inside.

The cockpit was not equipped with egress hatches. The airplane's windows were an integral part of the airframe structure and could not be opened. Pilot and passenger egress was through the forward passenger door or through the over wing hatch.

The flight engineer's station was located in the middle of the cabin near the right over-wing emergency hatch. Firefighters found the flight test engineer's seat in the forward cabin near the flight test engineer's body. The seat swivel adjustment was found locked in the forward facing position. The seat was separated by impact forces from its floor mounts and seatback vertical supports. The seat mounts were found attached to the floor seat track. No floor damage was found at the flight test engineer's station. There was no evidence of fire damage or sooting on the floor mounts. The restraint system was found attached to the seat by the tie down strap on the forward frame of the seat pan. The five point restraint system end fittings were found latched inside the release buckle. The left and right seat belts and shoulder harness straps were burned through. The seat was designed to withstand the following loads: 9 G forward, 4 G lateral, 4.65 G up and 8.1 G down.

TESTS AND OTHER RESEARCH

Airplane Performance

Safety Board staff conducted an airplane performance study as part of the accident investigation (see figure 2). According to FDR, CVR and flight test data, the nose gear strut was extended (before elevator input) as weight diminished on the nose gear about 0.5 second before rotation. Main gear liftoff occurred about 1449:50, as the airspeed reached 143 knots. FDR-derived data indicated that the PF used about 10° of nose-up elevator to initiate rotation, and main gear liftoff occurred about 1.2 seconds later, with a pitch angle of between 2.8° and 3.8°. The 10° nose-up elevator input was maintained for 0.8 second after liftoff until the pitch attitude reached 12°, according to FDR data. Pitch attitude continued to increase over the next 1.4 seconds, peaking at 20°, while nose-up elevator input decreased from 9° to 1° nose up. According to the FDR, the vane AOA reached 23°about 3.4 seconds after start of rotation. According to Bombardier, the airplane enters the stall warning region after reaching an AOA of 19°.

FDR data indicated that the airplane began an uncommanded right roll just before reaching peak pitch attitude. The CVR recorded the sound of the stick shaker at 1449:51, and the stick shaker sound continued for 2.2 seconds. During this time, a nose-down elevator input of about 14° was recorded, followed by a 5.5° nose-up elevator control input, consistent with pilot control inputs to correct the airplane's pitch and roll oscillations. The pitch attitude decreased to 4.3° nose up and the bank angle increased to about 80° right-wing down. During the next 3 seconds, the airplane rolled left to about wings level as the pitch attitude increased to 18° nose up. The vane AOA on the second pitch up was 26.4°. The second pitch up oscillation was followed by a second pitch down to -2°, and a right-wing down roll to 61°. This pitch down was followed immediately by a pitch up and roll back to wings level, reaching nearly level pitch attitude and 40° right-wing down at impact, according to FDR data. Peak nose-up elevator input at this time (1449:55) was about 16°.

The CVR recorded the intermittent activation of stick shaker, aural stall, and bank angle warnings beginning with the first pitch up to 20° until about 1 second before impact. After initial rotation, all elevator, rudder, and aileron inputs by the pilot were consistent with inputs to counter pitch and roll oscillations, according to FDR information. FDR data indicated a peak pitch rate of 8.4° per second. (The airplane's ADAS, which recorded test flight data at a higher sampling rate, indicated a pitch rate of 9.6° per second).

According to FDR data and information derived from the Safety Board staff's integration study of FDR data (flightpath integration), the airplane's peak airspeed was 170 knots. The flightpath integration indicated that the airplane's peak altitude was about 70 feet. FDR information indicated that the engines were operating at 90 percent fan speed until impact.

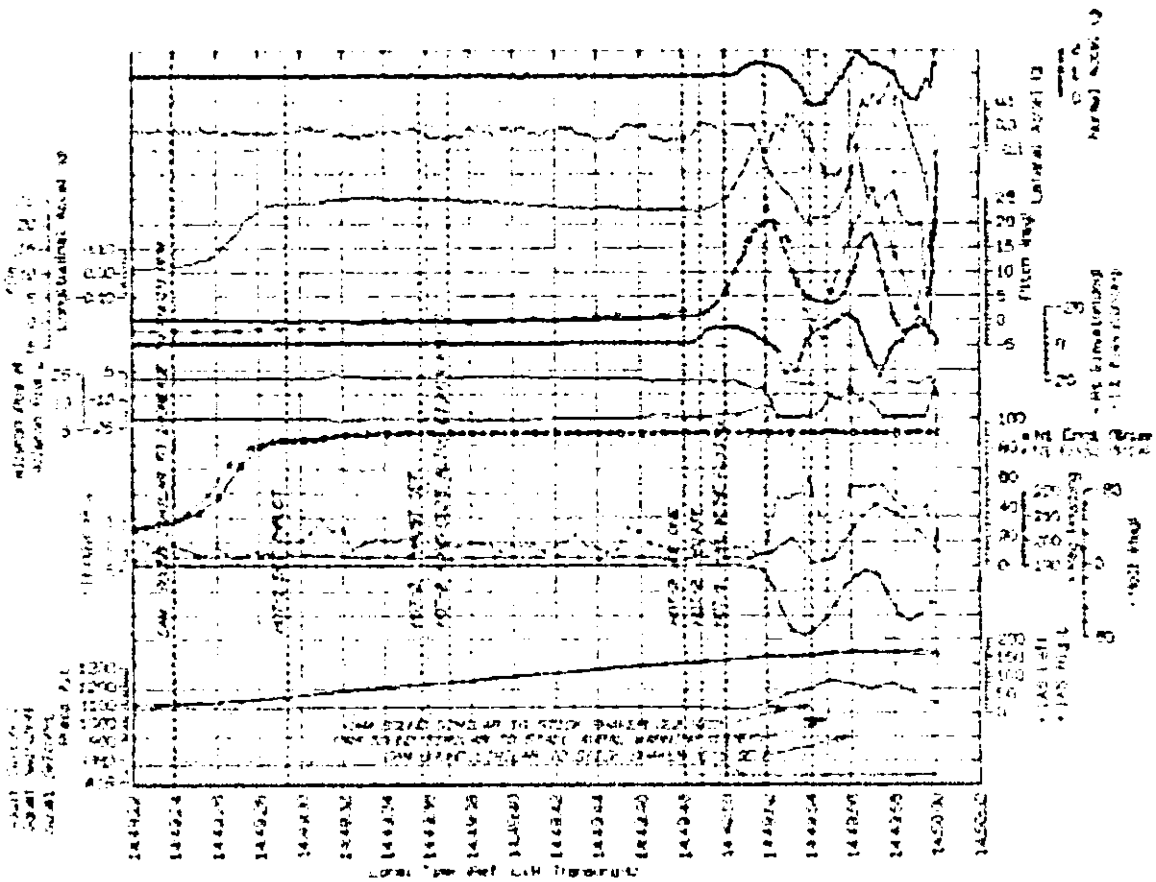

Figure 2. Review of the Pilot Flying's Previous Takeoff Performance

Safety Board staff reviewed flight data to determine the peak pitch (rotation) rates per second during previous takeoffs performed by the PF.

Data showed a 7.2°-per-second rotation rate on a Challenger test flight on August 16, 2000. The airplane's ramp weight was 41,511 pounds and the c.g. was 31.0 percent MAC. Data also showed a 6.5°-per-second rotation rate on takeoff on a Challenger ferry flight from Barrow, Alaska, to Fairbanks, Alaska, on September 14, 2000, and a 6.0°-per-second rotation rate on takeoff from Fairbanks to Wichita on September 29, 2000, about 2 weeks before the accident. For the Fairbanks-to-Wichita flight, the airplane's ramp weight was 47,204 pounds and the c.g. was 35.5 percent MAC. The 35.5 percent MAC was the farthest aft c.g. that the PF had flown in the accident airplane, according to Bombardier flight test records. According to Bombardier flight test data, the stall protection system did not activate on these flights. The data indicated that the maximum pull control column force exerted by the PF during these operations was generally greater than 40 pounds. Bombardier stated that the stick force used by the accident pilot during the accident flight rotation "was near and within the upper limit of the normal range of stick forces, based on results from other pilots."

The accident pilot also flew the Global Express in the weeks before the accident. Flight 592, a Global Express BD-700-1A10 flight on September 22, 2000, showed a 8.3°-per-second pitch rate. A week earlier, on September 15, flight 589 showed a 6.8° rotation rate. A 5.8°-per-second pitch rate was recorded for flight 599, another Global Express, on October 4, 2000. The takeoff c.g. range for the Global Express was between 23 percent and 35 percent MAC.

Bombardier compiled additional takeoff data from 50 flights flown by other BFTC pilots, which included operational flights, certification test flights, and the accident flight (flight 535). According to Bombardier, the maximum pull control column force during normal operations was less than 40 pounds. The parameters examined were maximum pitch rate at rotation versus Mach number and c.g., and maximum control column forces at rotation versus c.g.

Bombardier computed maximum AOA (alpha) measured by the alpha stall vane during rotation as a function of Mach number. According to Bombardier, the maximum alpha stall vane angles recorded during operational takeoffs were about 14°. The maximum alpha stall vane angle values during abused certification takeoffs (that is, nonstandard takeoffs conducted for flight test purposes) were between 14° and 19°. The maximum alpha stall vane angle values for the accident pilot's operational takeoffs were between 15° and 17.5°. The maximum alpha stall vane angle for the accident flight was 23°. This angle was 4° above the normal setting for stick shaker activation, according to Bombardier.

In addition, Bombardier data indicated that the maximum pitch rates during operational takeoffs were 3.4° to 6.1° per second. Maximum pitch rates during abused (or nonstandard) [35] takeoffs during certification were between 3.5° and 7.0° per second. The maximum pitch rates for certification performance takeoffs were between 4.8° and 7.5° per second. The maximum pitch rates for operational takeoffs performed by the accident pilot were between 6.0° and 7.6° per second. As noted previously, the maximum pitch rate for the accident flight recorded by the onboard ADAS was 9.6° per second, according to recorded data.

Center of Gravity and Pitch Feel Sensitivity Studies

The Safety Board staff conducted c.g. and PFS sensitivity studies in an engineering flight simulator at Bombardier Aerospace facilities in Montreal as part of the accident investigation. The first c.g. study was conducted without pilots and used elevator values derived from the accident flight's FDR. The study indicated that with a c.g. of 37.9 percent MAC (the start of the takeoff roll), the alpha vane AOA did not reach the stick pusher value (for activation). At 40.5 percent MAC (the c.g. after rotation), the alpha vane AOA peaked about 5° beyond stick pusher value (see figure 3). [36]

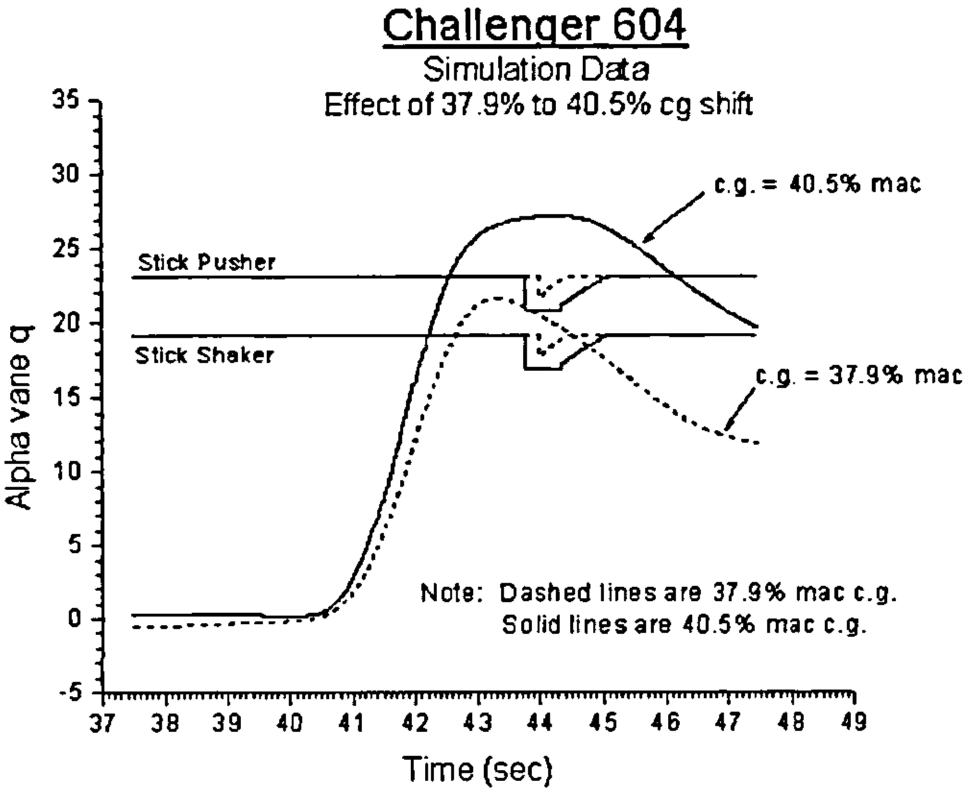

Figure 3. C.g. Sensitivity and Stick Shaker/Pusher Threshold Values

In a second c.g. study, an FAA test pilot and a Transport Canada test pilot, who were rated in the CL-604, performed takeoffs in the Bombardier engineering flight simulator to determine the effects of c.g. location on rotation rate (and the ability to capture the prescribed takeoff pitch attitude) and to examine whether there were perceptible differences between the handling characteristics of the modified PFS and the production PFS installed on in-service CL-604 airplanes. The pilots performed takeoffs with c.g. locations ranging from 35.0 percent MAC to 42.0 percent MAC. The pilots reported that aft c.g. positions caused them to rotate at a somewhat higher rate. The pilots noted that these effects were more noticeable when they used increased rotation rates (about 6° instead of the normal 3° rotation rate). When increased rotation rates were used, the pilots noted that the stick shaker frequently activated but only briefly. The pilots also indicated that the simulator was controllable at all c.g. locations using both normal and increased rotation rates.

In the PFS sensitivity study, each pilot performed takeoffs with either the modified or production PFS units. The c.g. was set at 40.5 percent MAC for each takeoff. The pilots reported no handling differences between the modified PFS and the production PFS units.

Safety Board staff and Bombardier also conducted simulation studies to determine how the pilot's elevator inputs during the accident would affect pitch rates at different c.g. configurations. The simulations indicated that the pilot's elevator inputs produced a pitch rate of 5.5° per second at 35 percent MAC and a rate of 10.5° per second at 40.5 percent MAC (the c.g. the accident pilot encountered after rotation).

PFS Unit Examinations

The PFS units (model Nos. TY2614 and TY1741) recovered from the airplane were examined at TRW Aeronautical Systems, Lucas Aerospace, United Kingdom, under the supervision of the United Kingdom Air Accidents Investigation Branch. A visual and x-ray examination was performed and no anomalies were noted except for smoke discoloration. No anomalies were found during manufacturer-conducted tests before delivery, during acceptance tests in Wichita before installation of the units on the accident airplane, or during postaccident acceptance testing.

COMPANY INFORMATION

Company History and Organizational and Flight Test Structure

Bombardier was a Canadian manufacturer of ground and water transportation equipment before it purchased Canadair on December 23, 1986. The company purchased Learjet Corporation on June 29, 1990. Test development activity for the Learjet line continues at the BFTC.

At the time of the accident, Bombardier Aerospace comprised eight manufacturing plants located in five cities, two aircraft parts distributions centers, four approved maintenance organizations in four cities, and four approved training organizations in two cities.

At the time of the accident, a manager of flight test operations and safety was assigned to BFTC operations. His duties included providing administrative operational support to engineering flight test personnel, ensuring compliance with U.S. Federal Aviation Regulations and Canadian Aviation Regulations for pilot currency and qualification tracking, managing flight logs, dispatching, and piloting test flights. The manager of flight test operations and safety was the only person assigned to the BFTC's safety department.

At the time of the accident, the manager of flight test operations and safety reported directly to the vice president of flight test at BFTC, who in turn reported to the vice president of engineering. The vice president of flight test at BFTC was on the same organizational level as the vice presidents of engineering at the Toronto, Belfast, Wichita, and Montreal operations. He was also on the same management level with the vice presidents of program management for product development in Montreal, the director of quality assurance in Montreal, and the vice president of the Tucson Completion Center. [37] According to Bombardier, the manager of flight test operations and safety currently reports to the vice president of flight test at BFTC and the executive vice president for engineering and product development at company headquarters in Montreal.

Company Flight Test Accident and Incident History

Before the accident flight, Bombardier and Learjet experienced two fatal accidents (including a 1980 accident involving a Canadair CL-600), two nonfatal accidents and one incident.

On April 3, 1980, a Canadair Limited CL-600 was destroyed during stall testing near California City, California. [38] The pilot was killed, and the copilot received minor injuries. The flight test engineer was not injured. According to statements from the surviving pilot and flight test engineer, the flight crew was troubleshooting a noise associated with stalls conducted during previous flight test activities. Airplane control was lost during the stall, and the emergency spin recovery parachute was deployed. According to the copilot and flight test engineer, who were able to bail out, attempts to jettison the parachute were not successful and airplane control was never recovered.

On July 26, 1993, a Canadair CL-600-2B19 was destroyed during lateral and directional stability testing near Byers, Kansas. [39] The two test pilots and flight test engineer were killed. The probable cause of the accident was determined to be the "captain's failure to adhere to the agreed upon flight test plan for ending the test maneuver at the onset of pre-stall stick shaker, and the flight crew's failure to assure that all required switches were properly positioned for anti-spin chute deployment. A factor which contributed to the accident was the inadequate design of the anti-spin chute system which allowed deployment of the chute with the hydraulic lock switch in the unlocked position." [40]

On April 25, 1997, a Canadair BD700-1A10 landed wheels-up following avionics testing at Toronto, Canada. The test crewmembers were not injured. A Canada Transportation Safety Board (TSB) investigation determined that the flight crew did not lower the landing gear and had not followed a landing checklist. The aural gear warning had been disarmed during the flight test and not re-armed by the pilots following the test.

On October 27, 1998, a Learjet 45 was destroyed after colliding with a pickup truck parked next to the runway during water ingestion testing near Wallops Island, Virginia. [41] The copilot and flight test engineer received minor injuries. The probable cause of the accident was determined to be the "failure of the pilot to obtain/maintain alignment with the water pool, which resulted in a loss of control. Factors in the accident were the inadequate preflight planning of the flight test facility and the airplane manufacturer which resulted in hazards in the test area and the subsequent collision of the airplane with a vehicle."

Bombardier also reported a flight test-related incident that occurred on July 21, 2000, when a Global Express BD-700-1A10 experienced an elevator jam following its first production test flight. The flight crew used a combination of thrust and pitch trim to maintain airplane control. The flight crew managed to free the right-hand elevator and landed at Lester B. Pearson International Airport in Toronto, Canada. A company investigation revealed that an unflagged rigging pin was not removed before the flight. [42]

Company Training

At the time of the accident, Bombardier production and experimental test pilots attended initial and recurrent flight training at a company-owned or a commercial flight training facility that is structured for operational flying, such as charter and private operations. No test scenarios were presented during these courses. Three-week initial training comprised 2 weeks of ground school and 1 week of simulator training. One day of line-oriented flight training was provided during simulator training.

Company flight test training is on-the-job, according to Bombardier's senior engineering test pilot. Flight test maneuvers are demonstrated to pilots, and the maneuvers are then performed by the pilot in training. Bombardier sends its test pilots and flight test engineers to a 2-week flight test short course at a civilian flight test school. Between 33 percent and 40 percent of flight test personnel had received military training or had attended a civilian test pilot school before being hired.

The company's chief test pilot at the time of the 1993 Byers, Kansas, accident told Safety Board investigators that flight test training was conducted as an apprenticeship. He stated that pilots learned maneuvers and procedure by observing from the jumpseat or second pilot seat. The chief test pilot stated that pilots did not receive external test pilot training and that they did not use the company's simulator for flight test training.

Postaccident interviews with Bombardier flight test employees indicated that no formal safety training meetings were conducted. Safety issues were presented during all-hands meetings. Several test pilots stated that they were not familiar with details of previous Bombardier flight test accidents and would like to be provided flight test incident and accident information.

Company Flight Test Procedures

Bombardier's flight test operational and safety policy manual, *Bombardier Flight Test Standards and Procedures 3000* (BFTC 3000), was published on October 10, 1996, and revised (with revision A) on December 14, 1998. Parts of the manual were incorporated into FAA Order 4040.26, "Aircraft Certification Service Flight Safety Program, [43] which established flight test briefing, risk assessment, and risk management procedures. Neither FAA nor Transport Canada regulations required Bombardier to have a flight test policies and procedures manual.

The 1996 BFTC 3000 manual did not require a test hazard analysis (THA) document, which addresses hazards, their causes, their effects, minimizing procedures, corrective action, and relevant remarks. Revision A contained provisions for hazard identification and risk reduction. Bombardier's chief of flight test operations and safety stated that the document was not used in Bombardier's sustaining programs at the time of the accident but that it was a phased-in program that had been implemented in the company's developmental (experimental) programs, such as the RJ 700 program. [44]

Both documents list risk levels of high, medium, and low for flight maneuvers or flight conditions. A high risk level indicates a high probability of an incident or accident involving severe damage to equipment and/or injury to personnel. Approval for high risk flights must be received from Bombardier's vice president for flight test or the engineering flight test director.

High risk test flights include new prototype flight testing. The manual states that such tests will be defined high risk "until an operation envelope covering stability and control, engine operation... [has] been defined." The tests included "all flight testing for the expansion or definition of limits appropriate to stability and control, flutter, performance, maximum airspeed and engine operation, testing that could result in loss of all engines, flight control failures, high speed 'upset' tests, initial stall tests, [and] stall tests with adverse c.g., aerodynamic, configuration, or component changes." High risk test flights also included "evaluation of unproven components in critical systems or the airplane in critical environments (e.g. high altitudes, high or low speeds, braking systems, flight controls, life support)..., structural demonstrations at limit values, ... takeoff performance with actual engine shutdown, maximum brake energy test, maximum rudder sideslips, high altitude depressurization [or] any flight test, which, in the opinion of the test pilot-in-command and/or a representative of the engineering discipline responsible for the flight test to be conducted, warrants consideration as high risk."

A medium risk level indicates the probability of an incident or accident combined with moderate damage to equipment and/or injury to personnel. According to the manual, these tests "require more than routine supervision." Such flights must be approved by the Lear/Canadair program manager or the chief of flight test operations and safety. Medium risk flights include, "loss of one engine, including fuel starvation due to negative or lateral G, extreme attitudes, testing where close visual chase is required, flight outside of the current normal flight and/or operational envelope..., operating at minimum usable fuel [and] intentional single engine shutdowns."

A risk level of low indicates that there is a low probability of incident or accident combined with minimal damage to equipment and/or injury to personnel, according to the manual. The risk assessment authority for these flights is the PIC.

Bombardier's safety risk assessment process is described in BFTC 3000 Revision A as follows:

8.5.2 Steps in Deliberate Safety Risk Management

a. **Hazard Identification:** Hazard identification begins with the preparation of the test requirements document... and [conducting] a preliminary hazard analysis. This analysis is a list of hazards that could occur and result in mishaps/incidents/accidents. This preliminary hazard analysis is developed using experience, scenario thinking, archives, and similar techniques.

8.5.5 The Safety Risk Assessment Process

a. **Aircraft Configuration:** All test aircraft will be configured in accordance with Bombardier Aerospace, Transport Canada, or the Federal Aviation Administration directives as appropriate for the conduct of the test.

b. **Crew:** All flight crews on the test or chase aircraft will be qualified and current IAW [in accordance with] BFTC 3000 prior to the start of the test.

c. **Briefings:** All test personnel will participate in pre test briefings.

d. **The Completed Safety Risk Assessment** will be briefed prior to each flight. The Safety Risk Assessment format will vary IAW program directives. However, each completed Safety Risk Assessment is required to contain the following information.

1) Decision Authority Signature
2) Risk Assessment
3) Hazard Identification (Not required for low risk flights) [45]
4) Risk Reduction (Not required for low risk test flights) [46]

Surveillance of the Bombardier Flight Test Facility

Under a bilateral agreement with the United States, Transport Canada has direct regulatory oversight of the BFTC facility. However, there are no Canadian or U.S. regulations specific to the conduct of flight test operations. The last Transport Canada inspection of the BFTC facility before the accident was conducted on November 5, 1999. A full-time, on-sight Transport Canada inspector was not assigned to the BFTC facility until after the accident.

As part of initial certification and subsequent modification programs, Transport Canada test pilots and flight test engineers are involved with BFTC management and flight test crews during certification tests to validate company compliance. FAA and JAA flight test crews also fly with BFTC flight test crews to validate Transport Canada certification of new and modified airplanes. Although not defined as regulatory oversight of the operation, the activities provide and opportunity to observe company operations, according to Transport Canada.

The FAA's MIDO and Wichita Aircraft Certification Office (ACO), located at ICT, provide oversight for the manufacture and certification of Learjet airplanes manufactured at the Bombardier Learjet facility in Wichita. The Wichita MIDO also issues special flight authorizations for Bombardier-Canada airplanes based on limitations developed by Transport Canada. Although the FAA's Wichita ACO is located at ICT, the FAA's ACO in Valley Stream, New York, has certification oversight for the CL604 and other aircraft manufactured by Bombardier in Canada. The New York ACO has no direct regulatory oversight responsibility of Bombardier airplanes manufactured in Canada and test flown in Wichita. However, according to the manager of the New York ACO, FAA certification personnel are authorized to validate Canadian certification test points.

Transport Canada Postaccident Audit of Bombardier's Wichita Facility

After the accident, Transport Canada conducted a Special Purpose Audit at the BFTC from October 25 to 27, 2000. The audit report commended Bombardier "for documenting procedures for the safe conduct of flight tests [the standards and procedures manual 3000]" but that "the audit revealed that the company management does not always enforce the provisions of the manual." The audit report stated that Bombardier project directives authorize specific BFTC engineers to "develop and approve developmental and experimental modifications specific to the flight test aircraft that can have significant effects on safety." The report noted that "documentation or specific procedures were unavailable to demonstrate that other engineering disciplines, potentially affected by the modification, provided sufficient analysis to support safe operation of the aircraft." [47]

In addition, the audit report stated that the "chief of flight operations and safety at BFTC is an unusual position in that it combines the 'Safety Manager' function with that of 'Operations Manager, which due to their functions have conflicting or incompatible roles."

The audit report noted that BFTC has a "well documented safety risk management [SRM] process" but that the SRM process did not address several areas. According to the report, these areas included the following:

> a) The risk level of a particular flight test activity is assigned prior to the expected effect of the minimizing or mitigating procedures. The hazard associated with using a[n] SRM tool that assigns risk level without taking into account the effectiveness of the risk reduction procedures is that the residual risk of a test could actually

be higher than perceived;

b) Low risk tests require no risk reduction, or identification of mitigation procedures. This is contrary to one of the basic principles of flight test safety, which is quoted in Section 8.5.1 of BFTC S&P 3000, 'Accept no unnecessary risk'; and

c) Low risk tests are defined as 'all test flying not described as high or medium risk'. There are lists of what are considered high and medium risk tests. The implication is that if it is not listed in the high or medium lists, then it must be low, without any analysis being performed.

d) The procedures in place have the potential, particularly in situations of time pressure, to over rely on the TDS [test definition sheet] generated risk analysis. Under such circumstances, further in-depth analysis of the risk associated with the particular test might be warranted.

The audit report concluded that "it was evident that the level of activity at BFTC was very high and is predicted to continue at this pace. The tempo of operations continues to place working pressures that have the potential [to] affect flight safety."

ADDITIONAL INFORMATION

The wreckage was released and all retained components were returned to Bombardier Incorporated. The FAA, Bombardier and General Electric were parties to the investigation. The TSB assigned a technical adviser to the investigation. Transport Canada provided technical personnel and resources throughout the investigation, including assistance in FDR/CVR readouts and Bombardier simulator tests.

Normal Takeoff Procedures

According to the Bombardier Aerospace *Challenger 604 Operations Reference Manual*, the PF rotates to 14° at 3° per second after the "rotate" call from the PNF. The same rotation rate is used for an abnormal takeoff (engine failure after V_1) but with a reduced pitch attitude of 10°. The rotation rate value listed in the *Challenger 604 Operations Reference Manual* is based on an industry average for transport-category aircraft takeoff profiles.

Flight Test Safety Standards

During the investigation, Safety Board staff examined flight test standards and programs developed by the FAA, the U.S. military, and the civilian National Test Pilot School. FAA certification test pilots attend an initial 6-week standardization course at a civilian test pilot school and receive 2 weeks of recurrent training. The course covers helicopter and fixed-wing flight test fundamentals, flight test safety, and flight test crew resource management (CRM). According to the FAA, the majority of FAA test pilots had received formal test pilot training from a military test pilot school before being hired, although the FAA also hires test pilots who have at least 1 year of industry flight test experience. FAA test pilots validate test points that have already been performed by airplane manufacturers.

The aircraft certification flight safety program established in FAA Order 4040.26 requires FAA management personnel who participate in safety management training to disseminate lessons learned to those involved in certification and to receive CRM training. The order also formalized procedures for the formal assessment of flight test risks and the acceptance of residual risks when signing the type inspection authorization or test plan. The order defined risk management as follows:

The process by which an assessment is made of the risks involved during a flight test, the establishment of mitigating procedures to reduce or eliminate the risks, and a conscious acceptance of the residual risks. Risk assessment is normally done by a safety review process in which a flight test plan is reviewed by project and non-project personnel in order to draw out potential hazards and recommend mitigating (or minimizing) procedures. Experience has shown that knowledgeable non-project personnel who are similarly involved in other projects provide valuable contributions to this process. They can identify areas that may have been overlooked by the project team (aircraft manufacturer vs. limited flight test experience), and flight crew currency in both the test method(s) and aircraft type.

U.S. Air Force Flight Test Center (AFFTC) Instruction 91-5, "AFFTC Test Safety Review Process," directs the application of system safety principles to the planning and conduct of all AFFTC and other designated test programs. It states that safety planning and technical planning are integral and that a "smart test team" will interweave technical and safety issues throughout the project planning process. The document emphasizes the identification and elimination/control of test hazards, the preparation of safety-related forms that include a THA, and the importance of safety and technical reviews.

The National Test Pilot School publication, "Flight Test Training: Luxury or Necessity?" addressed the benefits and efficiency of training for flight test pilots and engineers. This publication summarized an FAA test pilot's views as follows:

In general, on-the-job trained personnel are usually quite good at what they do; but their abilities are dependent on what they have been shown in the past. Flight testers who have learned on-the-job usually demonstrate very little capability to move into new areas of testing because they haven't been taught the fundamental philosophy of flight test. This is particularly noticeable in the area of test safety and the incremental approach to test flying.

ANALYSIS

General

The captain and first officer were properly certificated and qualified in accordance with applicable Federal regulations and company requirements.

The airplane was operating in accordance with a Canadian flight permit and a special use authorization issued by the FAA and was properly equipped to conduct flight tests. Examination of the flight controls, the modified PFS units, and the airplane's engines and systems found no evidence of pre-impact malfunction.

Visual meteorological conditions prevailed. Weather was not a factor in the accident.

Pilot Actions and Weight and Balance Shift

According to FDR information and calculated performance data, the airplane's maximum pitch rate after rotation was 9.6° per second, an extremely rapid pitch rate which was approximately three times greater than the average 3° per second pitch rate recommended in the *Challenger 604 Operations Reference Manual.* Safety Board staff review of the PF's previous takeoff performance indicated that he had commanded excessive pitch rates during several takeoffs in the months before the accident, including 6.5°- and 6°-per-second pitch rate takeoffs in the Challenger from Barrow and Fairbanks, Alaska, a month before the accident; a 7.2°-per-second rotation rate on a Challenger test flight on August 16, 2000; and a 8.3°-pitch-rate takeoff in a Global Express on September 22, 2000.

The amounts of fuel in the airplane's center, three-in-line auxiliary fuel tanks were not isolated from each other, which allowed fuel to move freely through pipes between tanks, especially during acceleration and rotation. Postaccident calculations determined that the c.g. moved aft as the airplane accelerated down the runway as fuel shifted rearward in the auxiliary fuel tanks, tail tanks, and wing tanks. By the time the airplane reached a pitch attitude of 13.8° 20 seconds after the start of the takeoff roll, the airplane's c.g. increased to at least 40.5 percent MAC, according to Safety Board staff calculations. Although fuel some migration is normal and expected in all airplanes, the CL-604's center fuel tank design allowed for significant fuel migration above the range accounted for in the airplane's certified c.g. range limits. Safety Board staff also considered a scenario that did not include fuel migration. Simulation testing indicated that without the fuel migration factor, the airplane's c.g. would have been sufficiently forward to prevent the airplane from pitching up sufficiently to trigger the airplane's stall protection system.

Thus, the aft c.g., including the c.g. change during the takeoff phase, combined with the high pitch attitude and pitch rate commanded by the pilot, resulted in stall and loss of control. Moreover, the aft c.g. and the aggressive pitch control inputs by the pilot eliminated the safety margin that the c.g. limit and the lower pitch rate guidance of 3° per second were intended to provide. Safety Board staff and Bombardier simulation studies indicated that either restoring the c.g. margin or reducing the pitch rate to 3° per second would have provided an adequate safety margin.

Based on FDR data, flight data of the PF's previous takeoffs, and postaccident fuel migration and shift calculations, it is evident that the pilot's pitch control, combined with unanticipated aft c.g. (fuel) shift during acceleration, resulted in an excessive rotation rate and an unexpected and faster pitch rate after liftoff, which caused the airplane to stall. The FAA and Transport Canada issued ADs after the accident addressing the issue of fuel migration (lowering the aft c.g. limit) and the potential for exceeding the airplane's aft c.g. limit during acceleration or climb.

FDR data indicated that the stick pusher activated twice (following two pitch up oscillations) after the airplane's pitch angle reached the stick shaker and stick pusher activation thresholds, and that the pilot made elevator inputs to counter the downward pitch angle induced by the stick pusher. During this time, the CVR recorded the sounds of stick shaker, aural stall and bank angle warnings. Based on this data, it is evident that the second combination of stall, stick pusher activation and subsequent up elevator inputs by the pilot occurred at an altitude too low for recovery when the airplane was experiencing wide excursions in pitch attitude and roll.

As noted previously, postaccident examination determined that the modified PFS units, which were to be tested during the flight, were not a factor in the accident.

Flight Test Oversight

Safety Board staff examined Bombardier's flight test operations, company procedures, and safeguards to minimize risk. At the time of the accident, Bombardier was phasing in a new flight test procedures manual, which included significant changes and additions in the areas of flight test preparation, hazard identification and analysis, and risk reduction. However, the changes had not yet been implemented in the Challenger sustaining program. Although the Challenger program was defined as a sustaining program because the airplane had received prior certification, the flight was nevertheless experimental because it was designed to test a component change that affected the airplane's handling qualities.

During the investigation, it was determined that the accident flight's risk assessment was subject to several interpretations. For example, the accident flight was assessed as a low risk test flight by Bombardier's manager of flight test operations and safety, who stated that the determination was made because the airplane was operating within its c.g. range and because "the modification was stabilizing." A Transport Canada test pilot later came to the same conclusion. However, an FAA test pilot concluded that the flight was a medium risk flight because it involved the modification of a flight control system. This disparity in risk assessment underscores the importance of a formal safety review and THA standard, especially when there are competing assessments. Even if the changes to PFS units were considered minor and ultimately judged not to pose a medium risk, it is noted that the risk assessment was made minutes before the flight and did not take into account that the changes were to a flight control system that was to be tested in flight for the first time during a complex maneuver.

Pilot selection and crew pairing are also part of the flight test safety equation. According to Bombardier, test flight training is on-the-job. Although on-the-job flight test training is a common industry practice, several airplane manufacturers (including Bombardier) and flight test schools have implemented an incremental approach to flight test training. This approach includes a gradual increase in flight test complexity during on-the-job training and the pairing of newly hired flight test pilots with an experienced flight test pilot before the new hires are allowed to conduct test flights as PICs. It is noted that the accident pilot, whose experience was largely in routine, entry-level operational and production testing, rather than flight testing, was assigned as PIC to test airplane control performance and airplane handling qualities in a complex flight test maneuver that he had never flown. The copilot, who was an experienced test pilot in other airplanes, was assigned second-in-command duties to familiarize himself with the Challenger, not to demonstrate flight test procedures and maneuvers that were unfamiliar to the accident pilot.

During its investigation, Safety Board staff reviewed test flight safety information from several sources, including the FAA, U.S. Air Force and the National Test Pilot School. The sources recommend developing THA worksheets for test flights, which include information on potential hazards, risk minimizing procedures, or emergency procedures. Briefing a test flight with a THA helps pilots focus on the specific risks involved in a test flight and helps to minimize the risk of complacency. Bombardier did not use these worksheets for preflight test briefings.

Neither the flight test card nor the preflight briefing for the accident flight called for a "build-up" of the flight test maneuver to be flown. A typical build-up for such a maneuver would have called for a gradual entry into the maneuver, at lower speeds and at a more stable c.g. location, before executing the prescribed maneuver at higher speeds and G forces and aft c.g. configurations. The preflight briefing also did not include a discussion about test maneuver techniques or about what procedures to follow in the event of a problem or failure in the modified systems to be tested. Pitch rate targets were also not discussed in the context of an aft c.g. test flight. Although the accident flight was to be conducted within the airplane's aft c.g. limit, the c.g. was near the aft limit and should have been briefed to increase awareness of pitch rate performance in this configuration.

Safety Board staff review of Bombardier flight data from 50 flights flown by BFTC pilots, including several senior test flight and management pilots, indicated that pilots routinely commanded pitch rates that were more than double the recommended rate of 3° per second during operational takeoffs. Company flight operations data, collected from every Bombardier test flight and archived, is not reviewed as part of an overall company flight operations quality assurance program. Therefore, this high pitch rate practice, and its potential for hazard, was not identified by senior Bombardier management.

Finally, despite experiencing three fatal and two nonfatal accidents during product development, Bombardier did not have a safety manager who reported directly to senior management at headquarters in Montreal, did not conduct regular safety meetings, and did not maintain a "lessons learned" safety database accessible to flight crews.

Based on its review of Bombardier's flight test operations and other relevant safety programs, the investigation determines that Bombardier's oversight of its flight test program was inadequate because risk assessment procedures in place for the Challenger program were not followed and because a more comprehensive risk assessment program, which would have required a more timely and thorough risk assessment of the accident flight, had not been implemented for the Challenger test program, although it had been used for 2 years in the company's RJ 700 program. Further, it is evident from the investigation that Bombardier's operation of its flight test program was deficient because the preflight briefing was inadequate, because a relatively inexperienced flight test pilot was chosen for a flight that involved a complex maneuver he had never flown (and in an aft c.g. configuration greater that he had ever flown), because a build-up for the accident flight was not considered, and because the company failed to identify a history of its pilots' practice of high rotation rate takeoffs, which becomes even more critical in airplanes configured with aft c.g.'s. Finally, it is evident from the investigation that Bombardier's safety program was deficient because the safety manager at the time of the accident did not report directly to senior management. However, it should be noted that the BFTC safety manager now reports directly to senior management in Montreal and that Revision A of BFTC 3000 is now used for the Challenger program.

Transport Canada and FAA Oversight of Flight Test Programs

Under the terms of a bilateral agreement, Transport Canada had direct regulatory oversight of Bombardier's BFTC operations involving the company's Canadian-manufactured airplanes, although the last inspection of the facility was conducted nearly a year before the accident. Although Transport Canada assigned a full-time inspector to the BFTC facility after the accident, there was very little surveillance of the facility's flight test operations at the time of the accident. Further, there are no Canadian or U.S. regulations specific to the conduct of flight test operations. Neither FAA nor Transport Canada regulations require Bombardier, or other flight test operations, to have a flight test policies and procedures manual.

It is evident from the investigation that Bombardier is developing and using its *Flight Test Standards and Procedures 3000* manual, but Transport Canada's audit observation indicated that the company did not always enforce the provisions of its own manual. Thus, Transport Canada and the FAA are only monitoring a largely voluntary program. The flight test operations and the corporate safety culture they require would benefit from the adoption of Transport Canada- and FAA-approved flight test standards and procedures. It should be noted that Transport Canada is currently considering regulations to require the use of an approved flight test operations manual and is implementing additional procedures to improve regulatory oversight of flight test operations, including those at BFTC.

Survival Factors

The emergency response to the accident site was timely, with two ARFF vehicles and three firefighters arriving at the scene within 90 seconds of the crash. However, there were not sufficient ARFF personnel equipped with protective gear in the immediate response to fight the fires and perform a rescue. The first responders to the scene, two ARFF fire trucks and three ARFF personnel, initiated a mass application of water and firefighting agent to extinguish the fuel-fed, exterior fire, which had engulfed the fuselage. The firefighters stated that they could hear the pilots calling for help after the large exterior fires had been extinguished. Two of the three personnel were occupied in their vehicles with firefighting activities, according to ARFF officials. Firefighters stated that additional personnel during the initial response would have allowed them to suppress the cockpit fire more quickly.

During its investigation of a runway overrun accident involving a McDonnell Douglas MD-82 in Little Rock, Arkansas, in 1999, [48] the Safety Board examined whether a passenger who needed to be rescued from the wreckage would have survived if sufficient ARFF personnel had been available to perform a rescue. In a situation similar to the Challenger accident, rescue efforts could not be conducted effectively until off-airport firefighters arrived at the scene. Although the Safety Board could not determine whether the passenger would have survived if more ARFF personnel had been available, it expressed concern that Federal regulations did not ensure that ARFF units would be staffed at levels sufficient to conduct simultaneous firefighting and rescue activities. [49] As a result, on October 23, 2001, the Safety Board issued Safety Recommendation A-01-65 to the FAA. Safety Recommendation A-01-65 asked the FAA to "amend 14 *Code of Federal Regulations* 139.319 (j) to require a minimum Aircraft Rescue and Fire Fighting staffing level that would allow exterior firefighting and rapid entry into an airplane to perform interior firefighting and rescue of passengers and crewmembers." [50]

The flight test engineer's station was located in the middle of the cabin. The flight test engineer's body was found forward near the cockpit bulkhead. He had suffered severe blunt force injuries. The flight test engineer's seat frame was found near his body with the 5-point latch buckled. The lap belts were found burned through. Damage to the seat, the seat floor mounts and the injuries sustained by the flight test engineer indicate that scenario three, that the flight test engineer's seat failed, is the most likely. Based on seat damage, evidence of seat frame separation in overload and the lack of similar separation of instrument racks near his seat, it is evident that the flight test engineer's seat separated during the impact sequence, and that his injuries were consistent with a lack of restraint.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of this accident was the pilot's excessive takeoff rotation, during an aft center of gravity (c.g.) takeoff, a rearward migration of fuel during acceleration and takeoff and consequent shift in the airplane's aft c.g. to aft of the aft c.g. limit, which caused the airplane to stall at an altitude too low for recovery. Contributing to the accident were Bombardier's inadequate flight planning procedures for the Challenger flight test program and the lack of direct, on-site operational oversight by Transport Canada and the Federal Aviation Administration.

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[1] Unless otherwise indicated, all times are central daylight time based on a 24-hour clock. The actual time of accident is approximate, based on flight data recorder (FDR) and air traffic control (ATC) information.

[2] Experimental and engineering test flights are flown to determine whether newly designed and experimental aircraft operate according to design standards. Based on these flights, test pilots make suggestions for improvements. Production test pilots test new airplanes for airworthiness after the airplanes come off the assembly line and before they are delivered to customers.

[3] According to 49 CFR Section 830.2, for classification purposes, a fatal injury is one in which death results within 30 days of the accident.

[4] The accident flight was also a training and orientation flight for the copilot.

[5] PFS units replicate aspects of the aerodynamic loads (absent in hydraulically driven control systems) through artificial feel and centering units, allowing the pilots to feel control input resistance. The units increase control column, control wheel, and rudder pedal resistance as the flight control surfaces are moved from their neutral positions.

[6] The maneuver to be flown for the flight test is known as a wind-up turn. During this maneuver, the airplane is put into a bank and the control column is continually pulled back to maintain the indicated airspeed. Control column forces are evaluated throughout the maneuver. A Federal Aviation Administration (FAA) test pilot described the wind-up

turn as “one of the hardest maneuvers to do in flight test.”

[7] The airplane was equipped with a combination of fixed weights and interconnected forward and aft ballast tanks. A water/glycol mixture could be moved forward or aft between the tanks, to change the c.g. for flight test purposes. The movement of the water/glycol mixture is controlled by an electric pump operated by the flight test engineer, or through gravity transfer (at an appropriate flight attitude). In addition, a lead ballast was located in the rear of the airplane.

[8] To comply with the PFS unit control force item listed by the CAA, Bombardier had the vendor (Lucas Aerospace Division of TRW Aeronautical Systems) modify the elevator control system’s PFS units to increase the second break out force. The first breakout force is the force necessary to move the control column, rudder, or other flight controls from the neutral position. The production PFS units provided initial movement of the control column from zero after the first breakout force was exceeded. The column force then increases linearly with column position until a second breakout force is reached, after which the column force continues to increase with column position at a reduced rate (to prevent excessive column movement). The modification on the accident airplane added shims at the end of an internal spring to increase preload for the second breakout. The change increased the second breakout point from the original 40 pounds to 50 pounds of force. According to Bombardier, the test flight was intended to demonstrate that the modified PFS units were sufficient to meet the CAA requirements in the heavy weight/aft c.g. configuration.

[9] The flight control sweeps were flight test checklist items to collect data.

[10] The pilot and copilot display control panels retained a selected heading of 230° in nonvolatile memory.

[11] The stick shaker, or control column shaker, is designed to warn pilots of an impending aerodynamic stall, and is accompanied by audible alerts and lights. For more information about the airplane’s stall warning system, see section 1.8.

[12] The CL-604 is equipped with an aural bank angle warning system. For more information about the airplanes aural warning systems, see section 1.8.

[13] An STC authorizes alteration of an aircraft engine or other component that is operated under an approved type certificate.

[14] Recurrent simulator training was the only formal proficiency check performed by

Bombardier at the company's commercial training facility in Montreal.

[15] Pilot logbook information indicates a total time of 6,585.5 hours.

[16] A special flight authorization permits a foreign-registered civil aircraft that does not have the equivalent of a U.S. standard airworthiness certificate to be operated within the United States.

[17] Stall protection vanes are located on the left and right side of the fuselage. They measure the local airflow on the forward fuselage. The stall vane measured angles are used to derive the airflow over the airplane's wings and provide stall warning and stall prevention. All AOA values in this report are vane AOA.

[18] No SPC maintenance was recorded during the period that included the airplane's final five flights.

[19] The non-phase advanced shaker and pusher angles are based on a flap setting of 20° and a pressure altitude of less than 2,000 feet.

[20] The stick pusher activates when each vane angle (on the left side and right side of the airplane's nose) reaches the preset activation angle.

[21] FAA publication FAA-H-8083-1, *Aircraft Weight and Balance Handbook*, states that fuel weight is determined by its specific gravity and temperature.

[22] The standard day, sea level density for Jet A fuel is about 6.789 pounds per U.S. gallon.

[23] Fuel samples taken at the Bombardier facility on November 16, 2000, nearly matched the typical fuel density of 6.75 pounds per gallon.

[24] The 13.8° value was chosen as a minimum flow, or best-case scenario assuming fuel shifts near rotation.

[25] The value of 40.5 percent MAC does not include tolerances for c.g. position or for changes in fuel density that could change this MAC value by more than 1 percent in either direction.

[26] Index C includes air carrier aircraft of at least 126 feet in length but less than 159 feet in length. According to 14 CFR 139, a minimum of two or three ARFF vehicles must carry a total quantity of 3,000 gallons of water for foam production.

[27] For more information on the synchronization of flight test and FDR data, see the Flight Data Correlation Study in the Safety Board's docket for this accident.

[28] The Safety Board uses the following categories to classify the levels of CVR recording quality: excellent, good, fair, poor, and unusable. An excellent recording is one that is very clear and easily transcribed. A good recording is one in which most of the crew conversations can be accurately and easily understood. The transcript that is developed may indicate unintelligible words or phrases. Any loss in the transcript can be attributed to minor technical deficiencies or momentary dropouts in the recording system or to a large number of simultaneous cockpit/radio transmissions that obscure each other. A poor recording is one in which a transcription is nearly impossible because a large portion of the recording is unintelligible.

[29] For information about the cabin passenger door, emergency exit and the flight test engineer's seat see the section titled, "Survival Aspects."

[30] The five drugs of abuse tested in the postaccident analysis are marijuana, cocaine, opiates, phencyclidine, and amphetamines.

[31] ARFF officers and firefighters reported that they first heard a loud noise and saw black smoke at the west side of the airport. The crash alarm activated as personnel were running to their vehicles. The ARFF chief stated that, before he responded to the scene, he confirmed that the ARFF dispatcher had contacted 911 and had requested mutual assistance from Sedgwick County and the Wichita Fire Department (WFD).

[32] In addition to two police cars, the airport had four ARFF vehicles: S-1 was a 1997 quick response vehicle equipped with 300 gallons of water, 40 gallons of 3 percent aqueous film forming foam (AFFF) and 450 pounds of dry chemical agent. Safety 2 and 3 were Oshkosh T-1500 vehicles equipped with 1,585 gallons of water, 205 gallons of 3 percent AFFF and 700 pounds of dry chemical agent. S-4 was an Oshkosh M-1500 equipped with 1,500 gallons of water and 180 gallons of 3 percent AFFF; S-4 was undergoing maintenance and did not respond to the accident.

[33] According to the Federal Aviation Regulations (FAR), cockpit front and side windshield panes and the supporting structure for these panes must withstand, without penetration, the impact of a 4-pound bird when the velocity of the airplane (relative to the

bird along the airplane's flightpath) is equal to the value of V_c (design cruise speed) at sea level, described in 14 CFR 25.335(a). V_c for the accident airplane is 300 knots indicated airspeed below 8,000 feet.

[34] Several smaller holes were punched through the left and right front windows.

[35] The takeoff demonstrations included early rotation (V_r minus 5 knots) with one engine inoperative; early rotation (V_r minus 10 knots, with a rapid rotation (or over rotation of 2° pitch) with all engines operating; and maximum pitch mistrim within the takeoff trim band with all engines operating.

[36] Simulator fidelity diminishes after entry into the stall.

[37] According to International Civil Aviation Organization Circular 247-AN/148, Section 3.10, a safety program "should be administered by an independent company safety officer who reports directly to the highest level of corporate management." The Safety Board, the FAA, and industry safety groups have also recommended that the safety officer be independent and report directly to top management. Safety Recommendation A-94-201 asked the FAA to require all carriers operating under Part 121 and Part 135 to "establish a safety function, such as outlined in Advisory Circular (AC) 120-59, "Air Carrier Internal Evaluation Programs." AC 120-59 stated that an evaluation program, which includes audits, inspections and evaluations, should be an "independent process that organizationally has straightline reporting responsibility to top management." The AC added that "this management [safety] position should be above the level that directly supervises work accomplishment or procedural development and should have direct contact with the chief executive officer or equivalent." Safety Recommendation A-94-201 was listed "Closed—Acceptable Alternate Action" after the FAA issued Joint Flight Standards Bulletins (HBAT 99-19 and HBAW 99-16) to FAA principal inspectors that provided guidance for the development of a comprehensive safety department and the suggested functions, qualifications, and responsibilities for a director of safety position.

[38] The description for this accident, LAX80FA073, can be found on the Safety Board's Web site at <http://www.ntsb.gov>.

[39] The description for this accident, CHI93MA276, can be found on the Safety Board's Web site at <http://www.ntsb.gov>.

[40] As a result of this investigation and an unrelated flight test accident involving a

Lockheed C-130, the Safety Board issued Safety Recommendation A-94-101, which asked the FAA to inform members of the flight test community about the circumstances of these accidents. Specific to the Byers, Kansas, accident, A-94-101 urged that "all companies involved in flight test of airplanes with anti-spin parachute systems ... incorporate a design feature that would prevent the parachute from deploying if the jaws securing the parachute to the airplane are open." According to Bombardier, the spin chute system has been redesigned to prevent the chute's deployment before it is secured to the airplane.

[41] The description for this accident, IAD99FA008, can be found on the Safety Board's Web site at <http://www.ntsb.gov>.

[42] The description for this accident, TSB Occurrence No. A00O0150, can be found at the TSB Web site at <http://bst.gc.ca>.

[43] FAA Order 4040.26 was initially published in 1997 and was revised on March 23, 2001.

[44] The Challenger 604 was considered to be under the sustaining program because the airplane had been certified. The accident flight was considered experimental because it was to test an unproven change to the airplane.

[45] According to the BFTC 3000 manual, hazard identification "begins with the preparation of the test requirements document," which includes "a preliminary hazard analysis." The manual states that the preliminary hazard analysis "is developed using experience, scenario thinking, archives, and similar techniques."

[46] The BFTC 3000 manual lists risk reduction measures to be conducted before the flight, including consideration of whether or not "this configuration (aerodynamic or systems) [has] been flight-tested."

[47] In a November 27, 2003, letter to the Transportation Safety Board of Canada (forwarded to the Safety Board), Bombardier challenged several conclusions and observations contained in Transport Canada's postaccident audit. The company stated that it had "challenged Transport Canada ... and provided substantial proof that the subject documentation and procedures were readily available and that the required engineering oversight for the safe conduct of flight testing was beyond reproach." In addition, Bombardier claimed that the audit "lacked specifics" and that "many of its findings were refuted by Bombardier." Corrective actions were also taken, according to Bombardier, including having the safety manager report directly to the executive vice president of engineering on safety issues and to the vice president of flight test on day-to-

day issues.

[48] National Transportation Safety Board, *Runway Overrun During Landing, American Airlines Flight 1420, McDonnell Douglas MD-82, N215AA, Little Rock, Arkansas, June 1, 1999,* Aircraft Accident Report NTSB/AAR-01/02 (Washington, DC: NTSB, 1999).

[49] The Safety Board had similar concerns during its investigation of an emergency landing of Air Tran flight 913 in Greensboro, North Carolina, on August 8, 2000, because of dense smoke in the cockpit. The Safety Board concluded that if the passengers and crew had not been able to evacuate, there would not have been enough ARFF personnel to enter the airplane and rescue occupants. The description for this accident, DCA00MA079, can be found on the Safety Board's Web site at <http://www.ntsb.gov>.

[50] In a February 19, 2002, letter to the Safety Board, the FAA stated that it had asked the ARAC Airports Issue Group to create an ARFF Requirements Working Group to examine ARFF staffing levels as part of an overall ARAC review of 14 CFR Part 139. On October 17, 2002, Safety Recommendation A-01-65 was classified "Open—Acceptable Response," pending results of the ARAC working group and implementation of the recommendation.

12/07/2006

MHI MH-2000
Prototype Helicopter

Daily News Nagoya

Prev Next Index Root

[DNN 001128] Helicopter test flight crash kills pilot in Mie and 1 article

From: Yoko Naito
Date: Thu, 7 Dec 2000 19:14:56 +0900

Helicopter test flight crash kills pilot in Mie

Police reported on Monday that one person died when a locally built helicopter crashed at around 2:40 p.m. in a rice field near Yanagi Station on the Kintetsu Suzuka Line in Suzuka City, Mie Prefecture.
According to Mitsubishi Heavy Industries Ltd., which built the aircraft, the six occupants on board were employees of the local company. Only pilot Kenzo Takahashi, 54, did not survive the incident.
Authorities said that the helicopter, owned by Nagoya Aerospace Systems Works (an affiliate of MHI), took off from a company plant next to Nagoya Airport in Komaki City for a test flight over the Ise Bay.
Police said that parts of the helicopter were found near the scene of the accident and an investigation into the cause is underway.
MHI said that the company produced the MH-2000 prototype on July 29 of 1996.

Citizens voice concerns over health issues

Aichi Prefecture recently released the results of a questionnaire that asked citizens about their health and attitudes toward the maintaining healthy lifestyles.
The questionnaire was also intended to get a grasp on how citizens are making use of prefecture-run recreational facilities, the prefecture said.
The prefecture said that roughly 80 percent of the 587 citizens who responded felt anxiety about their health. Nearly 86 percent of respondents said they didn't get enough exercise, the prefecture said, while roughly 73 percent said they had experienced forms of mental pressure or stress in the last month.

--Compiled by Tokuko Ogawa

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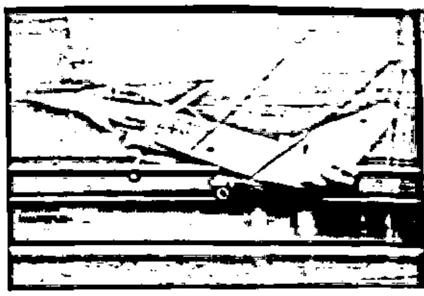
TEL:+81-52-971-0906/FAX:+81-52-951-8429 : http://www.eal.or.jp/DNN/

Prev Next Top Index Root



Sayonara MH-2000

Mitsubishi Heavy Industries halted plans for its 10-seat MH-2000 helo. A type certificate was issued in 1997, but the first prototype was lost in an accident during a flight test in 2000. Design improvements were made and six more vehicles were built, but sales never took off.

Jan 27, 2001

1/27/01

Equipment Malfunction Likely Cause of An-70 Crash

Alexey Komarov/Moscow

A crash landing of an Antonov An-70 four-engine propfan transport on Jan. 27 appears to have been caused by equipment failure, according to unofficial reports.

The aircraft, a prototype being used in the test flight program, crashed shortly after takeoff following an engine failure, further delaying the already troubled development program (*AW&ST* Feb. 5, p. 44).

Although the official findings of the inquiry board, headed by Valery Voskoboinikov of the Russian aerospace agency Rosaviakosmos, have not yet been released, the investigation team has traced the incident to a rupture in a hydraulic line feeding the counterrotating propfans on engine number three, according to an official at the Antonov Design Bureau, which designed the aircraft.

The line break led to a loss of pitch control on the rear set of blades, creating a negative thrust of approximately 5 metric tons and generating turbulence along the wing and strong vibration, the official said.

To compensate for the power drop, the An-70 crew pushed the engine throttle forward to maximum position, but due to a malfunction in the free turbine RPM sensor on engine number one, the automatic engine control unit received an overcrank signal and shut down the engine. The aircraft lost speed, and the crew performed a gear-up emergency landing on a snow-covered field.

The damaged aircraft was transported to the Polet aviation plant in Omsk for repair. After a detailed airframe examination, damaged elements will be replaced, and the aircraft returned to the Antonov plant in Kiev.

An-70 program leaders hope to have the aircraft back in the air this May in time for the Paris air show.

Meanwhile, bilateral negotiations were planned early this month to nail down a series production program for the Ukrainian airlifter, which is urgently needed by the Russian armed forces. However, Russia still has to pay Ukraine a reported $50 million owed for development.

WORLD NEWS & ANALYSIS

An-70 Crash Disrupts Airlifter Program

ALEXEY KOMAROV/MOSCOW

The crash landing of the Antonov An-70 prototype threatens to further delay the troubled airlifter program, and has Ukrainian and Russian engineers scurrying to recover.

The second—and only—prototype of the four-propfan transport made an emergency landing shortly after takeoff from Omsk in Siberia on Jan. 27, damaging the aircraft and injuring four of the 33 people on board. Two of the engines had failed.

The Russian-Ukrainian An-70 was on its way from the Antonov Design Bureau base in Kiev to Yakutsk for cold certification trials. It was carrying 11 crewmembers and 22 engineers and technicians, along with about 1 ton of test equipment. The aircraft had landed in Omsk about 12:30 a.m. local time to refuel after the 5.5-hr. flight from Kiev, and had taken off again at 5:38 a.m. for Yakutsk with 38 metric tons of fuel on board.

> The An-70 is among Russia and Ukraine's top priorities

Barely 16 sec. into the flight, one of the starboard engines failed, followed 4 sec. later by the failure of one of the port engines.

THE CAPTAIN, Vitaly Gorovenko, was able to perform a gear-up landing on a snow-covered field next to the airport. Due to skillful piloting and the An-70's short takeoff and landing capabilities, the landing was relatively soft and there was no fire. The four injuries were minor.

A preliminary investigation showed relatively little damage, according to Andrey Sovenko, an Antonov Design Bureau spokesman. Several skin panels on the central fuselage were damaged as were some aircraft subsystems, and the left outer engine and auxiliary power unit will have to be replaced. The skin can be fixed at the Polet aviation plant in Omsk. After field repairs, the aircraft will fly back to Kiev for full recheck and reconditioning, Sovenko said.

The damaged An-70 was powered by four ZMKB Progress/Zaporozhye D-27 propfans driving 16-blade Stupino SV-27 high-thrust, counterrotating propellers. The D-27 was specially developed for the An-70 and features a complex three-shaft design with a reduction gearbox. The manufacturer claims it offers 40% better economy than equivalent turboprops.

An investigation board is attempting to establish the reason for the engine failure. The board is headed by Valery Voskoboinikov of the Russian aerospace agency Rosaviakosmos, with assistance from specialists from the Russian and Ukrainian air forces, scientific industrial institutes, the Antonov Design Bureau and ZMKB.

A report is expected shortly, probably before Russian President Vladimir Putin and Ukrainian President Leonid Kuchma meet in Dnepropetrovsk in the first half of February to discuss aerospace cooperation. The An-70 project is among the two countries' top priorities, following the rejection last June of a proposal to base the European airlifter on the Russian-Ukrainian aircraft.

The first An-70 prototype was lost in a February 1995 midair collision on its fourth flight. The Antonov Design Bureau spent almost two years building the second aircraft, which made its first flight in April 1997.

At the end of last year, the An-70 reached the final stages of acceptance flight tests under a joint Russian-Ukrainian certification program, and a preliminary decision was made by the defense ministries of the two countries to approve the start of serial production. A final green light is expected this quarter.

"THERE ARE NO SIGNS yet that the accident will impact [this] decision," Sovenko said. Vasily Teplov, the An-70 chief designer, was even more sanguine: "The accident will not affect the An-70 serial production program," he said flatly.

The Aviant aircraft production plant in Kiev is reported to be close to a contract for an initial batch of five aircraft. Plans call for the first serial An-70 to be completed in 2002. The Ukrainian armed forces has a requirement for an estimated 65 An-70s, and Russia for up to 164.

6/22/01

ONE-OF-A-KIND

FAA INCIDENT DATA SYSTEM REPORT
Report Number: 20010622013109G

General Information

Local Date:	06/22/2001
Local Time:	12:00
City:	CARUTHERSVILLE
State:	MO
Airport Name:	CARUTHERSVILLE MEMORIAL
Airport Id:	M05

Aircraft Information

Aircraft Damage:	MINOR
Phase of Flight:	FCD/PREC LDG FROM CRUISE
Aircraft Make/Model:	CA-8
Airframe Hours:	43
Operator Code:	
Operator:	HOME CARE EQUIPMENT
Owner Name:	

Narrative

EXPERIMENTAL AIRCRAFT PERFORMING FLIGHT TESTING AT 15,500 FEET MSL. AT TAKEOFF, PILOT DETERMINED THAT 104 GALLONS OF FUEL WAS ONBOARD AIRCRAFT. WHILE AT ALTITUDE, PILOT STATED ENGINE QUIT DUE TO APPARENT FUEL STARVATION. HOWEVER, AIRCRAFT FUEL TOTALIZER ESTIMATED 44.2 GALLONS OF FUEL REMAINED. PILOT CONTACTED MEMPHIS CENTER FOR THE NEAREST AIRPORT LOCATION, WHICH TURNED OUT TO BE VAN BUREN, MO AIRPORT. AIRCRAFT SPIRALED DOWN TO AIRPORT AND PILOT ELECTED TO LAND OFF THE RUNWAY ONTO THE GRASS DUE TO RUNWAY DROPOFF AT THE END. AIRCRAFT PROPELLERS CONTACTED SOFT GROUND PRIOR TO COMING TO REST RESULTING IN BENT PROPELLER BLADES. OTHER NOTABLE AIRCRAFT DAMAGE WAS TO THE AIRCRAFT SKIN NEXT TO LANDING GEAR. CREW SUSPECTS FUEL LEAK FROM UNDERSIDE OF RIGHT WING. THERE WERE NO INJURIES. SECOND PILOT ONBOARD AIRCRAFT WAS PERFORMING FLIGHT ENGINEER/RECORDING DUTIES ONLY.

Detail

Primary Flight Type:	PERSONAL
Secondary Flight Type:	PLEASURE
Type of Operation:	GENERAL OPERATING RULES
Registration Number:	155JD
Total Aboard:	2
Fatalities:	
Injuries:	
Landing Gear:	
Aircraft Weight Class:	UNDER 12501 LBS

Engine Make: TURBOPROP
Engine Model: WALTER M601E
Engine Group:
Number of Engines: 1
Engine Type:

Environmental/Operations Information "Exhibition" Category

Primary Flight Conditions: VISUAL FLIGHT RULES
Secondary Flight Conditions: UNKNOWN
Wind Direction (deg):
Wind Speed (mph):
Visibility (mi):
Visibility Restrictions:
Light Condition: DAY
Flight Plan Filed: UNKNOWN
Approach Type:

Pilot-in-Command

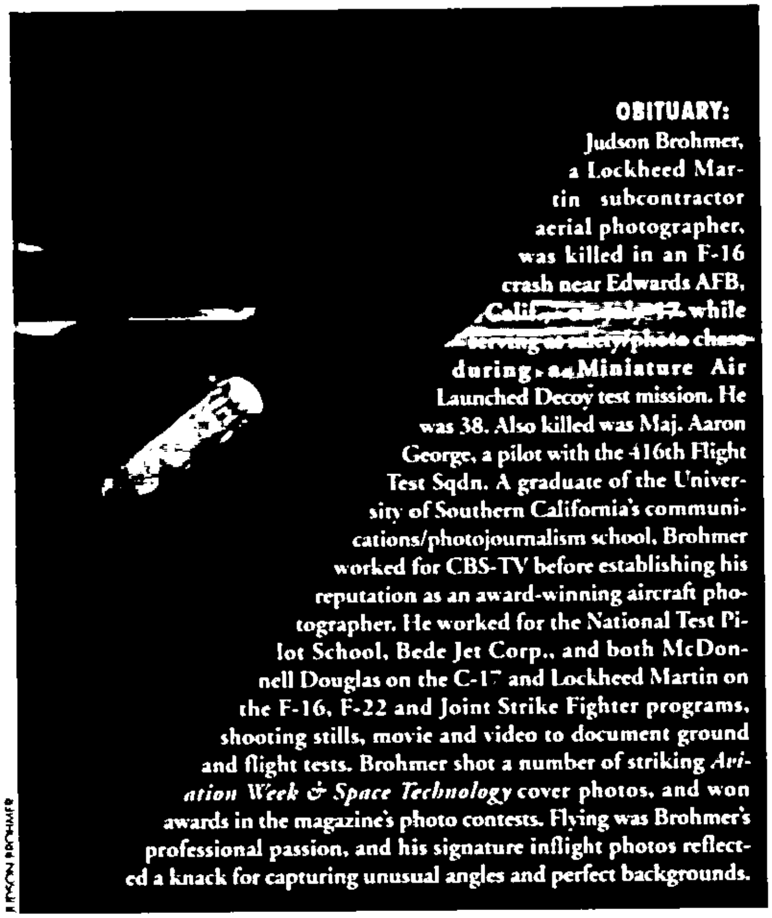
Pilot Certificates: COMMERCIAL PILOT FLIGHT INSTRUCTOR
Pilot Rating: AIRPLANE SINGLE, MULTI-ENGINE LAND
Pilot Qualification:
Flight Time (Hours)
Total Hours: 15500
Total in Make/Model: 42
Total Last 90 Days: 60
Total Last 90 Days Make/Model:

7/17/2001
EAFB

negligence trial with Singapore judge Tan Lee Meng seeking written submittals from attorneys within five weeks. Tan also instructed the plaintiffs to choose a focus for their case—pilot suicide or negligence by SilkAir's management. They are seeking unspecified damages from the airline for the December 1997 loss of a 737 that has been linked to pilot suicide. ○

RUSSIA

A celebration of the 75th anniversary of Russian naval aviation was marred by a fatal accident involving a Sukhoi Su-33 naval fighter. The July 17 accident occurred during an air show at the Naval Aviation Pilot Combat Training Center in Ostrov. The pilot, Maj. Gen. Timur Apakidze, deputy commander of Russian Naval Aviation, was killed in the crash which occurred on approach after



JUDSON BROHMER

OBITUARY: Judson Brohmer, a Lockheed Martin subcontractor aerial photographer, was killed in an F-16 crash near Edwards AFB, Calif., [illegible] while serving as [illegible] safety/photo chase during a Miniature Air Launched Decoy test mission. He was 38. Also killed was Maj. Aaron George, a pilot with the 416th Flight Test Sqdn. A graduate of the University of Southern California's communications/photojournalism school, Brohmer worked for CBS-TV before establishing his reputation as an award-winning aircraft photographer. He worked for the National Test Pilot School, Bede Jet Corp., and both McDonnell Douglas on the C-17 and Lockheed Martin on the F-16, F-22 and Joint Strike Fighter programs, shooting stills, movie and video to document ground and flight tests. Brohmer shot a number of striking *Aviation Week & Space Technology* cover photos, and won awards in the magazine's photo contests. Flying was Brohmer's professional passion, and his signature inflight photos reflected a knack for capturing unusual angles and perfect backgrounds.

The FAA is also taking a close look at TWA's maintenance procedures after the carrier had five emergency landings due to engine-related problems July 11-18. ○

With a 92% turnout, about 85% of 17,000 Boeing employees in the Puget Sound area have voted against unionization. The International Assn. of Machinists and Aerospace Workers petitioned for the vote, seeking to represent administrative, software and technology workers. Last year, a white-collar strike severely curtailed commercial aircraft deliveries at company facilities in the area for 40 days as 16,000 engineers and technicians represented by the Society of Professional Engineering Employees in Aerospace walked out (*AW&ST* Mar. 27, 2000, p. 42). ○

11/21st/2002

Airplanes, [..]e British Aviation Club in London [..]st week that the next new aircraft from [th]e company would be an ultra-efficient design in the 200-250-seat category with availability in 2007-08. Cruise speed would be similar to the 747's, rather than the transonic region. Earlier, Boeing said the fate of the Sonic Cruiser would be decided by year-end, but officials now [say] decision may not be announced until early next year.

PanAmSat is expected to join Intelsat in bidding for Paris-based Eutelsat, with the Paris-based satellite operator likely to attract larger deals worth about $3 billion from both U.S.-based companies. The U.S. bids are likely to intensify grumbling from Europe, and particularly France, where fears of a takeover have reached the "strategic threat" level (*AW&ST* Nov. 25, p. 26).

Eurofighter has announced it was to restart flight testing of the Typhoon combat aircraft. Flight testing had been suspended in the wake of the loss of Development Aircraft 6 on Nov. 21.

2002

Korea Aerospace Industries/Lockheed Martin T-50 advanced trainer/light attack fighter flies at its operational altitude of 40,000 ft. on a recent test flight. Called the Golden Eagle, the T-50's maximum service ceiling is estimated at 48,500 ft., meaning climb is then limited to 100 ft./min. at full afterburner. The 40,000-ft. test included flutter, control and stability tests at Mach 0.6. The aircraft is powered by a General Electric F404-GE-102 engine derived from the F/A-18 (*AW&ST* Dec. 3, 2001, p. 58). KAI is using two test articles that by early this month had achieved 24.1 flight hours on 24 flights. High speeds, including use of the afterburner, at the high altitude are expected in coming weeks.

Sikorsky has selected Turbomeca's Arriel 2S2 turboshaft engine to power future versions of the S-76 utility helicopter.

The ultralong-range Airbus A340-500 obtained European JAA certification after completing a 500-hr. flight test program. The Dash 500, a 313-seat aircraft, has a 8,650-naut.-mi. maximum range.

The U.S. aerospace industry is experiencing a "creeping crisis" led by plummeting sales of civil aircraft and a "virtually disappearing" civil space sector that is creating long-term structural problems, according to the Aerospace Industries Assn.

AIA President and CEO John W. Douglass told 350 members of the industry, government and media in Washington last week that the crisis is developing incrementally with bad news coming in "almost every day." For example, aerospace companies during the past 18 months have announced layoffs of 93,000 workers. Douglass said the industry's employment level is at its lowest since 1953 and in peacetime since the 1930s.

Total industry revenues declined to $148.2 billion this year from $153.1 billion in 2001, with another drop of $10 billion forecast for next year. Civil aircraft sales are expected to drop nearly $12 billion in 2003 after falling $8 billion this year. Military aircraft and missile sales are softening the blow of the civil sector with growth of nearly $4 billion this year and nearly $3 billion next year. However, the civil space sector is in even more distress than civil aircraft, with only two commercial satellites being sold worldwide this year instead of the 70 that were forecast for 2002 during the late 1990s. Douglass said the decline is presaging long-term structural problems such as airlines not having enough money to deploy the avionics equipment needed to develop a new air traffic control system.

On a positive note, AIA reported that the industry has logged a $5-billion increase in its trade balance this year as the dollar value of aerospace imports into the U.S. declined for the first time in seven years. The positive shift came despite a modest drop in U.S. aerospace exports.

Douglass believes recommendations in the just-completed report of the Commission on the Future of the U.S. Aerospace Industry can help turn the industry's situation around even though it will be hard to find solutions for the airline crisis. Last week, industry leaders met with senior representatives of several U.S. government agencies to develop action plans for implementing the recommendations. A follow-up meeting is planned for February.

RUSSIA

Russia's minister for economic development and trade, German Gref, is reported to have criticized Tupolev over the lack of progress on its Tu-334 regional jetliner. Gref warned that unless substantial progress was made, Russia faced losing its commercial aircraft sector within the next few years.

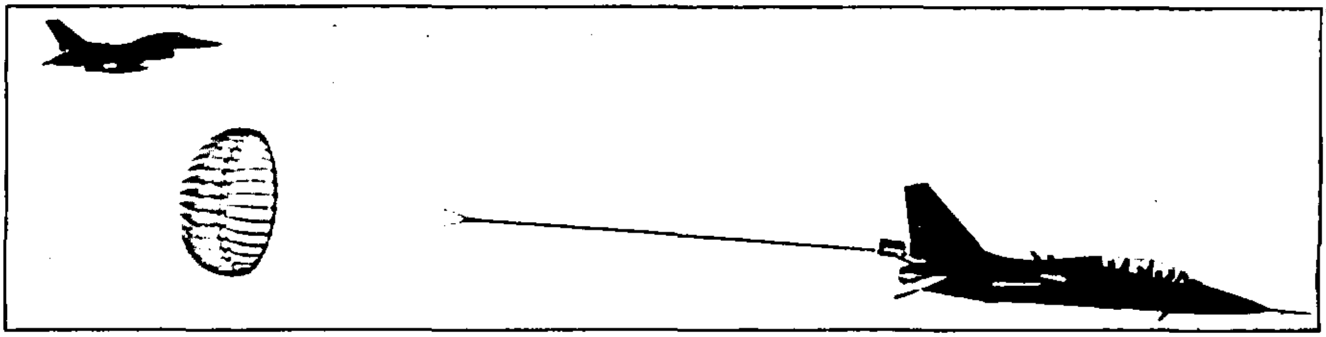
ASIA-PACIFIC

Philippines President Gloria Macapagal Aquino was handed a setback last week when the country's supreme court told her government to return to the negotiating table to sort out the controversy surrounding Terminal 3 at Manila's Nonoy Aquino International Airport. Aquino's government had abrogated a contract favorable to Philippine Air Terminal Co. (*AW&ST* Nov. 18, p. 48).

In a move met with protests by consumer groups, Australia's Tourism Task Force said airports and airlines will pass the costs of baggage screening equipment and other security measures on to passengers rather than see the government pick them up as an antiterrorism expense. Higher ticket prices are expected.

Correction: Kim Dae Jung is president of South Korea, not North Korea (*AW&ST* Nov. 11, p. 48). The leader of North Korea is Kim Jung Il.

T-50 Trainer Begins High AOA Flight Tests



LOCKHEED MARTIN

South Korea's air force has begun high angle-of-attack flight tests of the Korea Aerospace Industries/Lockheed Martin T-50 jet trainer (right in photo) at Sachon AB, to verify predicted AOA stall and departure limits, the aircraft's departure characteristics and the effectiveness of its digital flight control system (DFCS) in preventing stalls and recovering from them. Initial tests will use basic air-to-air loadings and include planned departures from controlled flights. The T-50's DFCS is designed to be departure-free during normal operations and to aid in the recovery of any out-of-control situation. It has a high angle-of-attack limiter of 25-deg. AOA. Some 47 flights over four months are planned and will be carried out by the second of four test aircraft. That aircraft has been fitted with an external spin recovery parachute assembly, which is shown during parachute testing. KAI and the air force have conducted some 400 T-50 test sorties.

started Boeing on a two-customer path that would serve it well, building aircraft for the military—the KC-135—and commercial customers—the 707.

The FAA has proposed an airworthiness directive requiring that certain Boeing 747-series aircraft undergo a one-time inspection to "find and fix" discrepancies of the frame web and inner chords on the forward edge frame of the No. 5 main entry door cutout. The proposed AD was prompted by a report of cracking of the frame web and inner chords. The FAA notes discrepancies could result in "cracking, subsequent severing of the frame and consequent rapid depressurization."

ASIA-PACIFIC

U.S. plans to reduce troop levels in South Korea are prompting talk that Seoul will increase its defense spending more than expected in Fiscal 2005. Won Jang-hwan, director of the Acquisition Policy Bureau, says the Ministry of Defense will seek a 13.4% increase next year, or 21.4 trillion won ($18.5 billion). The U.S. says the current level of 37,000 personnel will be cut 12,000-13,000 next year. U.S. troop commitment has been regarded as a benefit to U.S. suppliers. During the past decade, the U.S. has held close to 80% of Korea's defense procurement budget. With the troop pullback, however, European equipment makers are hoping that their chances of winning major contracts will be improved.

OBITUARIES: Albert V. Casey, former chairman and CEO of AMR Corp., died of a heart attack July 10 at home in Dallas. He was 84. In 1985, Casey retired from AMR after 11 years but remained a member of the board of directors until 1991. He was appointed by President George H.W. Bush in 1991 as president and chief executive of the Resolution Trust Corp., which oversaw failed savings and loan associations, and in 2002 President George W. Bush appointed Casey to a nine-year term on the U.S. Postal Service Board of Governors. In addition, Casey taught at Southern Methodist University's Edwin L. Cox School of Business. A native of Boston, Casey was president of the Times Mirror Co. for eight years before joining AMR in 1974 and overseeing the airline's headquarters move to Dallas from New York in 1979.

Azizan Zainul Abidin, chairman of Malaysia Airlines (MAS) and Petronas, Malaysia's national oil company, died at home near Kuala Lumpur on July 14 of an unknown cause. He was 69. Named MAS chairman in early 2001, Azizan helped restructure the carrier's operations while it was struggling with continuing losses. His leadership is credited with allowing the carrier in May 2003 to announce its first profit in six years.

Corrections: In a report on *Aviation Week & Space Technology's* Top-Performing Companies study, the position of Smiths Group plc was incorrectly stated (*AW&ST* July 5, p. 43). Thales, not Smiths, was the third-largest generator of cash flow return on investment among the major aerospace contractors.

The article "Looking Ahead" (*AW&ST* July 5, p. 25) contained an incorrect reference to the moon Titan. It orbits Saturn, not Jupiter.

A story on an advanced concept to reduce fratricide misidentified a U.S. Army aircraft being used as a surrogate for a close air support aircraft in a test (*AW&ST* June 21, p. 34). The aircraft was a Beech C-12 twin turboprop.

Honeywell will be the sole provider of air traffic and terrain avoidance warning functionalities for the Airbus A380, through its Aircraft Environment Surveillance System (*AW&ST* June 14, p. 11).

News Article

22 November 2002 - Eurofighter Typhoon DA6 Test Flight incident/Accident Update (Hallbergmoos – 22 November 2002) Further to an earlier report covering the air incident involving Eurofighter Typhoon DA6.

During a routine test flight in the mountainous Toledo region of Spain the twin-seat Eurofighter Typhoon DA6 was involved in an air incident that resulted in the loss of the aircraft. The aircrew, EADS CASA Chief Test Pilot, Eduardo Cuadrado and Spanish Air Force OTC Pilot, Ignacio Lombo, ejected safely from the aircraft and returned to the EADS-CASA Flight Test Centre in Getafe. Following medical checks both were released from care.

The incident occurred approximately 15 minutes after take off from Getafe Flight Test Centre over the Military Flight Test Range near Toledo (Poligono de Pruebas de Anchuras). The aircraft was flying level at 45,000ft at a speed of Mach 0.7. In accordance with pre agreed procedures for the use of development aircraft an investigation panel has been formed to establish the cause of the accident.

Eurofighter Typhoon DA6 is one of seven development aircraft in the programme. To date the DA-fleet has accumulated more than 2,000 flight test hours. DA6 has accumulated 362 missions for 326 flying hours. In addition, three Instrumented Production Aircraft (IPA) recently joined the flight test programme.

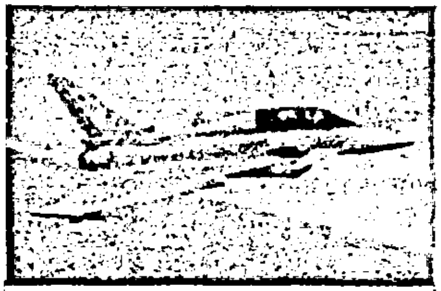
The Eurofighter Flight Test programme has an exemplary Flight Safety Record. This recent event is the only air accident to have occured in the Eurofighter development and flight test programme.

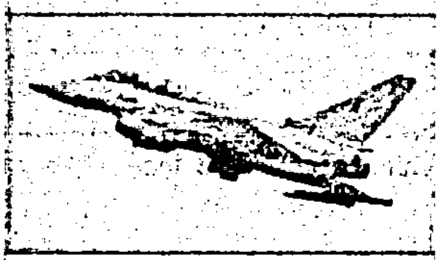
Like all DA-series aircraft, DA6 is fitted with specialized Flight Test Instrumentation and Flight Data Recorders. Real time data covering every aircraft system and parameter is sent to the Flight Test Centre throughout every flight for analysis.

Based on established processes for military air accidents the investigation will be headed by the Spanish Accident Investigation Agency (CITAM - Comision Investigacion Tecnica Accidentes Militares) on behalf of NETMA and the four Eurofighter partner nations.

In accordance with existing protocols Eurofighter will provide support to the investigation through a designated Eurofighter Accident Surveillance Team.

News Article





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develope

04/08/2003

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID: FTW03LA125	Aircraft Registration Number: N121CC
	Occurrence Date: 04/08/2003	Most Critical Injury: None
	Occurrence Type: Accident	Investigated By: NTSB

Location/Time

Nearest City/Place	State	Zip Code	Local Time	Time Zone
Olney	TX	76374	1545	CDT

Airport Proximity: On Airport	Distance From Landing Facility:	Direction From Airport:

Aircraft Information Summary

Aircraft Manufacturer	Model/Series	Type of Aircraft
CarterCopter	Prototype	Gyrocraft

Sightseeing Flight: No **Air Medical Transport Flight:** No

Narrative

Brief narrative statement of facts, conditions and circumstances pertinent to the accident/incident:

On April 8, 2003, at 1545 central daylight time, a CarterCopter prototype gyrocraft, N121CC, owned and operated by CarterCopter LLC, of Wichita Falls, Texas, sustained substantial damage during a wheels-up landing at the Olney Municipal Airport (ONY) near Olney, Texas. The private pilot and the flight test engineer were not injured. The research and development flight was operated under Code of Federal Regulations Part 91. Visual meteorological conditions prevailed, and a flight plan was not filed. The local flight originated from ONY at 1530.

The pilot reported in the Pilot/Operator Aircraft Accident Report (NTSB Form 6120.1/2) that while landing on runway 35 he was distracted by a twin-engine airplane taxiing on the runway and "forgot" to extend the landing gear prior to landing. The flight test engineer reported in the Passenger Statement Report (NTSB Form 6120.9) that the chase ground crew alerted the pilot that the landing gear was not extended. Subsequently, the pilot attempted to go around by applying full power; however, the gyrocraft impacted the runway surface.

Examination of the gyrocraft by the operator revealed that the tail boom was partially separated from the fuselage and the top of the right rudder was separated. Additionally, the propeller was damaged.

The gyrocraft, which was built from composite materials, was powered by a 350-cubic inch automotive engine, had accumulated over 360 hours. The pilot in command accumulated over 2,000 hours of flight time, 1,400 hours of rotorcraft, and 80 hours in the make/model of the gyrocraft.

The airport manager at the Olney Airport reported at the time of the accident, the winds were from the north at about 12 knots.

NTSB ID: FTW03LA125

Occurrence Date: 04/08/2003

Occurrence Type: Accident

Landing Facility/Approach Information

Airport Name	Airport ID:	Airport Elevation	Runway Used	Runway Length	Runway Width
OLNEY MUNI	ONY	1275 Ft. MSL	35	5000	50

Runway Surface Type: Asphalt

Runway Surface Condition: Dry

Type Instrument Approach: NONE

VFR Approach/Landing: Full Stop; Traffic Pattern

Aircraft Information

Aircraft Manufacturer	Model/Series	Serial Number
CarterCopter	Prototype	001

Airworthiness Certificate(s): Experimental (Special)

Landing Gear Type: Retractable - Tricycle

Homebuilt Aircraft?	Number of Seats:	Certified Max Gross Wt.	Number of Engines:
Yes	5	3750 LBS	1

Engine Type:	Engine Manufacturer:	Model/Series:	Rated Power:
Reciprocating	General Motors	350 CID	300 HP

- Aircraft Inspection Information

Type of Last Inspection	Date of Last Inspection	Time Since Last Inspection	Airframe Total Time
Continuous Airworthiness	03/29/2003	3.5 Hours	363.8 Hours

- Emergency Locator Transmitter (ELT) Information

ELT Installed? Yes | ELT Operated? No | ELT Aided in Locating Accident Site? No

Owner/Operator Information

Registered Aircraft Owner: CarterCopter	Street Address: 5720 Seymour Highway		
	City: Wichita Falls	State: TX	Zip Code: 76310
Operator of Aircraft: Same As Reg'd Aircraft Owner	Street Address: Same as Registered Aircraft Owner		
	City:	State:	Zip Code:

Operator Does Business As: | Operator Designator Code:

- Type of U.S. Certificate(s) Held: None

Air Carrier Operating Certificate(s):

Operating Certificate: | Operator Certificate:

Regulation Flight Conducted Under: Part 91: General Aviation

Type of Flight Operation Conducted: Flight Test

National Transportation Safety Board
FACTUAL REPORT
AVIATION

NTSB ID: FTW03LA125
Occurrence Date: 04/08/2003
Occurrence Type: Accident

First Pilot Information

Name	City	State	Date of Birth	Age
Larry R Neal	Boyd	TX	On File	51

Sex: M | Seat Occupied: Left | Principal Profession: Civilian Pilot | Certificate Number: On File

Certificate(s): Private

Airplane Rating(s): Multi-engine Land; Single-engine Land

Rotorcraft/Glider/LTA: Gyroplane

Instrument Rating(s): None

Instructor Rating(s): None

Type Rating/Endorsement for Accident/Incident Aircraft? No | Current Biennial Flight Review? 08/03/200

Medical Cert.: Class 3 | Medical Cert. Status: Valid Medical--no waivers/lim. | Date of Last Medical Exam: 08/13/200

light Time Matrix	All A/C	This Make and Model	Airplane Single Engine	Airplane Mult-Engine	Night	Instrument Actual	Instrument Simulated	Rotorcraft	Glider	Lighter Than Air
otal Time	2000	80	469	42	11			1408		
Pilot In Command(PIC)	1935	80	449	22	8			1388		
Instructor										
Last 90 Days	38	8						3		
Last 30 Days	20	8						12		
Last 24 Hours	2	2								

Seatbelt Used? Yes | Shoulder Harness Used? Yes | Toxicology Performed? No | Second Pilot? No

Flight Plan/Itinerary

Type of Flight Plan Filed: None

Departure Point	State	Airport Identifier	Departure Time	Time Zone
Same as Accident/Incident Location		ONY	1530	CDT

Destination	State	Airport Identifier
Local Flight		

Type of Clearance: Unknown

Type of Airspace: Class E

Weather Information

[redacted]urce of Briefing: Unknown

Method of Briefing: Unknown

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID: FTW03LA125
	Occurrence Date: 04/08/2003
	Occurrence Type: Accident

Weather Information

WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
E15	1545	CDT	1123 Ft. MSL	20 NM	145 Deg. Mag.

Sky/Lowest Cloud Condition: Clear Ft. AGL | Condition of Light: Day

Lowest Ceiling: None Ft. AGL | Visibility: 10 SM | Altimeter: 30.38 "Hg

Temperature: 12 °C | Dew Point: -2 °C | Wind Direction: 320 | Density Altitude: 795 Ft.

Wind Speed: 16 | Gusts: 21 | Weather Condtions at Accident Site: Visual Conditions

Visibility (RVR): Ft. | Visibility (RVV) SM | Intensity of Precipitation:

Restrictions to Visibility: None

Type of Precipitation: None

Accident Information

Aircraft Damage: Substantial | Aircraft Fire: None | Aircraft Explosion None

Classification: U.S. Registered/U.S. Soil

- Injury Summary Matrix	Fatal	Serious	Minor	None	TOTAL
First Pilot				1	1
Second Pilot					
Student Pilot					
Flight Instructor					
Check Pilot					
Flight Engineer					
Cabin Attendants					
Other Crew				1	1
Passengers					
- TOTAL ABOARD -				2	2
Other Ground					
- GRAND TOTAL -				2	2

NTSB ID:	FTW03LA125
Occurrence Date:	04/08/2003
Occurrence Type:	Accident

Administrative Information

Investigator-In-Charge (IIC)

Hector R Casanova

Additional Persons Participating in This Accident/Incident Investigation:

Paul D. Vercellino
Maintenance Inspector
Federal Avation Administration
Forth Worth, TX 76177

FORM APPROVED FOR USE THROUGH 7/31/96 BY OMB NO.3147-0001.

NATIONAL TRANSPORTATION SAFETY BOARD
PILOT/OPERATOR AIRCRAFT ACCIDENT REPORT
This form To Be Used For Reporting Civil Aircraft Accidents Involving Commercial and General Aviation Aircraft

Location

Nearest City/Place, State, Zip Code	Date of Accident	Local Time (24 HOUR CLOCK)	Zone	Elevation At Accident Site
OLNEY MUNICIPAL AIRPORT OLNEY, TEXAS	04/08/03	14:30	central	1274 Feet MSL; ____ Feet MSL

If The Accident Occurred On Approach, Takeoff or Within 3 Miles of An Airport, Complete The Following Information

Proximity To Airport

1.☑ On Approach 3.☐ Within 1/2 Mile 5.☐ Within 1 Mile 7.☐ Within 3 Miles
2.☐ Within 1/4 Mile 4.☐ Within 3/4 Mile 6.☐ Within 2 Miles 8.☐ Beyond 3 Miles

Airport Name	Airport Ident	Runway/Landing Surface Conditions:
OLNEY MUNICIPAL		1.☑ Direction: 350 2.☑ Length: 5,000 3.☑ Width: 50' 4.☑ Surface: Paved 5.☑ Condition: Good

Phase Of Operation:

1.☐ Standing 3.☐ Takeoff 5.☐ Cruise 7.☐ Approach 9.☐ Hover/Maneuver
2.☐ Taxi 4.☐ Climb 6.☐ Descent 8.☑ Landing 10.☐ Altitude Of In-Flight Occurrence ____ Feet MSL

Aircraft Information

Registration Mark	Aircraft Manufacturer	Aircraft Type/Model	Serial Number	Cert Max Gross WT
N121CC	Carter Copters	Gyroplane	001	

Type Of Aircraft
1.☐ Airplane 2.☐ Helicopter 3.☐ Glider 4.☐ Balloon 5.☐ Blimp/Dirigible 6.☐ Ultralight 7.☑ Gyroplane 8.☐ Specify____

Type Of Airworthiness Certificate
1.☐ Normal 2.☐ Utility 3.☐ Acrobatic 4.☐ Transport 5.☐ Restricted 6.☐ Limited 7.☑ Experimental 8.☐ Specify____

Amateur Built
1.☑ Yes 2.☐ No

Landing Gear
1.☐ Tricycle—Fixed 2.☑ Tricycle—Retractable 3.☐ Tailwheel—Fixed 4.☐ Tailwheel—Retractable 5.☐ Tailwheel—Retractable Mains 6.☐ Amphibian 7.☐ Skid 8.☐ Limited 9.☐ Specify____

No. Of Seats Flight/Cabin
Crew 2
Pax 3

Stall Warning System Installed
1.☐ Yes 2.☑ No

IFR Equipped
1.☑ Yes 2.☐ No

Engine Type
1.☐ Reciprocating—Carburetor 2.☑ Reciprocating—Fuel Injected 3.☐ Turbo Prop 4.☐ Turbo Jet 5.☐ Turbo Fan 6.☐ Turbo Shaft

Engine Manufacturer	Engine Model/Series	Engine Rated Power	Type Of Fire Extinguishing System Used
General Motors	350 C.I.D. Corvette	1. 320 Horsepower 2. 1,300 Lbs Thrust	1. None 2. Specify Charged powder

Engine(s)	Date of Mfg.	Mfg. Serial No.	Total Time	Time Since Inspection	Time Since Overhaul
Engine No. 1	04/15/01	12561108	185.4 Hours	3.6 Hours	3.5 Hours
Engine No. 2			Hours	Hours	Hours
Engine No. 3			Hours	Hours	Hours
Engine No. 4			Hours	Hours	Hours

Type Of Maintenance Program
1.☐ Annual 2.☐ Manufacturer's Inspection Program 3.☐ Other Approved Inspection Program(AAIP) 4.☑ Continuous Airworthiness 5.☐ Specify____

Type Of Last Inspection
1.☐ Annual 2.☐ 100 Hours 3.☐ AAIP 4.☑ Continuous Airworthiness

Date Last Inspection Performed 03/29/03 (M/D/Y)
Time Since Last Inspection 3.5 Hours
Airframe Total Time 363.8 Hours

Emergency Locator Transmitter (ELT)

ELT Manufacturer	Model/Series	Serial Number	Battery Date
Ameri-King Corp	AK-450	354130	(M/D/Y) 01/01/05

Switch: 1.☐ On 2.☐ Off 3.☑ Armed
Operated: 1.☐ Yes 2.☑ No
Aided In Accident Location: 1.☐ Yes 2.☑ No

Registered Aircraft Owner
Carter Copters

Address 5720 Seymour Hwy Wichita Falls, TX 76310

Operator Of Aircraft
1.☑ Same As Registered Owner
2. Name
3. DBS:

Address
1.☑ Same As Registered Owner
2.____

NTSB Form 6120.1/2 (11/87) This Form replaces NTSB Forms 6120.1 (rev 10/77) and 6120.2 (Rev 10/77)

Owner / Operator Information (cont.)

Operator (Certificate Number)	Operator Designator (4 Letter Designator)

Purpose Of Flight And Type Of Operation

Regulation Flight Conducted Under
1.☐ FAR91 (only) 4.☐ FAR 121 7.☐ FAR 133
2.☐ FAR91D 5.☐ FAR 125 8.☐ FAR 135
3.☐ FAR 103 6.☐ FAR 129 9.☐ FAR 137

Purpose of Flight
1.☐ Personal 6.☐ Aerial Observation
2.☐ Business 7.☐ Other Work Use
3.☑ Educational 8.☐ Public Use
4.☐ Executive/Corporate 9.☐ Ferry
5.☐ Aerial Application 10.☐ Positioning

Operator Authority
FAR121
1.☐ Domestic
2.☐ Flag
3.☐ Supplemental
FAR 135
4.☐ On Demand
5.☐ Commuter
FAR 133
6.☐ Rotorcraft External Load
FAR125
7.☐ Large Aircraft
FAR 129
8.☐ Foreign

FAR 121, 125, 127, 129, 135 Revenue Operations
1.☐ Scheduled
2.☐ Non Scheduled
3.☐ Domestic
4.☐ International
5.☐ Passenger
6.☐ Cargo
7. Specify________

Pilot Information

Pilot Name	Pilot Certificate No.	Address	Nationality
Larry Ronald Neal	[redacted]	[redacted] Boyd, TX 76023	U.S.A

Certificate (s)
1.☐ Student 3.☐ Commercial 5.☐ Flight Instructor 7.☐ Military 9.☐ None
2.☑ Private 4.☐ Airline Transport 6.☐ Flight Engineer 8.☐ Foreign 10.Specify________

Rating (s)
1.☐ None 6.☐ Helicopter
2.☑ Single Engine Land 7.☐ Glider
3.☐ Single Engine Sea 8.☐ Free Balloon
4.☑ Multiengine Land 9.☐ Airship
5.☐ Multiengine Sea 10.☑ Gyroplane

Instrument Rating (s)
1.☑ None
2.☐ Airplane
3.☐ Helicopter

Instructor Rating (s)
1.☑ None 6.☐ Instrument Airplane
2.☐ Airplane S.E. 7.☐ Instrument Helicopter
3.☐ Airplane M.E. 8.☐ Ground Instructor
4.☐ Helicopter 9.☐ Specify________
5.☐ Glider

Type Ratings/Student Endorsements	Date Of Biennial Flight Review or Equivalent (M/D/Y)	BFR Aircraft
	08/03/01	1. Make Gyroplane 2. Model Air Command

Medical Certificate	Date Of Last Medical (M/D/Y)	Limitations / Waivers	Date Of Birth (M/D/Y)
1.☐ None 3.☐ Class 2 2.☐ Class 1 4.☑ Class 3	08/13/01	Limitations Waivers	06/24/51

Degree Of Injury
1.☑ None
2.☐ Minor
3.☐ Serious
4.☐ Fatal

Seat Occupied
1.☑ Left 4.☐ Front
2.☐ Right 5.☐ Rear
3.☐ Center

Person At Controls At Time Of Accident
1.☑ Pilot In Control 4.☐ Non-Pilot
2.☐ Second Pilot 5.☐ No One
3.☐ Both Pilots

Seat Belt Available
1.☐ Yes
2.☐ No

Seat Belt Used
1.☑ Yes
2.☐ No

Shoulder Harness Available
1.☑ Yes
2.☐ No

Shoulder Harness Used
1.☑ Yes
2.☐ No

Source Of Pilot Flight Time Information
1.☑ Pilot Logbook 4.☐ Company
2.☑ Operators Estimate V.L. 5.☐ Specify________
3.☐ FAA Records

Flight Time	All A/C	This Make & Model	Airplane Single Engine	Airplane Multiengine	Night	Instrument Actual	Instrument Simulated	Rotorcraft	Glider	Lighter Than Air
Total Time	2,000	80.7	469.3	42.1	11.6			1408		
Pilot In Command (PIC)	1,935	80.7	449.0	22.0	9.0			1,388		
Instructor										
This Make & Model										
Last 90 Days	37.1	8.1						30		
Last 30 Days	20.0	8.1						11.9		
Last 24 Hours	2.2	2.2								

Second Pilot Information

Second Pilot Responsibilities At The Time Of Accident
1.☐ Co-Pilot 2.☐ Dual Student 3.☐ Safety Pilot 4.☐ Check Pilot 5.☑ None (Pilot-Rated Passenger)

Pilot Name	Pilot Certificate No.	Address	Nationality
Brad King	[redacted]	[redacted] Mansfield, Texas	U.S.A.

Certificate (s)
1.☐ Student 3.☐ Commercial 5.☐ Flight Instructor 7.☐ Military 9.None________
2.☑ Private 4.☐ Airline Transport 6.☐ Flight Engineer 8.☐ Foreign 10.Specify________

econd Pilot Information (cont.)

ting (s)
- 1.☐ None
- 2.☐ Single Engine Land
- 3.☐ Single Engine Sea
- 4.☐ Multiengine Land
- 5.☐ Multiengine Sea
- 6.☐ Helicopter
- 7.☐ Glider
- 8.☐ Free Balloon
- 9.☐ Airship
- 10.☑ Gyroplane

Instrument Rating (s)
- 1.☐ None
- 2.☐ Airplane
- 3.☐ Helicopter

Instructor Rating (s)
- 1.☐ None
- 2.☐ Airplane S.E.
- 3.☐ Airplane M.E.
- 4.☐ Helicopter
- 5.☐ Glider
- 6.☐ Instrument Airplane
- 7.☐ Instrument Helicopter
- 8.☐ Ground Instructor
- 9.☐ Specify________

pe Ratings/Student Endorsements

Date Of Biennial Flight Review or Equivalent (M/D/Y)

BFR Aircraft
1. Make________
2. Model________

dical Certificate
- ☐ None
- ☐ Class 1
- 3.☐ Class 2
- 4.☑ Class 3

Date Of Last Medical (M/D/Y)

Limitations

Waivers

Date Of Birth (M/D/Y)

egree Of Injury
- ☑ None
- ☐ Minor
- 3.☐ Serious
- 4.☐ Fatal

Seat Occupied
- 1.☐ Left
- 2.☑ Right
- 3.☐ Center
- 4.☐ Front
- 5.☐ Rear

Seat Belt Available
- 1.☑ Yes
- 2.☐ No

at Belt sed
- ☑ Yes
- ☐ No

Shoulder Harness Available
- 1.☑ Yes
- 2.☐ No

Shoulder Harness Used
- 1.☑ Yes
- 2.☐ No

- 1.☐ Pilot Logbook
- 2.☐ Operators Estimate
- 3.☐ FAA Records
- 4.☐ Company
- 5.☐ Specify________

ight Time	All A/C	This Make & Model	Airplane Single Engine	Airplane Multiengine	Night	Instrument Actual	Instrument Simulated	Rotorcraft	Glider	Lighter Than Air
tal Time										
ot In Command (PIC)										
structor										
is Make & Model										
st 90 Days										
st 30 Days										
st 24 Hours										

ther Personnel

Name	Seat	Address (City & State)	Crew	Non-Revenue	Revenue	Non-Occupant	FAA	Fatal Serious Minor None

ight Itinerary Information

ast Departure Point
1. Airport ID ONY
2. City/Place Olney
3. State Texas

Time Of Departure
1. Time 2:00
2. Time Zone Central

Destination
1. Airport ID 0XI4
2. City/Place OLNEY
3. State Texas

Flight Plan Filed
- 1.☑ None
- 2.☐ VFR
- 3.☐ IFR
- 4.☐ VFR/IFR
- 5.☐ Company (VFR)
- 6.☐ Military (VFR)

If Weather Was Involved, State If Weather Briefing Was Obtained or If Weather Reports Were Checked And How It Was Accomplished

uel On Board At Last Takeoff
18 gallon Gallons
or
________ Pounds

Fuel Type
- 1.☐ 80/87
- 2.☐ 100 Low Lead
- 3.☐ 100/130
- 4.☐ 115/145
- 5.☐ Jet A
- 6.☑ Automotive
- 7.Specify________

ther Services, If Any, Prior to Departure

eather Information At The Accident Site

ource Of Weather Information (Pilot/Operator, Weather Observation)
Pilot

Light Condition
- 1.☐ Dawn
- 2.☑ Daylight
- 3.☐ Dusk
- 4.☐ Bright Night
- 5.☐ Dark Night

Visibility
20 Miles

Temp (°F)
75°

Weather Information At The Accident Site (cont.)

Dew Point	Altimeter Setting	Sky/Lowest Cloud Condition
(°F)	"Hg	1.☑ Clear; 2.☐ Scattered ____ Feet AGL; 3.☐ Broken ____ Feet AGL; 4.☐ Overcast ____ Feet AGL; 5.☐ Partial Obscuration; 6.☐ Obscured

Wind Information	Restriction To Visibility	Type Precipitation	Intensity Of Precipitation
1. Direction 350; 2. Velocity 20 Kts; 3. Gusts 5 Kts			1.☐ Light; 2.☐ Moderate; 3.☐ Heavy; 4. Specify ____

Turbulence (Multiple Entry)
1.☑ None 2.☐ Light 3.☐ Moderate 4.☐ Severe 5.☐ Extreme 6.☐ Clean Air 7.☐ In Clouds

Damage To Aircraft And Other Property

Degree Of Aircraft Damage	Fire
1.☐ None 2.☐ Minor 3.☑ Substantial 4.☐ Destroyed	1.☐ Yes 2.☑ No 3.☐ In-Flight 4.☐ On Ground

Description Of Damage To Aircraft And Other Property
Skid damage to fuselage + tail booms - prop + spinner destroyed -

Mechanical Malfunction Failure

1.☑ No
2.☐ Yes — List The Name Of The Part, Manufacturer, Part No., Serial No. And Describe The Failure

Total Time	
On Part ____ Hours	At Overhaul ____ Hours

Collision Accident
If Collision Accident Occurred, Complete The Information For Other Aircraft

Registration Mark	Aircraft Manufacturer	Aircraft Type/Model	Degree Of Aircraft Damage
			1.☐ Destroyed 2.☐ Substantial 3.☐ Minor 4.☐ None

Registered Aircraft Owner	Address

Pilot Name	Address	Pilot Certificate No.

Evacuation Of Aircraft

Assistance Received
1.☐ Outside Person (s) 2.☐ Auxiliary Lighting 3.☐ Slide 4.☐ Rope 5.☐ Ladder 6.☐ Specify None

Method Of Exit (State Approximate Number Of Persons Using Each Of The Following
1. Main Door 2 2. Auxiliary Door ____ 3. Emergency Exit ____

Recommendation (How Could This Accident Have Been Prevented)
Operator/Owner Safety Recommendation (Optional Entry)

Additional Flight Crew Members

For Each Additional Flight Crew Member, Exclusive Of Cabin Attendants Complete The Following Information

Name	FAA Certificate No.	Address ______	Title

Certificate(s)
1.☐ Student 3.☐ Commercial 5.☐ Flight Instructor 7.☐ Foreign
2.☐ Private 4.☐ Airline Transport 6.☐ Flight Engineer 8.Specify ______

Ratings/Endorsements	Total Flight Time	Flight Time This Accident

Name	FAA Certificate No.	Address ______	Title

Certificate(s)
1.☐ Student 3.☐ Commercial 5.☐ Flight Instructor 7.☐ Foreign
2.☐ Private 4.☐ Airline Transport 6.☐ Flight Engineer 8.Specify ______

Ratings/Endorsements	Total Flight Time	Flight Time This Accident

Name	FAA Certificate No.	Address ______	Title

Certificate(s)
1.☐ Student 3.☐ Commercial 5.☐ Flight Instructor 7.☐ Foreign
2.☐ Private 4.☐ Airline Transport 6.☐ Flight Engineer 8.Specify ______

Ratings/Endorsements	Total Flight Time	Flight Time This Accident

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Narrative History Of Flight

Describe What Occurred In Chronological Order, The Circumstances Leading To The Accident And The Nature Of The Accident. Describe The Terrain and Include a Sketch Of Wreckage Distribution If Pertinent. Attach Extra Sheets If Needed. State Point Of Departure, Time Of Departure, Intended Destination And Services Obtained.

After performing the planned flight I became distracted by a twin engine aircraft that was back taxiing down runway 35, I made one extra Right HAND PAttern + Then Hovered while waiting for the twin engine aircraft to depart, I forgot to Lower the Landing gear + skidded the Carter Copter for about 200' after touch down.

I Hereby Certify That The Above Information Is Complete And Accurate To The Best Of My Knowledge

Date Of This Report	Signature Of Pilot/Operator
04/22/03	[signature]

Signature Of Person Filing Report Other Than Pilot/Operator

1. Signature ____

2. Type Or Print Name ____

3. Title ____

For NTSB Use Only

NTSB Accident No.	Reviewed By NTSB Office Located At	Name Of Investigator	Date Report Received
FTW03LA125	Arlington, TX SCR	Hector Casanova	4/18/03

NTSB Form 6120.1/2
PILOT/OPERATOR AIRCRAFT ACCIDENT REPORT

Forms may be obtained from the National Transportation Safety Board Field Offices and the Federal Aviation Administration. Flight Standards District Offices.

Rules pertaining to aircraft accident., accidents, overdue aircraft, and safety investigation are contained in Part 830 of the National Transportation Safety Board's Regulations, 49CFR. These rules state the authority of the Board's Regulations, 49CFR. These rules state the authority of the Board, define accidents, injuries, and other terms, and provide procedures for initial and immediate notification by aircraft pilots/operations.

A. APPLICABILITY

The pilot/operator of an aircraft shall file a report with the Field Office of the National Transportation Safety Board nearest the accident or incident. The report shall be filed within ten (10) days after an accident for which notification is required by Section 830.5 or when after seven (7) days an overdue aircraft is still missing.

The Pilot/Operator Aircraft Accident Report Form is used in determining the facts, conditions, and circumstances for aircraft accident prevention activities and for statistical purposes. It is necessary that ALL questions be answered completely and accurately to serve the above purposes.

B. DEFINITIONS

1. "Aircraft Accident" means an occurrence with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, and in which any person suffers death, or serious injury as a result of being in or upon the aircraft or by direct contact with the aircraft or anything attached thereto, or in which the aircraft receives substantial damage.

2. "Substantial Damage" means damage or structural failure which adversely affects the structural strength, performance or flight characteristics or the aircraft, and which would normally require major repair or replacement or the affected component. NOTE: Engine failure (damage limited to an engine), bent fairing or cowling, dented skin, small punctured holes in the skin or fabric, ground damage to rotor or propeller blades, damage to landing gear, wheels, tires, flaps engine accessories, brakes, or wing tips are not considered "substantial damage" for purposes of this report.

3. "Demolished" includes destruction by fire

4. "Operator" means any person who causes or authorizes the operation of an aircraft, such as the owner, lessee, or bailee of an aircraft.

5. "Fatal Injury" means any injury which results in death within thirty (30) days of the accident.

6. "Serious Injury" means any injury which (1) requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received: (2) results in a fracture of any bone (except simple fracture of finger, toes, or nose): (3) involves lacerations which cause severe hemorrhages, nerve, muscle, or tendon damage: (4) involves injury to any internal organ; or (5) involves second- or third-degree burns, or any burns affecting more than 5 percent of the body surface.

INSTRUCTIONS TO PILOTS/OPERATORS FOR COMPLETING THIS FORM
It is necessary that ALL questions on this report be answered completely and accurately.

Item 1. Location: Use the name of the nearest community that has a Post Office in the state where the accident occurred. *Date & Time:* Indicate if daylight saving or standard time.
Elevation: Provide elevation of the accident site.
Airport Identification: Provide 3 or 4 character identifier. *Runway:* Direction—heading being used; Surface—composition, i.e., concrete asphalt, grass, etc.; Condition—wet, slick, soft, etc.
Phase of Operation: During what Phase of Operation did the accident occur. Note: If the accident occurred inflight, state the altitude of the occurrence.

Item 2. Aircraft Data: Make and Model—enter as shown on aircraft registration certificate; Engine—enter make and model as shown on engine nameplate.
Certificated Max Gross Weight—Indicate the certificated max gross weight for the aircraft involved in the occurrence.
Type of Fire Extinguishing system— Include hand type extinguishers, if fire was involved, and extinguisher was used.

Item 3. Purpose of Flight and Type of Operation: More than one selection may be made to indicate the type of operation that was being conducted at the time of the occurrence.

Item 4. Pilot Information — Pilot-in-Command (PIC) Includes solo flight time. Instructor—indicate all dual flight instructor given.
Item 5. Second Pilot Information—Indicate the capacity in which the second pilot was acting at the time of the accident.
Item 6. Self-Explanatory.
Item 7. Self- Explanatory.
Item 8. Weather Information at the Accident Site. Indicate the wether conditions at the accident site at the time of occurrence.
Sky/Lowest Cloud Condition: If cloud condition was scattered, broken or overcast, include height of clouds above ground level.
Restriction to Visibility: Haze, dust, smoke, fog, etc.
Type Precipitation: Rain, snow, hail, etc.
Item 9. Collision Accident. This includes collision with parked aircraft.
Item 10-14. Are self-explanatory.
Item 15. Additional Flight Crew Members. This page should be completed if there are more than two required flight crew members on the aircraft. This also includes a check airman performing official duties. For aircraft requiring two flight crew members or less, and there were not other required flight crew members involved, separate this page.

FORM APPROVED FOR USE THROUGH 9/30/97 BY OMB NO. 3147-0002

NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D.C. 20594

PASSENGER STATEMENT

The National Transportation Safety Board, a Federal Agency, is charged by an Act of Congress with the investigation of transportation accidents. The Safety Board issues reports and makes recommendations to other federal and local agencies and to the industry to prevent future accidents and to prevent unnecessary injuries caused by such accidents.

We would appreciate very much your assistance in giving us the benefit of your personal observations and comments regarding this accident so that we may better evaluate the facts, conditions and circumstances surrounding this accident. Your observations also could assist us greatly in our evaluation of the cause of injuries as well as the adequacy of equipment and procedures affecting your survival and escape.

In addition to completing the following specific information, please feel free to comment on any aspect, before, during or after the accident, that you believe may have had a bearing on the accident cause or on subsequent events.

STATEMENT

Date of Accident: 4-8-03 Location of Accident: OLNEY, TX

Name: BRADLEY KING Age: [redacted] Height: [redacted] Weight: [redacted]

Address: [redacted] MANSFIELD, TX 76063

Occupation: RETIRED Telephone: [redacted]

Injuries: NONE

If you sustained injuries and were treated, provide name and address of doctor or treatment facility:

Are you handicapped (through vision, missing limbs, spinal problems, etc., which may affect your movements.) Please specify:

Seat Location: If you do not recall your seat number, please specify your position as on the left or right, aisle or window location, number of rows from the front or back, near a specific door or any other method which will assist in locating your position.

COPILOT SEAT RIGHT FRONT

A. MY OBSERVATIONS BEFORE THE ACCIDENT

Describe your observations before the accident happened such as the weather conditions; the lighting conditions; whether or not you have a seatbelt fastened; your outside observations, etc.

CONDITIONS WERE GOOD. STRONG BUT FAIRLY STEADY WINDS. UNLIMITED VISIBILITY.

I HAD MY 5 POINT HARNESS FASTENED AND HELMET ON + SECURED

B. MY OBSERVATIONS DURING THE ACCIDENT

Describe the accident circumstances considering such things as any unusual occurrences during the accident; the presence of fire or smoke; the direction in which you were thrown; the severity of the impact; etc.

WE WERE DOING A DESCENT FOR A SHORT ROLL LANDING. AT APPROXIMATELY 30 FT ONE OF THE CHASE VEHICLE ~~CRE~~ CREW MEMBERS TOLD US THE LANDING GEAR WAS UP. ~~A~~ THE PILOT WENT TO FULL POWER TO TRY TO GO AROUND WE WERE TOO LOW AND IMPACTED THE RUNWAY. THERE WAS A HARD BUT NOT SEVERE JOLT THEN THE AIRCRAFT SKIDDED ABOUT 200 FT AND CAME TO A STOP.

C. MY OBSERVATIONS AFTER THE ACCIDENT

Describe your method of escape and any difficulties encountered with your seat, seatbelt, dehris, etc.; the reaction and behavior of other passengers; your observations of any outside rescue attempts; any occurrence which seemed unusual to you; etc.

THE CHASE ~~A~~ VEHICLE CREW ARRIVED ALMOST IMMEDIATELY AND REQUESTED A THUMBS UP FROM ~~EA~~ EACH OF US. AFTER RECEIVING AFFIRMATIVE THEY WAITED FOR THE ROTOR TO STOP BEFORE REMOVING THE DOOR AND WE EXITED THE AIRCRAFT.

D . OTHER GENERAL OBSERVATIONS

You may use this space to comment on any other aspect of the accident or you may sketch the general accident scene as you observed it, your escape method or the location of fire, etc.

THE AIRCRAFT RECEIVED CONSIDERABLE DAMAGE BUT THE CREW COMPARTMENT WAS NOT COMPROMISED. THERE WAS NO INJURY TO EITHER THE PILOT OR COPILOT

Bradley M King

Signature

NORMAL PROCEDURES

BEFORE EXTERIOR CHECK

1. Covers, Tiedowns, Locking Devices, Grounding Cables – Removed and stowed
2. Cockpit safety check
   – Master & Ignition Switches Off)
   – Red guarded switches (4) – DOWN
3. Publications/Aircraft & Pilot documents
4. Fuel sample (first flight of the day)

EXTERIOR CHECK

1. Main rotor blades, linkages, spindle, pylon, & mast
2. Left cockpit window area
3. Nose, nose wheel, and nose boom
4. Right cockpit window
5. Right wing leading edge
6. Right wing trailing edge
7. Right main landing gear
8. Right side engine compartment
9. Ballistic chute cover – Installed and secure
10. Right tail boom and rudder
11. Camera cap removed
12. Horizontal stabilator
13. Left rudder and tail boom
14. Propeller and propeller hub
15. Left side engine compartment
16. Ballistic chute – verify armed
17. Fuel quantity and quality
18. Left main landing gear
19. Left wing trailing edge
20. Left wing leading edge

INTERIOR CHECK

1. Cabin - Condition and security
2. Restraint harness – Fasten and adjust
3. Helmets – Fasten and adjust
4. Main gear – AIR EXTEND
5. Nose gear – AIR EXTEND
6. Prerotate clutch pressure – LOW
7. Air pump – OFF
8. VAC pump – OFF
9. Collective Assist – MANUAL
10. Pylon – MANUAL
11. – MANUAL
12. – MANUAL
13. Gnd Ext - OFF
14. Fan (cockpit air) – As desired
15. Fuel pumps – REAR
16. Prop Controller – AUTO
17. Avionics Master switch – OFF
18. A/S – MANUAL
19. Pilot/Copilot switch - Left
20. Cyclic Lock - Lock
21. Master switch – OFF
22. Circuit breakers – IN (except cooling fans (2) & electric air pump (1))
23. Copilot Display/Reset – UP
24. Copilot main display switch – UP
25. Prop Control switches – CENTERED
26. Engine Ignition switches (2) – OFF
27. Intercom priority – CNTR (headset) (VOX light on, Music light off)
28. Collective hold switch – (left cyclic) AFT/MANUAL
29. Prerotator clutch/rotor rpm switch – (right cyclic) AFT

NORMAL PROCEDURES

ENGINE START

1. Throttle – IDLE
2. Master switch – ON
3. Avionics master switch – ON
4. Alarms – VERIFY working
5. Center display – SELECT Page 1
6. Pilot & Copilot Display – As desired (Page 12)
7. Collective – Set at 0°
8. Electric Air Pump Circuit Breaker – IN then OUT (verify air pump operating)
9. Avionics – As needed
10. Radio Selection – 2 & Both
11. Brakes – HOLD
12. Signal ground crew – "PROP CLEAR"
13. Ignition engine switch – ON (check light on)
14. Ignition aux battery switch – ON
15. Start switch – OUT/MOMENTARILY DOWN
16. Alarms – CHECK
17. Display page 1 – CHECK parameters
18. Air Pump – ON (check pressure)
19. Vacuum Pump – OFF
20. Verify Pilot & Copilot switch- Coll & Prerotate
21. Collective Assist – AUTO
22. Pylon - AUTO
23. Fuel pumps – TOGGLE & VERIFY, set to REAR
    – Low pressure – OFF / REAR (Verify warning)
    – High Pressure – FRONT / OFF / REAR (Verify engine sputters in OFF and return to REAR)
24. Display page 2 – Check EGTs
25. Display page 3 – Verify parameters (Cyclic trim – Check and set 0° S/S & +5° (aft) F/A)

NORMAL PROCEDURES

BEFORE TAXI

1. Engine water temp – VERIFY 150 deg min
2. Flight Instruments – ON As needed
3. Suction gauge – GREEN (if pump on)
4. Fuel Quantity – CHECK
5. Navigation/anti-collision lights – AS REQ

PREROTATE FOR TAXI

1. Throttle – IDLE (1200 RPM)
2. Collective hold switch – AFT (left cyclic switch)
3. Collective – CHECK hold then set at 0°
4. Cyclic Position – 0° S/S / +5° (aft) F/A
5. Clutch pressure – LOW
6. Pylon – AUTO – Check aft 18°
7. Clutch arming switch – AFT (right cyclic switch)
8. Signal ground crew – "ROTOR CLEAR"
9. Prerotate clutch – ENGAGE (check light on)
10. Brakes – PUMP (until no pedal movement)
11. Cyclic – FULL AFT (90 RPM TO 120 RPM)
12. Clutch pressure – HIGH at 120 RPM
13. Throttle – INCREASE gradually until 145 RPM
14. Brakes – HOLD
15. Clutch arming switch – FORWARD (right cyclic switch)
16. Throttle – IDLE (1200 RPM)
17. Flight Controls – VERIFY free & correct (TM checks if required)
18. Spindle trim – VERIFY proper motion (≈ 50% travel), set 0
19. Brakes – CHECK

NORMAL PROCEDURES

REPEAT PREROTATE (When Rotor < 40 RPM or Flapping > 3° or for Take off)

1. Brakes – HOLD
2. Set Pitch Hold – 4°
3. Throttle – IDLE (1200 RPM)
4. Collective hold switch – AFT (left cyclic switch)
5. Cyclic – 0 degrees S/S and + 5 degrees (aft) F/A
6. Collective – Set to 0°
7. Clutch pressure switch – LOW if RPM ≤ 120
8. COLL ASSIST – AUTO
9. Pylon – AUTO
10. A/S – MANUAL
11. Cyclic Lock - LOCKED
12. Clutch arming switch – AFT (right cyclic switch)
13. Prerotate clutch – ENGAGE (check light on)
14. Brakes – PUMP (until no pedal movement)
15. Clutch pressure switch – HIGH if RPM > 120
16. Throttle – INCREASE gradually until 225 RPM
17. Brakes – HOLD
18. Clutch arming switch – FORWARD (right cyclic switch)
19. Cyclic Lock Switch - UNLOCK
20. Throttle – IDLE (1200 RPM)

NORMAL PROCEDURES

BEFORE LANDING (Prior to 1,000' AGL)

1. Main Gear – AIR EXTEND (below 125 MPH)
2. Nose Gear – AIR EXTEND (below 125 MPH)
3. Rotor RPM – Check and adjust with collective (225 RPM MIN)
4. Check Gear Lights – 3 GREEN (after approx 10 sec)
5. Check Red pressure lights – 2 OUT (after approx 10 sec) Nose gear red light ON indicates < 300 PSI
6. Main gear pressure – CHECK
   - ➢ 175 PSI normal / 100 PSI min
7. Air pump pressure – CHECK
   - ➢ 175 PSI normal / 100 PSI min
   - ➢ Nose gear pressure indicated while nose gear being pumped

BEFORE TAKEOFF

If WATER X TEM (WexT) ≥ 235°

1. Point aircraft into wind
2. Throttle – 2000 RPM until water temp is < 235°

If WATER X TEM (WExT) < 235°

3. Cockpit and tail boom cameras – ON
   - Cycle master switch – OFF momentarily
   - Cameras – ON
   - Displays – RESET
4. Prerotate (see procedure on N-5)
   - Throttle – INCREASE slowly to full throttle once engine > 1800 RPM)
   - 325–350 RPM (rolling) or 375–425 RPM (jump)

NORMAL PROCEDURES

ENGINE SHUTDOWN

1. Throttle – IDLE
2. Avionics master switch – OFF
3. Ignition & Battery switch – OFF
4. Cyclic Lock - LOCKED
5. Brakes – HOLD
6. Cyclic – 0 degrees S/S and +5 degrees (aft) F/A
7. Raise collective slowly to decay rotor rpm
   (full up < 200 RPM)
8. Collective - DOWN
9. Clutch pressure – HIGH (< 90 RPM)
10. Clutch arming switch – AFT (right cyclic switch)
11. Prerotate clutch – ENGAGE (check light on)

When rotor stops

10. Master switch – OFF

BEFORE LEAVING THE AIRCRAFT

1. Forms – Complete
2. Cockpit safety check
   1. Master switch – OFF
   2. Ignition switch – OFF
   3. Ignition battery switch – OFF
3. Walk-around – Complete
4. Secure aircraft – As required

EP-1

EMERGENCY PROCEDURES

FIRE ON THE GROUND

1. Fire – CONFIRM
2. Fire extinguisher switch(s) – ON based on appropriate high temp. light
3. Cabin door – OPEN
4. Engine ignition – OFF
5. Ignition battery switch – OFF
6. Master switch – OFF

When rotor arc is clear

7. Aircraft – EVACUATE

ENGINE OR ELECTRONICS BAY FIRE (INFLIGHT)

1. Throttle - REDUCE to minimum practical
2. Fire extinguisher – ACTIVATE
3. High pressure fuel pump – OFF
4. Land – As soon possible (plan for power-off approach and landing)

<u>If fire persists</u>

5. Engine ignition – OFF
6. Ignition battery switch – OFF

After landing

7. Engine ignition – OFF
8. Ignition battery switch – OFF

When rotor arc is clear

4. Aircraft – EVACUATE

EP-2

EMERGENCY PROCEDURES

EXCESSIVE NOISE/VIBRATIONS

1. Collective – FULL DOWN
2. Throttle – IDLE
3. Land – as soon as possible (plan for power-off approach and landing)
4. Throttle – only as required for landing

UNIDENTIFIED NOISE/VIBRATIONS ON THE GROUND

1. Engine ignition – OFF
2. Collective – RAISE slowly to decay rotor RPM (full up < 200 RPM)
3. Clutch pressure switch – HIGH (< 90 RPM)
4. Collective – 0° < 90 RPM
5. Clutch/brake arming switch – ARMED
6. Clutch switch – ENGAGE (check light on)

When rotor stops

7. Master switch – OFF

EP-3

EMERGENCY PROCEDURES

UNIDENTIFIED NOISE/VIBRATIONS IN FLIGHT

Climb and turn in direction of airfield
Determine source of noise/vibration

Rotor noise/vibration

1. Collective – REDUCE as much as practical
2. Rotor RPM – REDUCE to Min practical
3. Lower landing gear
4. Land – As soon as possible (plan for power-on approach and landing)

Engine/propeller noise/vibration

1. Throttle – REDUCE as much as practical
2. Lower landing gear
3. Land – As soon possible (plan for power-off approach and landing)

If vibration excessive

4. Engine ignition – OFF
5. Electric air pump – ON (circuit breaker in)

After landing

6. Engine ignition – OFF

EP-4

EMERGENCY PROCEDURES

RUDDER FAILURE

1. Airspeed - REDUCE
   - Throttle – slowly reduce to min practical
   - Pitch Attitude – slowly increase
   - Collective – as required to maintain rotor

RPM

2. Landing Gear – DOWN
3. Land as soon and as slow as possible
4. Engine ignition – OFF
5. Master switch – OFF

EP-5

EMERGENCY PROCEDURES

ROTOR CONTROL FAILURE

If unable to maintain aircraft control

1. Ballistic Chute - DEPLOY
2. Lower landing gear
3. Engine ignition – OFF
4. Master switch – OFF
5. Prepare for crash landing

If able to control aircraft

1. Airspeed – MAINTAIN GREATER THAN 150 MPH with power and glide path control
2. Land – as soon as possible (Plan for power-on approach and landing)
3. Landing gear – DO NOT LOWER OFF RUNWAY
4. Fly shallow approach maintaining no less than 150 MPH until just above runway
5. Reduce power when landing is assured and hold nose off runway as long as possible

After landing

6. Engine ignition – OFF

EP-6

EMERGENCY PROCEDURES

ENGINE/THROTTLE FAILURE

If engine failed or throttle stuck closed

1. Throttle – MAXIMUM AVAILABLE (until landing assured)
2. Lower landing gear
3. Electric air pump – ON (circuit breaker in)
4. Collective – AS REQUIRED to maintain flapping within limits
1. Plan for power-off approach and landing
2. Airspeed – Maintain between 40 & 70 MPH
5. Short roll landing – ACCOMPLISH

If throttle stuck open

1. Climb until landing assured
2. Landing gear – DOWN when landing assured
3. Electric air pump circuit breaker – IN
4. Engine ignition – OFF when landing is assured
5. Engine battery switch – ON after engine stops
6. Plan for power-off approach and landing
7. Maintain airspeed between 40 & 70 MPH
8. Short roll landing – ACCOMPLISH
9. Master switch – OFF

EP-7

EMERGENCY PROCEDURES

NOSE GEAR FAILS TO EXTEND

1. Air pump circuit breaker - RESET
2. Landing gear switch - RESET
3. Land normally and leave aircraft on tail wheels

ONE MAIN GEAR FAILURE TO EXTEND

1. Landing gear – RETRACT MAIN
2. Nose gear – EXTEND
3. Consider landing on soft terrain

ALL/BOTH MAIN GEAR FAILURE TO EXTEND

1. Air pump circuit breaker – RESET
2. Landing gear switch – RESET
4. Consider landing on soft terrain

EXPANDED PROCEDURES

TAKEOFF

1. Brakes – Hold
2. Torque - increase slowly to full throttle once engine >1800 RPM
3. Cyclic – Full aft (10 deg)
4. Clutch arming switch – FORWARD (right cyclic switch)
5. Brakes release - when engine speeds up
6. Steer with brakes until approx 40 mph
7. Collective - 4° in 2 sec. Start once aircraft is rolling and lined up. This helps hold pitch attitude. In it's retract position, landing gear is mushy and detracts from pitch capture.
8. Capture pitch attitude (lower line on horizon) and hold with cyclic.
9. Hold collective until "flapping warning" then decrease collective to hold maximum rotor pitch (4-5 degrees of flapping). This will occur about 3 seconds after liftoff.
10. As aircraft is climbing and accelerating, move cyclic forward to hold pitch attitude.
11. Climb at 75 mph minimum to mid-field and then slowly accelerate to 95 mph.
12. Landing gear – UP (1,000 AGL minimum)

EXPANDED PROCEDURES

NORMAL LANDING (Best rate of glide)

1. Collective - set to hold 4-5° flapping
2. Approach speed - 75 mph
3. At twenty feet AGL - Start gentle flare with cyclic to stop descent and level. Allow aircraft to pitch up and lower line to rise two inches above horizon and then reset to lower line to horizon
4. Cyclic - AS REQUIRED to hold lower line on horizon
5. Collective - AS REQUIRED to flare
6. Cyclic - AFT as main gear touchdown
7. Keep collective up and stick back until aircraft nose is lowered

Once nose firmly on the ground

8. Collective – Full down
9. Cyclic – Full Centered

NORMAL LANDING (Steepest Approach)

1. Collective - set 0 degrees
2. Approach speed - 60 mph
3. At thirty feet AGL - Start gentle flare with cyclic to stop descent and level. Allow aircraft to pitch up and lower line to rise two inches above horizon and then reset to lower line to horizon
4. Cyclic - AS REQUIRED to hold lower line on horizon
5. Collective - AS REQUIRED to flare
6. Cyclic - AFT as main gear touchdown
7. Keep collective up and stick back until aircraft nose is lowered

Once nose firmly on the ground

8. Collective – Full down
9. Cyclic – Full Centered

ZERO ROLL LANDING

1. Collective – 0° till rotor RPM is above 300
2. On final – 75 MPH airspeed (65 MPH min)
3. Throttle – idle

At approximately 20 ft AGL

4. Flare
   - Cyclic - position lower windshield reference line 2" above horizon and then back to horizon after slowed
5. Collective as required to cushion landing
6. Touch down at near full collective
7. Use brakes to prevent aft rotation during aerobrake

AERODYNAMIC BRAKING

13. Cyclic – As required to hold lower line on horizon
14. Brakes – Use as a drag device to control landing attitude as collective tends to pull you backwards.
15. Collective – Slowly increase as speed slows (reach 8° or more as aircraft ground speed slows to 20 MPH.
16. Brakes – Increase braking as required to gently lower the nose before ground speed drops below 10 to15 MPH.
17. Cyclic – Full aft prior to nose drop
18. Keep collective up and stick back until aircraft nose is lowered

Once nose firmly on the ground

19. Collective – Full down
20. Cyclic – Full Centered

AIRCRAFT STOPS ON TRAINING WHEELS

If Rotor RPM > 225 RPM

1. Collective – Down
2. Rotor – Confirm 225 RPM or greater
3. Cyclic – Full aft
4. Brakes – release
5. Throttle – Increase until ≥ 15 MPH
6. Throttle – Idle
7. Brakes – Gently lower nose before aircraft stops
8. Collective – Slowly increase as nose lowers
   - Should be > 8° when lower line is on horizon
9. <u>Keep collective up and stick back until nose is lowered</u>

Once nose firmly on the ground

10. Cyclic – Full forward
11. Collective – 0°

If Rotor RPM ≤ 225

1. Cyclic – Centered (+5 F/A)
2. Throttle – Idle
3. Avionics master switch – OFF
4. Ignition & aux battery switches (2) – OFF
5. Brakes – Hold
6. Raise collective slowly to decay rotor rpm (full up < 200 RPM)
7. Clutch pressure switch – HIGH (< 90 RPM)
8. Collective – Down < 90 RPM
9. Clutch arming switch – AFT (right cyclic switch)
10. Prerotate clutch switch – ENGAGE (check light on)
11. Master switch – OFF (once rotation stops)
12. Exit aircraft
13. Lift on horizontal stabilizer until nose lowers

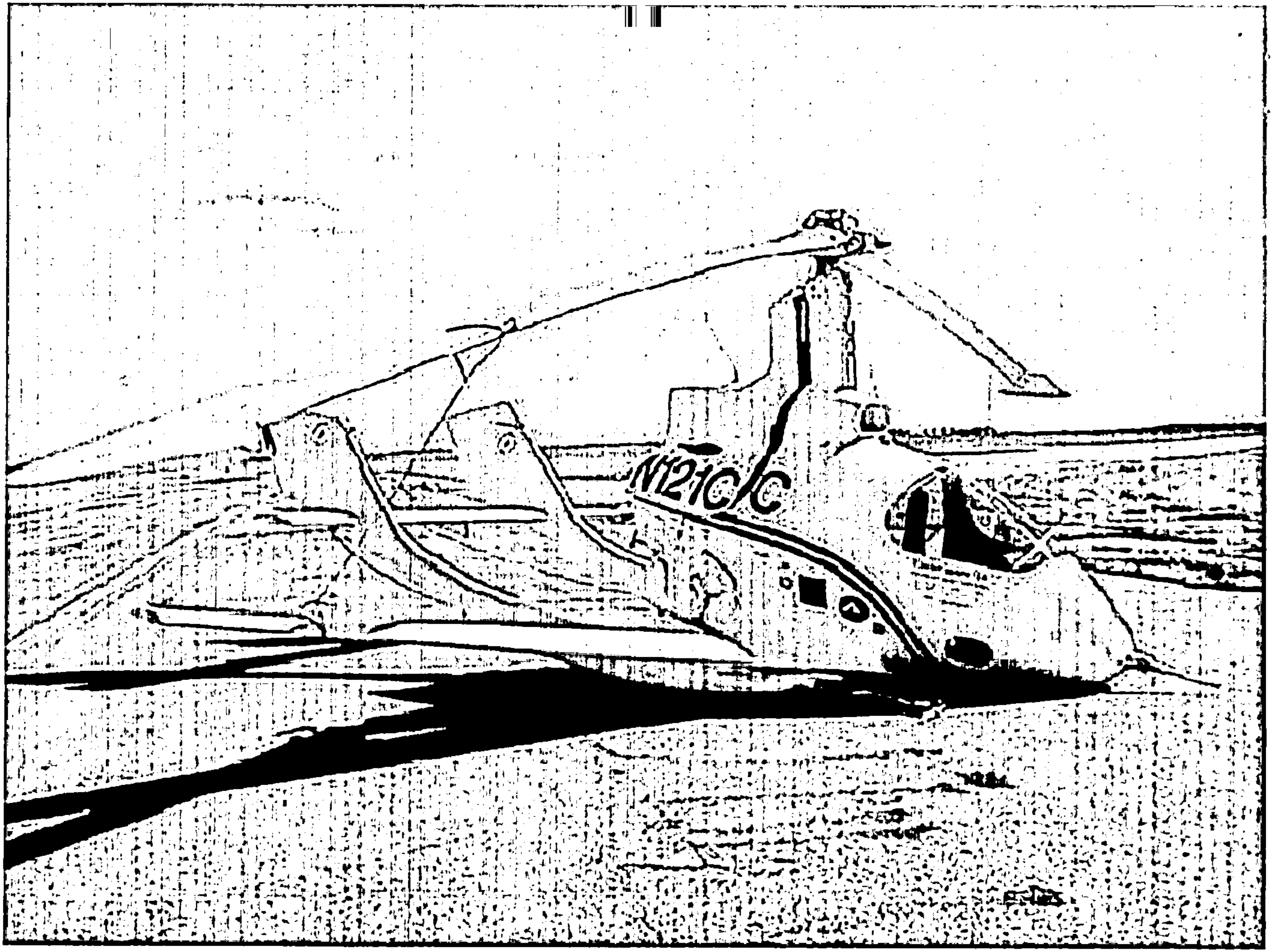

Photo. General view of the gyrocraft's fuselage damage.

National Transportation Safety Board

Docket Contents

Project ID (Primary)	Mode	Location
56772	Aviation	

NTSB Accident ID	Occurrence Date	Location
FTW03LA125	Apr 08, 2003	Olney, TX, United States

Creation Date	Last Modified	Public Release Date & Time
May 27, 2003	Jun 03, 2003 11:17	Jun 03, 2003 10:20

Comments

1	May 27, 2003	Pilot/Operator Aircraft Accident Report, NTSB Form 6120.1	7	
2	May 27, 2003	Passenger Statement	3	
3	May 27, 2003	Miscellaneous. Checklist for the Cartercopter gyrocraft	10	
4	May 27, 2003	Photo. General view of the gyrocraft's fuselage damage.		1

National Transp[redacted]on Safety Board
Washingt C 20594

Brief of Accident

Adopted 07/23/2003

FTW03LA125
File No. 13695 04/08/2003 Olney, TX Aircraft Reg No. N121CC Time (Local): 15:45 CDT

Make/Model: CarterCopter / Prototype
Engine Make/Model: General Motors / 350 CID
Aircraft Damage: Substantial
Number of Engines: 1
Operating Certificate(s): None
Type of Flight Operation: Flight Test
Reg. Flight Conducted Under: Part 91: General Aviation
Aircraft was Homebuilt

	Fatal	Serious	Minor/None
Crew	0	0	2
Pass	0	0	0

Last Depart. Point: Same as Accident
Destination: Local
Airport Proximity: On Airport
Airport Name: OLNEY MUNI
Runway Identification: 35
Runway Length/Width (Ft): 5000 / 50
Runway Surface: Asphalt
Runway Surface Condition: Dry

Condition of Light: Day
Weather Info Src: Weather Observation Facility
Basic Weather: Visual Meteorological Cond
Lowest Ceiling: None
Visibility: 10.00 SM
Wind Dir/Speed: 320 / 016 Kts
Temperature (°C): 12
Obstr to Vision: None
Precipitation: None

Pilot-in-Command Age: 51

Certificate(s)/Rating(s)
Private; Multi-engine Land; Single-engine Land; Gyroplane
Instrument Ratings
None

Flight Time (Hours)

Total All Aircraft: 2000
Last 90 Days: 38
Total Make/Model: 80
Total Instrument Time: Unk/Nr

While landing on runway 35, the pilot was distracted by a twin-engine airplane taxiing on the runway and "forgot" to extend the landing gear prior to landing. The chase ground crew alerted the pilot that the landing gear was not extended. Subsequently, the pilot attempted to go around by applying full power; however, the gyrocraft impacted the runway surface.

FTW03LA125

File No. 13695	04/08/2003	Olney, TX	Aircraft Reg No. N121CC	Time (Local): 15:45 CDT

Occurrence #1: WHEELS UP LANDING
Phase of Operation: LANDING - FLARE/TOUCHDOWN

Findings
1. (C) GEAR EXTENSION - NOT PERFORMED - PILOT IN COMMAND
2. (F) DIVERTED ATTENTION - PILOT IN COMMAND
3. WHEELS UP LANDING - PERFORMED - PILOT IN COMMAND

Findings Legend: (C) = Cause, (F) = Factor

The National Transportation Safety Board determines the probable cause(s) of this accident as follows.
The pilot's failure to extend the landing gear. A factor was his diverted attention.

04/26/2003

SJ-30

Flutter Testing

National Transp[redacted]n Safety Board
Washing[redacted]C 20594

Brief of Accident

Adopted 3/30/2005

IAD03MA049
File No. 17499 | 4/26/2003 | Loma Alta, TX | Aircraft Reg No. N138BF | Time (Local): 10:05 CDT

Make/Model: Sino-Swearingen / SJ30-2
Engine Make/Model: Williams International / FJ-44-2A
Aircraft Damage: Destroyed
Number of Engines: 2
Operating Certificate(s): None
Type of Flight Operation: Flight Test
Reg. Flight Conducted Under: Part 91: General Aviation

	Fatal	Serious	Minor/None
Crew	1	0	0
Pass	0	0	0

Last Depart. Point: San Antonio, TX
Destination: Local
Airport Proximity: Off Airport/Airstrip

Condition of Light: Day
Weather Info Src: Weather Observation Facility
Basic Weather: Visual Meteorological Cond .
Lowest Ceiling: None
Visibility: 10.00 SM
Wind Dir/Speed: 330 / 010 Kts
Temperature (°C): 16
Obstr to Vision: None
Precipitation: None

Pilot-in-Command Age: 59

Certificate(s)/Rating(s)
Airline Transport; Multi-engine Land; Single-engine Land
Instrument Ratings
Airplane

Flight Time (Hours)

Total All Aircraft: 12000
Last 90 Days: 39
Total Make/Model: 625
Total Instrument Time: Unk/Nr

The corporate jet was in a descent to attain a Mach 0.884 target speed during an airplane type certification flutter test. The airplane (a unique test bed) had a known speed-dependent tendency to roll right which was attributed to wing and aileron twist deviations. As the speed increased during the accident flight, the pilot had to apply full left aileron to be able to maintain airplane control. The airplane completed the test point about 30-degrees right-wing-low, and subsequently began to roll to the right, "like a barrel roll...not real fast," that the pilot reported he could not stop. Although the manufacturers engineering analysis (which did not include any high-speed wind tunnel testing) predicted positive lateral stability up to Mach 0.90, lateral control was lost during the accident flight, and the airplane rolled about 7 times during a 49-second timeframe, from about 30,500 feet until a near-vertical ground impact. A review of telemetry data revealed that, just before the rolls began, the airplane's elevator moved to the 3.5 degrees trailing-edge-up (TEU) position, and the airplane's heading deviated right. Less than 1 second later, the rudder moved from 2 degrees trailing-edge-left (TEL), to 6.5 degrees TEL, and the combination of the TEU elevator and the left rudder input coincided with a marked increase in airplane's right deviation. Elevator-up deflection and rudder-left defection were maintained, with some variation in magnitude, to nearly the end of the data. Because the known speed-dependent tendency to roll right had created significant control problems on a previous flight, the ailerons were removed, modified and replaced, and a Gurney flap was added to the right wing. After the addition of the Gurney flap, the lateral trim margin improved to about 40 percent required (where 50 percent was neutral) up to 305 KCAS. It was then determined that flutter testing could continue to higher airspeeds if the pilot needed to apply a "small" wheel force to augment the trim. The pilot had been instructed to reduce airspeed if there was a problem during the flutter testing, and had done so during an uncommanded roll to the left on the previous flight. Telemetry data from the accident flight revealed that at initiation of the upset, the pilot attempted to level the wings and raise the nose, but the airplane continued to diverge from stable flight, and it continued to accelerate beyond the airplanes demonstrated flight diving speed. It is undetermined if the pilot could have reduced the speed of the airplane in time, during the initiation of the upset, so that the airplane would not diverge. After the accident, the company conducted high-speed wind tunnel tests, and found that lateral stability decreased with increasing Mach and angle of attack (AOA). Lateral stability became negative (unstable) above Mach 0.83, and rudder input intended to augment lateral trim above a certain Mach could aggravate the situation. In addition, a TEU elevator input would increase AOA, and also result in deteriorated lateral stability. High speed wind tunnel data also revealed that roll authority deteriorated above Mach 0.86, and by Mach 0.88, the aileron upper and lower surfaces were both in separated flow regions. The follow-on flutter test airplane, which successfully completed the certification requirements, was equipped with vortex generators and thicker trailing-edge ailerons. It also did not require the external trim device needed on the accident airplane due to improvements in manufacturing.

IAD03MA049
File No. 17499 4/26/2003 Loma Alta, TX Aircraft Reg No. N138BF Time (Local): 10:05 CDT

Occurrence #1: LOSS OF CONTROL - IN FLIGHT
Phase of Operation: DESCENT

Findings
1. AIRCRAFT CONTROL - NOT POSSIBLE
2. INFORMATION INSUFFICIENT - MANUFACTURER
3. (C) INADEQ SUBSTANTIATION PROCESS,INADEQ DOCUMENTATION - MANUFACTURER

Occurrence #2: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: DESCENT - UNCONTROLLED

Findings
4. TERRAIN CONDITION - GROUND

Findings Legend: (C) = Cause, (F) = Factor

The National Transportation Safety Board determines the probable cause(s) of this accident as follows.
The manufacturer's incomplete high-Mach design research, which resulted in the airplane becoming unstable and diverging into a lateral upset.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID: IAD03MA049	Aircraft Registration Number: N138BF
	Occurrence Date: 4/26/03	Most Critical Injury: Fatal
	Occurrence Type: Accident	Investigated By: NTSB

Location/Time

Nearest City/Place	State	Zip Code	Local Time	Time Zone
Loma Alta	TX	78840	1005	CDT

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	Direction From Airport:

Aircraft Information Summary

Aircraft Manufacturer	Model/Series	Type of Aircraft
Sino-Swearingen	SJ30-2	Airplane

Sightseeing Flight: No **Air Medical Transport Flight:** No

Narrative

Brief narrative statement of facts, conditions and circumstances pertinent to the accident/incident:

HISTORY OF FLIGHT

On April 26, 2003, at 1005 central daylight time, a Sino-Swearingen Aircraft Corporation (SSAC) SJ30-2, N138BF, serial number 002, was destroyed when it impacted terrain near Loma Alta, Texas. The certificated airline transport pilot was fatally injured. Visual meteorological conditions prevailed for the flight, which departed on an instrument flight rules flight plan from San Antonio International Airport (SAT), San Antonio, Texas, at 0911. The local test flight was conducted under 14 CFR Part 91.

At the time of the accident, the airplane was undergoing flutter testing for Federal Aviation Administration (FAA) type certification. SSAC Report 30-2222, "Flight Flutter Certification Test Plan for SSAC SJ30-2," delineated the flutter testing requirements, which included the Federal Air Regulation (FAR) Part 23.629 requirement that the airplane be demonstrated to be free from flutter, control reversal, and divergence up to the "demonstrated flight diving speed" (Vdf/Mdf). The testing was to be conducted in two phases, with the first phase planned to clear the airplane to its "maximum operating limit speed" (Vmo/Mmo) of 320 KCAS/Mach 0.83, and the second phase, to clear it to its Vdf/Mdf of 372 KCAS/Mach 0.90.

Phase 1 flutter testing had been successfully completed. The first flutter mission of phase 2, flight test number 230, was flown one day before the accident flight, with the same pilot onboard. The objective of that flight was to complete flutter test points 1-12 (Mach 0.844) and 1-13 (Mach 0.864). Test point 1-12 was completed, and subsequently, the airplane went into a uncommanded roll to the left, which the pilot recovered from. Afterwards, during test point 1-13, a discrepancy was noted between the pilot's displayed airspeeds and those reported by a chase plane pilot, so the pilot terminated the flight.

After the flight, the pilot realized that he had incorrectly set up the airspeed display in the test airplane, and was flying faster than his airspeed indicated. In addition, the pilot reported, that during the flight, he had felt a "rumble" in conjunction with the left roll. In his notes, he had written, ".855", and immediately below that, "Abrupt LH Roll [space] Rumble", and beneath that, "Rudder Input?"

According to the project's flutter consultant, a Designated Engineering Representative (DER), a

(Continued on next page)

Narrative (Continued)

possible explanation for the rumble was Mach buffet. However, to help confirm there wasn't an in-flight mechanical problem with the airplane, flight test personnel assigned a second SSAC pilot as a backseat chase plane observer for the next (accident) flight, flight test number 231.

The chase plane was a contracted Northrop T-38 jet, N638TC, with a pilot and the second SSAC test pilot onboard. The accident flight was also being monitored in a telemetry van in Rock Springs, Texas, by the flutter consultant and three SSAC personnel.

Prior to the test flight, a mission briefing, led by the accident test pilot, was conducted via conference call between the San Antonio-based personnel and the telemetry van personnel. According to a briefing participant, all of the flight test cards were covered, "including the test limitations, test set-up, test points, weight and balance, airspace operational considerations, aircraft limitations, maintenance actions since last flight, instrumentation status, and chase aircraft procedures." A number of witnesses also noted that the test points briefed were 1-14 (Mach 0.884), and 1-15 (Mach 0.894) if conditions permitted.

An "SSAC Flight Briefing Guide" was also utilized, which included a review of hazard analyses, and abnormal/emergency procedures. During the briefing, the test pilot stated that he was responsible for safety of flight.

The flutter consultant also stated that he had, during previous discussions, advised that for the purpose of flutter testing, if the pilot ran out of aileron/elevator trim, the tests could still be completed, even if the pilot had to hold aileron/elevator force to steady the airplane. He further stated, however, that the continuance of the testing would never override the pilot's decision as to whether the control forces were unacceptable or hazardous.

According to the flutter consultant, after takeoff, the accident airplane climbed to 39,000 feet, and prepared for a shallow dive along an easterly track for flight test point 1-14. A telemetry lock was then obtained. However, when the airplane reached indicated Mach 0.875, the test pilot called "Mark" on the radio. [An optional test point "14A" (Mach 0.874) was listed on the flutter test card; however, on the previous day's flight, it had been crossed out.] After the "Mark" was received, the pilot initiated a single pulse input to the elevator. After checking the telemetry strips, the consultant then gave a "Go" for a single pulse to the aileron, followed by another "Go" for a single pulse to the rudder. Telemetry van personnel noted that all the modes excited were "well damped."

Telemetry van personnel also reported that after the pulses were completed, the test pilot stated that the uncommanded roll to the left (which was experienced on the previous flight), did not occur. There was also no mention of a rumble. In addition, the chase plane pilots confirmed that there were no mechanical anomalies evident on the accident airplane.

The flutter consultant further stated that the accident airplane subsequently turned back to the west and began to climb back to 39,000 feet to prepare for the [easterly] dive to the 1-14 point. Discussion between the pilot and telemetry van personnel included the fact that the 1-14 point might be the last one of the mission due to fuel concerns, particularly for the chase plane.

Following telemetry lock, the airplane began a shallow dive. At indicated Mach 0.884, the pilot

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Narrative (Continued)

called "Mark." Each control surface was again pulsed by the pilot, and the responses were again "well damped."

Following the final pulse, the pilot was cleared to the next test point, 1-15 (indicated Mach 0.894), "if flight conditions permitted the test pilot to do so." However, the pilot did not acknowledge the clearance, but instead, reported that the airplane was rolling to the right, and he couldn't stop it.

In a written statement, the chase plane pilot confirmed that after the 1-14 test point had been completed, the test pilot was cleared to accelerate to the 1-15 test point, if able. At that time, the accident airplane appeared to be in a shallow right bank with the chase plane less than 500 feet above and 500 feet behind it. According to the chase plane pilot, "very soon thereafter," about 30,000 feet, the accident airplane began rolling to the right. The rolling maneuver appeared to be stable, and continued unchanged until ground impact. The accident airplane appeared to remain intact throughout the event, and no parts were seen departing the airframe. After the accident airplane began to roll, and the test pilot stated that he couldn't stop it, the chase pilot called, "get out" twice. The accident pilot responded that he couldn't get out, that there were too many "g's."

The second SSAC test pilot, who had been in the back of the chase plane, also reported that the accident sequence began after the completion of the 1-14 test point. During the sequence, the chase plane was not close enough to observe the accident airplane's control positions; however, the second SSAC test pilot observed the accident airplane's nose to be "a little low," and in an approximately 30-degree right bank after test point 1-14 was completed. A few seconds later, the accident airplane entered a "barrel-roll type maneuver" to the right, then continued to roll, and increased its dive angle until ground impact.

When the second SSAC test pilot saw the first roll, his first thought was, "what did he do that for?" Then he saw that the accident airplane "came around and made another barrel roll. It was not around a point like an aileron roll; and it was not real fast; it looked lazy." The chase pilot then mentioned the roll to the accident pilot, who replied that he couldn't stop it. The accident pilot did not say anything further about how the airplane was performing, or what he was experiencing.

At some point during the sequence of events, the accident pilot transmitted information about the flight controls and/or aileron trim; however, witness accounts differed on what and when it was transmitted. According to the chase plane pilot, the accident pilot stated, "I can't let go" after he was cleared to test point 1-15. The flutter DER stated that the accident pilot advised he "could not release the wheel" shortly after the 1-14 aileron pulse, and a telemetry engineer, who was calling out airspeeds to the DER, stated that the accident pilot reported, "full aileron trim and I can't let go" when the accident airplane had accelerated to Mach .881, prior to the 1-14 pulses.

PERSONNEL INFORMATION

-- Accident Pilot --

The accident pilot held an airline transport pilot certificate, with ratings for the Boeing 707, 727, and 747, and Airbus 300. He also had combat experience in the Vought F8J Crusader, and served a total of 30 years as an active duty and reserve Naval officer.

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Narrative (Continued)

According to the pilot's resume, dated July 2, 1996, he had 12-13 years of flight test experience prior to joining SSAC, including experience at LTV (Ling-Temco-Vought) Aerospace, Douglas Aircraft, the U.S. Navy, and General Electric. He was not a test pilot school graduate.

Between 1966 and 1969, the pilot flew A-1 Skyraiders, then transitioned to the A-3 Skywarrior. He subsequently flew EKA-3B conversion flights from a depot level rework facility, and later, F-8 Crusader and F-4 Phantom acceptance flights.

In 1969, the pilot qualified as a Boeing 727 flight engineer for a major airline. Later that year, when he was furloughed from the airline, he qualified as an agricultural application pilot. He later became involved in a short take off and landing (STOL) conversion as both a "project pilot" and a flight demonstration pilot, and he also flew the F-8 Crusader in an operational reserve fighter squadron.

From 1970 to 1972, the pilot was carrier-based, flying combat missions in Vietnam. He applied for the U.S. Navy Test Pilot School, but was shot down and captured about 1 week before selections were made. Once repatriated, the pilot pursued a college degree while concurrently serving as a fighter pilot instructor. The pilot subsequently completed two more tours of operational duty.

In 1973, the pilot again qualified as a flight engineer on a Boeing 727, and flew with a major airline through 1974. Between 1978 and 1983, the pilot participated in flight testing a turbine-powered agricultural application airplane, involving liquid and dry material dispersing. Between 1983 and 1985, the pilot served as a System Safety Engineer at Douglas Aircraft Company for the development of a Navy T-45 training system. As such, he was involved in hazard analysis and system safety for three prototype airplanes, along with simulators and academics. He also participated in system safety and hazard analysis for the NASA propfan program.

Between 1985 and 1988, the pilot was a flying flight test engineer on the McDonnell Douglas MD-80 transport airplane.

Records indicate that, in 1989, the pilot was hired as an "experimental test pilot" at General Electric's Flight Test Operation - Mojave. As one of only two pilots, he was "involved in virtually all aspects of testing for the various CFM Series, CF-6 Series and GE-90 Series engines." Testing included "stabilization on a test point, low altitude Vmax speed points, wind-up turns, airstart envelope determination, V2 climb profiles, over-rotation tests, aircraft stall maneuvering, high AOA investigation, zero 'g', various operability trials and profiles, plus others throughout the test envelope." The pilot became rated in the Boeing 707, 747 and Airbus 300 at that time.

The pilot also reported that he was a member of the Society of Experimental Test Pilots, and wrote the organization's Flight Readiness Review and Preflight documentation.

According to SSAC records, the pilot joined the company in 1997, and was serving as chief test pilot when the accident occurred. Prior to the accident flight, he had accumulated 294 flight hours in the accident airplane, and 331 flight hours in airplane serial number 001.

The pilot's logbook was not recovered after the accident, and according to an SSAC representative,

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Narrative (Continued)

the pilot always took his logbook with him on his flights. On July 3, 2002, the pilot's latest Federal Aviation Administration second class medical certificate was issued, and at that time, he reported 12,000 hours of total flight experience.

The second SSAC pilot reported that the accident pilot did not have experience performing flutter tests, but as chief pilot, he wanted to do it. The second pilot, who did have experience with flutter testing, provided training to the accident pilot. "I checked him out - he wanted to do it - we went out and I demo'd it, and he did it. He understood it; he's an F-8 guy. If I had any qualms about it, he wouldn't have been able to do it." The second SSAC pilot also stated that the accident pilot knew to slow the airplane should he run into any difficulty. "We discussed it a lot (power idle). We talked and talked about throttles idle. In my mind, I know he did that."

-- Second SSAC Test Pilot --

According to the second SSAC test pilot's undated resume, he had previously served as a test pilot at McDonnell Douglas on the MD-80 series and MD-11 certification programs. He also served as chief pilot, and was responsible for six test pilots and six loadmasters.

The second test pilot reported 7,000 hours of flight time, with 3,000 hours of test pilot experience over a 15-year period. He was also a graduate of the U.S. Air Force Test Pilot School.

-- DER --

Per a technical services agreement, the flutter consultant DER was hired to "provide oversight and guidance in the execution and documentation of flutter analysis" for certification compliance with FAR 23. In conjunction with the agreement, the consultant was "given authority as director of test preparation, test conduct, and analysis of results."

According to the DER's undated resume, he had worked in the field of aircraft flutter and dynamics for over 30 years. He had also been employed by Boeing for 12 years as a specialist engineer in flutter and vibration, and was involved with the Boeing 707, 727, 737, 747, and served lead engineer for the YC-14 flutter group. Previously, he performed flutter work, as a dynamics engineer, for development of the British Aircraft Corporation (BAC) Concorde. He became an independent DER in 1981, and "supported engineering work on projects ranging from the Cessna 180 to the Boeing 747 aircraft, with engineering analysis, design and testing as required for individual programs."

The DER also had several published papers to his credit, including "Transient Excitation and Data Processing Techniques Employing the Fast Fourier Transform for Aeroelastic Testing," "Effect of Stabilizer Dihedral and Static Lift on T-Tail Flutter," and "The Use of Transient Testing Techniques in the Boeing YC-14 Flutter Clearance Program."

COMPANY INFORMATION

According to a company representative, in May 1995, The Sino Swearingen Aircraft Company was formed as an international joint venture between Swearingen Aircraft, Incorporated, and Sino Aerospace Investment Corporation, Taipei, Taiwan. The Company's status later changed to a

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Narrative (Continued)

Corporation.

The original proof-of-concept SJ30, serial number 001, was built by Swearingen Aircraft, Inc., in the early 1990s, and first flew on February 13, 1991. In the mid-1990s, due to market demands and the products offered by competitors, the airplane was reconfigured. It was lengthened considerably, the wings were changed from anhedral to dihedral, and a new avionics suite was installed. It first flew in the new configuration in November 1996. By the time of the accident, the company had manufactured three more (flying) airplanes in that configuration, along with a static test platform and a fatigue test platform.

The company's headquarters were located at San Antonio International Airport, and a manufacturing facility was located in Martinsburg, West Virginia. The Martinsburg facility manufactured the vertical tail and the horizontal stabilizer. At that time, another company, Gamesa Aeronautica, of Vitoria, Spain, manufactured the wings and the fuselage. The San Antonio facility mated the wings, fuselage, and tail, installed the aircraft systems including the avionics, and flight tested the airplanes. All design and certification activities were accomplished at San Antonio.

SSAC was organized with Engineering, Manufacturing, and Quality Assurance departments reporting to the Senior Vice President of Operations. Engineering was comprised of Aerodynamics, Design, and Flight Test units. Manpower between the San Antonio and Martinsburg facilities totaled 382, of whom 118 reported to the Vice President of Engineering.

Airplane certification was being accomplished under an agreement between SSAC and the FAA, entitled, "Project Specific Certification Plan (PSCP) for SJ30-2, Report Number 30-041." The PSCP called for the certification of a "seven-passenger (including crew) airplane of conventional metal construction powered by two aft fuselage mounted Williams [International] FJ44-2A medium bypass turbofan engines." The airplane was to be certified in the commuter category for single pilot operation and all-weather capability, with a maximum operating Mach of 0.83 and a maximum altitude of 49,000 feet.

Formal engineering procedures governed airplane acceptance and development.

Engineering acceptance of flight test airplanes prior to first flight was governed by SSAC Engineering Procedure 007 (EP007), "a formal process...to determine and document the airworthiness of an aircraft prior to acceptance by the SSAC Test Operations Department." The procedure included a review by the SSAC Flight Safety Review Board, and a Flight Safety Review Checklist, including a flight test risk assessment.

Engineering changes to flight test airplanes was governed by SSAC Engineering Procedure 006 (EP006), which delineated "the method of configuration control to be used for the 'experimental' licensed aircraft which are owned and/or operated by...SSAC."

ACCIDENT AIRPLANE INFORMATION

The accident airplane, serial number 002, was first flown on November 11, 2000. At the time of the accident, the airplane was operating under a Special Airworthiness Certificate with Experimental

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Narrative (Continued)

Operating Limitations for the Purpose of Research and Development.

The airplane was inspected using an Approved Aircraft Inspection Program (AAIP) titled, "SJ30-2 Inspection Procedures Aircraft S/N 002, Report Number: QA-INSP-500 (QA-500)." Data accumulated during the airplane's design and operational testing was analyzed to formulate the inspection program requirements.

Inspections included the First Flight of Day Inspection, Next Flight Inspection, After Last Flight Inspection, Periodic/Phase Inspections (A, B, C) and Special Inspections. The Periodic/Phase inspections were accomplished at 100-hour intervals. Inspections were recorded on the Flight Test Work Order (FTWO).

Aircraft maintenance manuals had not been developed for the airplane. Maintenance was accomplished by FAA-certificated technicians using aircraft drawings and specifications in conjunction with vendor component maintenance manuals. Maintenance work was also recorded on the FTWO.

The last Periodic/Phase Inspection was a "B" Check, accomplished on January 14, 2003, at 284.2 hours. A First Flight of Day Inspection was accomplished on April 26, 2003, for the accident flight, at 315.9 hours.

According to an FAA inspector, a review of aircraft maintenance records revealed that SSAC was in compliance with the requirements of the approved aircraft inspection program.

The airplane was equipped with a trailing cone for static air pressure and a nose boom for dynamic air pressure. The combined inputs resulted in a "reference system airspeed." The pilot would have had to operate two cockpit switches to be able to display reference system airspeed. Failure to do so would have resulted in him reading a lower airspeed, generated from the airplane's internal airspeed indicating system.

The airplane was also instrumented to communicate 27 critical test parameters at 300 samples per second to a ground station van via telemetry, in order to support the flutter test plan. In addition, the airplane also had onboard computers, which recorded over 450 flight parameters.

METEROLOGICAL INFORMATION

Weather, recorded at an airport about 35 nautical miles to the south, included clear skies, winds from 330 degrees true at 10 knots, and 10 miles visibility.

WRECKAGE AND IMPACT INFORMATION

The wreckage was located at 29 degrees, 52.37 minutes north latitude, 100 degrees, 57.65 minutes west longitude, about 250 degrees magnetic, 10 nautical miles southwest of Loma Alta, Texas, and 350 degrees magnetic, 30 nautical miles north of Del Rio, Texas.

The accident site was located in a remote area of sparsely vegetated plateaus and canyons, at an

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Narrative (Continued)

elevation of 1,741 feet, near the top of one of the plateaus. The main crater was cut almost straight down, about 5 feet, into a sandstone formation. There were additional cuts, consistent with wing positions, oriented along a 085/265-degrees magnetic axis.

The wreckage was fragmented, with debris spread over an area of approximately 9 acres, dispersed 360 degrees around the impact crater. Evidence of all flight control surfaces was found at the scene. Slat tracks were identified; however, no slat structures were identified in the debris field. There was no evidence of an in-flight fire or in-flight failure of structural elements, and all fracture surfaces examined exhibited evidence of static overload. Control continuity could not be confirmed due to the severity of the impact damage.

The airplane's onboard computer hard drives were located; however, their condition precluded any data recovery.

MEDICAL AND PATHOLOGICAL INFORMATION

An autopsy and toxicological testing could not be performed.

TESTS AND RESEARCH

A Vehicle Performance Group was formed to review flight test and other pertinent data, including radar, telemetry parameters, lateral control and lateral trim documentation, and transonic wind tunnel tests. Results excerpted from the Vehicle Performance Group Study include:

-- Radar --

Long and short range radar data indicated that the accident airplane was on an easterly course, about 35 miles north of Del Rio, Texas at an altitude of 30,500 feet when the accident event began. The accident airplane was transmitting beacon code 4761 during the flight test and the chase plane, as second in a flight of two, was not transmitting an independent transponder code.

Subsequent to the accident, the chase plane began transmitting beacon code 4761.

-- Telemetry Data --

The telemetry data for the last 3 minutes of flight 231 was transcribed from binary to engineering units by SSAC personnel, and provided to the Safety Board.

The telemetry data included airplane flight conditions (altitude, airspeed, Mach number); magnetic heading; control surface positions for the elevator, rudder, and ventral rudder; fuel weight; and 19 accelerometer parameters requested to support the flutter certification testing. Onboard parameters of interest that were recorded, but unrecoverable, included accelerations near the airplane's center of gravity; angle of attack and sideslip angle; roll and pitch attitude; aileron surface, speedbrake, slat, flap, and gear positions; engine parameters; control input positions; and column, wheel, and pedal forces.

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Narrative (Continued)

No significant telemetry data dropouts occurred prior to the initiation of the event. However, the recorded telemetry data subsequent to the lateral upset event contained a large number of dropouts, which were attributed to the masking of the onboard antenna as the airplane rolled.

Telemetry scale limits were met or exceeded for three parameters. The calibrated airspeed reached, and remained at its maximum threshold value (400 knots) by 268 seconds, about 27 seconds prior to the end of data. In addition, the indicated Mach number maximum threshold value (Mach 1.0) was maintained between 272.9 and 278.3 seconds, and the telemetry minimum pressure altitude (10,000 feet) was reached, and maintained, beginning about 4 seconds prior to the end of the data.

-- Accident Event Timeline --

The timeline was based in part on SSAC document, "S/N 002 Accident Investigation Final Report: Lateral Instability Theory," dated August 1, 2003.

The telemetry data began at 130 seconds (10:02:10) with the airplane about 38,000 feet, Mach 0.805 passing through a magnetic heading of 36 degrees as it executed a right, shallow, descending turn toward a magnetic heading of approximately 073 degrees. The airplane accelerated to about Mach 0.83 by the time it completed the turn, and continued its shallow descent, accelerating to about Mach 0.85 by 180 seconds. The airplane stabilized about Mach 0.85 for nearly 8 seconds, while passing through 36,000 feet, then passed Mach 0.86 about 193 seconds. One second later, accelerometers recorded noticeably higher amplitude oscillations, consistent with high-speed buffet. (The lift coefficient at 194 seconds was calculated to be 0.25, which correlated to what would have been expected, based on the SJ30-2 buffet boundary curve.)

The airplane reached Mach 0.87 about 202 seconds, and maintained that airspeed as it passed through 33,500 feet. The airplane then reached Mach 0.88 at approximately 214 seconds, and as it stabilized at that airspeed, the rudder position transitioned from about 0 degrees, to about 1.5- to 2-degrees trailing-edge-left (TEL).

An elevator pulse was completed at 218.5 seconds, while the airplane was passing through 33,000 feet on a heading of 074 degrees magnetic.

A rudder pulse was completed at 228.5 seconds, while the airplane was passing through 31,500 feet.

An aileron pulse was completed by about 239 seconds, as the airplane passed through 30,500 feet.

Before the aileron pulse damped out, the rudder position moved, from about 2 degrees TEL to about 3.5 degrees TEL, during a 2-second timeframe. The ventral rudder position moved about 0.75 degrees TEL, the same direction as the rudder, between 237.8 and 243.2 seconds. About 240 seconds, and over a 3.2-second period, airplane heading deviated nose-right from about 074 to 076.5 degrees magnetic. About that time, the chase plane pilots reported that the accident airplane was in a shallow- to 30-degrees right bank.

At 243.2 seconds, the rudder moved about 1 degree TEL, from 3.5 to 4.5 degrees TEL, and the

(Continued on next page)

Narrative (Continued)

airplane-nose-right heading rate was briefly arrested at 244.4 seconds.

Until 243.2 seconds, the elevator remained relatively constant at its initial test condition position, near 1-degree trailing-edge-down (TED). After time 243.2, the ventral rudder position appeared to represent a scaled, offset reflection of the rudder position time history.

At 244.6 seconds, the elevator moved to about 3.5 degrees TEU in 1.8 seconds. The elevator maintained positions between 2 and 5 degrees TEU for the next 34 seconds. Also, about 244.6 seconds, as the elevator moved TEU, the airplane heading once again deviated airplane-nose-right.

At 245 seconds, rudder rate increased significantly, as the rudder moved 2 degrees TEL, over a 1-second period, to 6.5 degrees TEL.

The combination of increased TEU elevator and increased and rudder TEL coincided with a marked increase in airplane nose right heading rate. From about 246.2 seconds to the end of the telemetry data, magnetic heading established a periodic oscillation between 065 and 095 degrees magnetic with periods that varied between 6 and 9 seconds per cycle.

At 254 seconds, the accident airplane completed one roll, and through the end of telemetry, at 295.1 seconds, it completed about six more rolls. Elevator TEU deflection and rudder TEL deflection were maintained, with some variation in magnitude, to nearly the end of the data. Calibrated airspeed and Mach number increased to well beyond the SJ30-2 Vmo/Mmo and Vdf/Mdf design goals during the accident descent.

-- Performance Calculations --

Flight 231 pressure altitude, Mach number, and rudder position telemetry data were used to calculate the airspeed, ground speed, flight path angle, and sideslip angle. Radiosonde data was used to calculate the speed of sound. As the accident airplane accelerated toward the test condition Mach number, it transitioned from level flight to a flight path angle about 7 degrees below the horizon. The flight path angle was about 10 degrees below the horizon at the completion of the aileron pulse. At 243.2 seconds, as rudder deflection TEL opposed the airplane nose-right-heading deviation, the airplane's descent became increasingly steep. The flight path angle continued to decrease toward a final estimated value of 77 degrees below the horizon.

Sideslip angle was estimated as a function of rudder position based on SJ30-2 steady heading sideslip data. Results were considered valid only for periods when 1) the airplane was maintaining a relatively steady heading, and 2) rudder position was constant or slowly transitioning. Sideslip angle results were plotted between 210 and 247.5 seconds. Sideslip angle was calculated to vary between, at most, plus/minus 1 degree until the aileron pulse, when it increased to about 2 degrees between 238 and 243.2 seconds. The sideslip angle increased toward 2.7 degrees with increasing rudder TEL deflection between 243.2 and 244.4 seconds, at which point, the airplane established a nearly constant roll rate during the high speed descent.

-- Other Telemetry Data Features --

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Narrative (Continued)

The forward fuselage lateral and vertical acceleration parameters contained distinct features or "spikes" 10 times during the data collection. The features appeared only in the two forward fuselage accelerometer channels, which SSAC personnel attributed to interference from pilot radio transmissions.

The character of the left and right aileron accelerometer data changed between 220 and 230 seconds. The left hand (LH) aileron data indicated a cycle (plus 6 g's at 222.5 seconds; minus 3 g's at 228 seconds) not present in the right hand (RH) aileron data. The LH aileron cycle occurred at approximately 0.1 Hz. SSAC personnel concluded that the frequency was too low for a piezo-electric accelerometer measurement to be valid, and that the LH aileron accelerometer data feature did not likely reflect an actual flight event.

-- Accident Airplane Lateral Control History --

The lateral trim system used an adjustable trim spring to apply a constant force to the control wheel. The spring rate of the installed lateral trim system was equivalent to about 10 pounds of pilot wheel force, or about 15 percent total roll authority. The constant force design dictated that the amount of trim required to balance an aerodynamic force asymmetry was speed-dependent.

Utilizing telemetry and witness information, the Airplane Performance Group documented the airplane's lateral control history, which included:

In 1997, SSAC purchased a drag chute and developed flight test installation plans. At some point between 1997 and 2002, a decision was made not to implement the high speed drag chute installation, originally planned for flutter testing, due to pilot concerns about the possibility of an inadvertent chute deployment.

On May 7, 2002, a Temporary Test Aircraft Limitation (TTAL) was issued that limited pilot use of aileron trim to the 20- to 80-percent range of a 0- to 100-percent scale, where 50 percent was neutral. The TTAL was issued because the aileron trim motor bogged down at approximately 13.8 percent and 92 percent of travel.

Prior to flight 114, which occurred on June 1, 2002, a speed restriction of 250 KCAS was put in place. In addition, it was discovered that the airplane required a significant amount of roll trim adjustment, and that roll trim requirements were speed-dependent. As a result, the ailerons were removed, measured, and replaced, to attempt to correct twist deviations from the aileron surface design.

During flight 114, the airplane required much less roll trim adjustment, the roll trim requirement was consistently left-wing-down (LWD) and increased with airspeed, and the airplane could be trimmed in the lateral direction within the 250 KCAS speed restriction. SSAC personnel subsequently concluded that the airplane's tendency to roll right-wing-down (RWD) could be attributed to wing, and remaining aileron twist deviations from their respective surface designs.

After October 2002, the airspeed restriction was increased to 320 KCAS/Mach 0.83 following completion of Phase 1 flutter testing. The consistent LWD roll trim requirement was a known

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Narrative (Continued)

airplane-specific characteristic, which required nearly full LWD lateral trim at 320 KCAS.

For flight tests 199 and 200, December 16-17, 2002, the airplane was instrumented with tufts on the left and right wing upper surfaces. Two video cameras (one camera per wing) were installed to record real time tuft positions on each wing upper surface. Tuft testing confirmed the presence of large regions of shock-induced separation above Mach 0.81.

On April 14, 2003, the airplane's speedbrake travel was limited to 17.5 degrees of a nominal 35-degrees design travel, to reduce undesirable speedbrake deployment pitch characteristics (i.e., speedbrake deployment could cause a large, airplane-nose-down pitching moment).

On April 15, 2003, during an SSAC Safety Review Board (SRB) meeting, it was determined that due to the airplane's lateral trim issue and flutter test plan airspeeds exceeding 320 KCAS, full LWD trim and pilot hand pressure on the yoke would be required. The use of a Gurney flap on the right wing tip was approved. (The Gurney flap was an aerodynamic device intended to balance the airplane in the lateral axis, independent of airspeed, and restore lateral trim margin.)

On April 24, 2003, flight 229 was conducted to quantify Gurney flap effectiveness, flight-test the flutter instrumentation, and perform a telemetry range check. The Gurney flap improved the lateral trim margin, and for airspeeds up to 305 KCAS, approximately 40 percent lateral trim was required on a scale from 0 to 100 percent, where 50 percent was neutral.

Subsequent to the flight, SSAC personnel considered the fact that the airplane would likely require additional LWD control input to trim laterally as airspeed increased beyond Vmo (320 KCAS). The flutter test consultant indicated that the flutter data analysis would be valid if roll control pulses were superimposed on a basic wheel force required to hold wings level.

On April 25, 2003, as part of the pre-flight test review for flight 230, SSAC personnel decided to continue with the flutter testing if the pilot needed to apply a "small" wheel force to trim laterally as airspeed increased beyond Vmo (320 KCAS).

During flight 230, flutter test point 1-12 was completed. All available aileron trim was required at Mach 0.84 for the point, at altitudes between 31,000 and 30,000 feet. Rudder pedal was used to augment aileron trim (set at approximately 25 percent) as the airplane descended from 33,000 to 31,000 feet.

Data revealed that all of the earlier TTAL lateral trim margin (20 to 80 percent) was required to trim the airplane between Mach 0.84 and 0.86.

During flight 230, [approaching] test point 1-13, the airplane experienced an uncommanded LWD roll. The roll event was corrected by pilot wheel input over a period of about 20 seconds as the airplane decelerated below Mach 0.85. Rudder pedal was also used to augment the aileron roll control during the recovery.

Subsequent to the flight, SSAC personnel concluded that the LWD roll resembled a wing drop, likely caused by the presence of shock-induced separation. The pilot was briefed to expect increased

(Continued on next page)

Narrative (Continued)

vibration, buffeting, and possible wing drops as the airplane passed the 1g buffet boundary at Mach 0.86.

-- Stability and Control Characteristics --

Prior to the accident, SSAC estimated the SJ30-2 high speed stability and control characteristics by extrapolating low speed wind tunnel data, using methods in the USAF Stability and Control Data Compendium (DATCOM), conducting numerical simulation with Computational Fluid Dynamics (CFD) tools, and extrapolating flight test data.

-- Wind Tunnel Testing --

Between 1996 and 2002, SSAC personnel conducted eight low speed wind tunnel tests. A baseline SJ30-2 configuration was developed as a result of three tests completed between February 1996 and February 1997. Aerodynamic stability and control data for the production SJ30-2 configuration was collected during tests in October 1997, and May 1998. Secondary flight control surface asymmetry deployment effects were evaluated in September 2001. Speedbrake pitching moment characteristics, stall chute stinger/emergency egress deflector effects, and alternative speedbrake configurations were analyzed in August and October 2002. The low speed wind tunnel data revealed that separation, due to either speedbrake deployment or high (post-stall) angles of attack, tended to reduce wing lateral stability.

Following the flight 231 accident, SSAC personnel developed a test plan and authorized a transonic test to define the high speed stability and control characteristics of the SJ30-2. A1/9th scale model was built to SJ30-2 design loft specifications and completed in December 2003. The model design enabled hinge moment measurements generated by specific hinge-wise deflections of the horizontal stabilizer, aileron, elevator, rudder, and outboard spoiler/speedbrake flight control surfaces. In addition, vortex generator, thick trailing edge flap and aileron, Gurney flap, winglet, strake, and wing blade components were built and tested. During January 2004, transonic testing took place in an 8- by 9-foot transonic tunnel in Bedford, England.

In May 2004, results of the transonic test were presented to the Airplane Performance Group. The test data indicated that lateral stability on the SJ30-2 deteriorated with increasing Mach number and angle of attack. Lateral stability, measured in terms of rolling moment due to sideslip, became negative (unstable) above Mach 0.83. Because of this, a rudder input intended to augment the lateral trim (or roll capability) and raise a low wing could instead, beyond a certain Mach number, actually aggravate the situation. Similarly, an elevator TEU input would tend to increase the angle of attack, also resulting in deteriorated lateral stability.

The transonic wind tunnel test data also provided evidence that roll authority deteriorated above Mach 0.86. Flow visualization results revealed that upper wing surface flow separated between Mach 0.84 and 0.88, and lower wing surface flow separated between Mach 0.86 and 0.88, at 2-degrees angle of attack and 0-degree sideslip angle. A 1-degree angle of attack was representative of the accident flight condition lift coefficient.

-- Computational Fluid Dynamics --

(Continued on next page)

Narrative (Continued)

SSAC personnel utilized Computational Fluid Dynamics (CFD) methods for wing design, and to supplement SJ30-2 high speed stability and control database. Prior to the accident, vortex lattice and Euler methods were primarily used. Euler methods tended to predict shock locations farther aft than actual shock locations during transonic flight conditions.

Wing design calculations for the SA30 (a pre-SJ30-2 prototype) and SJ30-2 were performed using WIBCO, a NASA/Grumman transonic small disturbance code. A coupled integral boundary layer computation capability was available in WIBCO, but the code lacked an asymmetric analysis capability. WIBCO was used primarily by SSAC for cruise analysis, although runs were also made at Mach 0.88 (the dive Mach number at the time) to validate the onset of separation.

Prior to the accident, a three-dimensional MGAERO Euler code (inviscid mode) was used to design the pylon for cruise, analyze the flap track fairings, and provide stability predictions. MGAERO predicted a reduction in lateral stability above Mach 0.815, but positive lateral stability up to Mach 0.90. Two-dimensional CFD aileron studies indicted that aileron power would decrease with increasing Mach number.

Following the accident, SSAC made inviscid calculations up to Mach 0.9, including sideslip, in an attempt to understand three-dimensional, transonic, asymmetric characteristics. A more advanced, fully viscous NSAERO Navier-Stokes CFD code was also utilized to gain additional insight, and other advanced CFD methods were utilized to enhance the prediction of stability and control derivatives.

-- Accident Airplane Flight Testing --

Steady heading sideslip flight tests conducted with the accident airplane revealed a positive lateral stability from 1.2 Vs up to Mach 0.817. Sideslip angles up to 6 degrees were tested at Mach 0.817. Bank-to-bank roll testing demonstrated adequate aileron authority to Mach 0.819. Flight 230 data demonstrated the airplane's response to aileron and rudder inputs above Mmo.

Flight 199 and flight 200 high speed tuft test data confirmed the presence of large regions of shock-induced separation above Mach 0.81.

-- Airplane Improvements --

SSAC personnel made aerodynamic improvements to the SJ30-2 following the accident, as a result of post-accident design and development efforts. Vortex generators were added to the wings to delay the onset of shock-induced separation, and thicker trailing edge ailerons were installed to improve aileron effectiveness at high Mach numbers. In addition, a high-Mach-number roll spoiler system was prepared, to augment roll control above Mach 0.835.

As a result of additional design work initiated prior to the accident, the single speedbrake panel on each wing was relocated farther outboard to minimize the large pitch-down effects caused by tail lift interference, and the speedbrakes became operational at all airspeeds within the design deployment range.

(Continued on next page)

Narrative (Continued)

The new SJ30-2 flight flutter test airplane, serial number 004, N404SJ, was equipped with a high speed drag chute before flutter testing resumed. (Airplane serial number 003, N30SJ, was used primarily as a systems validation platform.)

-- Post-Accident Flight Test Data (Serial Number 004) --

High speed flight test results on serial number 004, which incorporated the configuration modifications outlined above, demonstrated improved SJ30-2 high speed stability and control characteristics. The airplane flew multiple flutter test points to Vd/Md (372 KCAS/0.90 Mach). The point of neutral lateral stability was found to be approximately 0.015 Mach higher at the critical altitude (28,000 ft) than that predicted by the transonic wind tunnel data. The modified SJ30-2 configuration maintained a positive lateral stability at Mmo (0.83 Mach) and demonstrated neutral lateral stability at approximately 0.85 Mach.

High-speed dive recovery (deceleration from Mach 0.885 to Mach 0.85), accomplished by reducing thrust to idle, resulted in a return to a laterally stable flight regime within about 9 seconds. Releasing rudder input from a nominally stabilized sideslip condition caused the airplane to return to wings level flight at all Mach numbers tested up to 0.90 Mach, even when the rolling coefficient moment due to sideslip was positive. Finally, the modified configuration repeatedly demonstrated controlled flight into the "unstable" regime, with positive roll control at all times and rapid recovery to Mmo when required.

SSAC successfully completed SJ30-2 flight flutter testing in August 2004, and demonstrated that the high-Mach-number roll spoiler, which was never installed, was not needed.

ADDITIONAL INFORMATION

-- Additional Airplane Improvements --

According to an SSAC representative, follow-on airplanes, serial numbers 003 (used primarily for systems validation), and 004 (handling and performance), exhibited well-balanced fight characteristics that did not require external trim devices. Serial number 002 was the first airplane to utilize current production tooling, while 003 and 004 represented continuous improvements in build accuracy due to the "learning curve and improvements in manufacturing tolerances."

-- Company Improvements --

According to the company's senior vice president of operations, in addition to the airplane improvements previously noted, the company initiated other improvements since the accident, including:

-- Personnel --

- Hired additional test pilots and flight test engineers, all having previous business jet certification experience.

(Continued on next page)

Narrative (Continued)

- Had all pilots and flight test engineers go through "recovery from unusual attitudes" training.

- Retained industry experts in aerodynamics, stability and flutter.

- Contracted outside experts to review all flight test reports for flight safety and duration.

- Enhanced the cross-functionality of flight test department personnel.

-- Equipment --

- Purchased a new telemetry van and equipment to provide 360-degree tracking, 1120 parameters, and a hot microphone from the test aircraft embedded in the data transmission.

- Moved the test area for critical flights to Edwards Air Force Base to utilize special test airspace and test equipment.

-- Processes --

- Re-examined company safety board review procedures to ensure that the chairman and members clearly understood their roles and authority.

- Hired additional safety board review members.

- Initiated a process to gradually step up speed and altitude tests, by comparing actual data to high speed wing tunnel data.

- Required review and approval by the company aerodynamics group prior to all flight test plans at Mach 0.83 or above.

-- Wreckage Release --

On September 17, 2004, the wreckage was released, and acknowledged by a representative of SSAC.

National Transportation Safety Board
FACTUAL REPORT
AVIATION

NTSB ID: IAD03MA049

Occurrence Date: 4/26/03

Occurrence Type: Accident

Landing Facility/Approach Information

Airport Name	Airport ID:	Airport Elevation	Runway Used	Runway Length	Runway Width
		Ft. MSL	NA		

Runway Surface Type: Unknown

Runway Surface Condition: Unknown

Type Instrument Approach: Unknown

VFR Approach/Landing: Unknown

Aircraft Information

Aircraft Manufacturer	Model/Series	Serial Number
Sino-Swearingen	SJ30-2	002

Airworthiness Certificate(s): Experimental (Special)

Landing Gear Type: Tricycle

Homebuilt Aircraft? No | Number of Seats: 3 | Certified Max Gross Wt. 13600 LBS | Number of Engines: 2

[redacted]ngine Type:	Engine Manufacturer:	Model/Series:	Rated Power:
Turbo Fan	Williams International	FJ-44-2A	2300 LBS

- Aircraft Inspection Information

Type of Last Inspection	Date of Last Inspection	Time Since Last Inspection	Airframe Total Time
Continuous Airworthiness	1/28/03	60 Hours	284 Hours

- Emergency Locator Transmitter (ELT) Information

ELT Installed? Yes | ELT Operated? No | ELT Aided in Locating Accident Site? No

Owner/Operator Information

Registered Aircraft Owner: Sino-Swearingen Aircraft Company	Street Address: 1770 Sky Place Boulevard		
	City: San Antonio	State: TX	Zip Code: 78216
Operator of Aircraft: Same As Reg'd Aircraft Owner	Street Address: Same as Registered Aircraft Owner		
	City:	State:	Zip Code:

Operator Does Business As: | Operator Designator Code:

- Type of U.S. Certificate(s) Held: None

Air Carrier Operating Certificate(s):

[redacted]perating Certificate: | Operator Certificate:

Regulation Flight Conducted Under: Part 91: General Aviation

Type of Flight Operation Conducted: Flight Test

National Transportation Safety Board
FACTUAL REPORT
AVIATION

NTSB ID: IAD03MA049

Occurrence Date: 4/26/03

Occurrence Type: Accident

First Pilot Information

Name	City	State	Date of Birth	Age
On File	On File	On File	On File	59

Sex: M | Seat Occupied: Left | Principal Profession: Civilian Pilot | Certificate Number: On File

Certificate(s): Airline Transport

Airplane Rating(s): Multi-engine Land; Single-engine Land

Rotorcraft/Glider/LTA: None

Instrument Rating(s): Airplane

Instructor Rating(s): Airplane Single-engine

Type Rating/Endorsement for Accident/Incident Aircraft? Yes | Current Biennial Flight Review?

Medical Cert.: Class 2 | Medical Cert. Status: Valid Medical--w/ waivers/lim. | Date of Last Medical Exam: 7/3/02

Flight Time Matrix	All A/C	This Make and Model	Airplane Single Engine	Airplane Mult-Engine	Night	Instrument Actual	Instrument Simulated	Rotorcraft	Glider	Lighter Than Air
Total Time	12000	625								
Pilot In Command(PIC)										
Instructor										
Last 90 Days	39	39		39						
Last 30 Days	17	17		17						
Last 24 Hours	3	3		3						

Seatbelt Used? Yes | Shoulder Harness Used? Yes | Toxicology Performed? No | Second Pilot? No

Flight Plan/Itinerary

Type of Flight Plan Filed: IFR

Departure Point	State	Airport Identifier	Departure Time	Time Zone
San Antonio	TX	SAT	0911	CDT

Destination	State	Airport Identifier
Local Flight		

Type of Clearance: IFR

Type of Airspace: Class A

Weather Information

[redacted]urce of Briefing: Flight Service Station

Method of Briefing: Telephone

National Transportation Safety Board
FACTUAL REPORT
AVIATION

NTSB ID:	IAD03MA049
Occurrence Date:	4/26/03
Occurrence Type:	Accident

Weather Information

WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
DRT	0953	CDT	1000 Ft. MSL	35 NM	180 Deg. Mag.

Sky/Lowest Cloud Condition: Clear Ft. AGL | Condition of Light: Day

Lowest Ceiling: None Ft. AGL | Visibility: 10 SM | Altimeter: 30.16 "Hg

Temperature: 16 °C | Dew Point: 5 °C | Wind Direction: 330 | Density Altitude: Ft.

Wind Speed: 10 | Gusts: | Weather Condtions at Accident Site: Visual Conditions

Visibility (RVR): Ft. | Visibility (RVV) SM | Intensity of Precipitation:

Restrictions to Visibility: None

Type of Precipitation: None

Accident Information

Aircraft Damage: Destroyed | Aircraft Fire: None | Aircraft Explosion None

Classification: U.S. Registered/U.S. Soil

- Injury Summary Matrix	Fatal	Serious	Minor	None	TOTAL
First Pilot	1				1
Second Pilot					
Student Pilot					
Flight Instructor					
Check Pilot					
Flight Engineer					
Cabin Attendants					
Other Crew					
Passengers					
- TOTAL ABOARD -	1				1
Other Ground					
- GRAND TOTAL -	1				1

NTSB ID:	IAD03MA049
Occurrence Date:	4/26/03
Occurrence Type:	Accident

Administrative Information

Investigator-In-Charge (IIC)

Paul R Cox

Additional Persons Participating in This Accident/Incident Investigation:

J. Chris Greene
Williams International
Walled Lake, MI

Eric West
FAA/AAI-100
Washington, DC

Robert E. Homan
Sino Swearingen
San Antonio, TX

National Transportation Safety Board

Docket Contents

Project Information

Project ID (mkey)	Mode	
56888	Aviation	
NTSB Accident ID	Occurrence Date	Location
IAD03MA049	Apr 26, 2003	Loma Alta, TX, United States

Docket Information

Creation Date	Last Modified	Public Release Date & Time
Jul 17, 2003	Jan 10, 2005 15:55	Jan 10, 2005 15:55
Comments		

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3	Sep 22, 2003	Structures 7 - Factual Report of Group Chairman	5	
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7	Aug 26, 2004	Area Maps	2	
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10	Sep 15, 2004	Pilot-Reported Flight Times Upon SSAC 1997 Hire	1	
11	Aug 26, 2004	Flutter Program Operations	3	
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13	Aug 26, 2004	SSAC Flt 230 Flutter Test Package with Pilot Notations	18	
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19	Sep 21, 2004	Aircraft Performance 13 - Vehicle Performance Group Factual	11	
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NTSB ITEM #101

FORM APPROVED FOR USE THROUGH 7/31/98 BY OMB NO.3147-0001.

NATIONAL TRANSPORTATION SAFETY BOARD
PILOT/OPERATOR AIRCRAFT ACCIDENT REPORT
This form To Be Used For Reporting Civil Aircraft Accidents Involving Commercial and General Aviation Aircraft

Location

Nearest City/Place, State, Zip Code	Date of Accident	Local Time (24 HOUR CLOCK)	Zone	Elevation At Accident Site
LOMA ALTA, TEXAS	4-26-03	1005	CDT	1741 Feet MSL / ____ Feet MSL

If The Accident Occurred On Approach, Takeoff or Within 3 Miles of An Airport, Complete The Following Information

Proximity To Airport
1.☐ On Approach 2.☐ Within 1/4 Mile 3.☐ Within 1/2 Mile 4.☐ Within 3/4 Mile 5.☐ Within 1 Mile 6.☐ Within 2 Miles 7.☐ Within 3 Miles 8.☐ Beyond 3 Miles

Airport Name	Airport Ident	Runway/Landing Surface Conditions:
		1.☐ Direction: 2.☐ Length: 3.☐ Width: 4.☐ Surface: 5.☐ Condition:

Phase Of Operation:
1.☐ Standing 2.☐ Taxi 3.☐ Takeoff 4.☐ Climb 5.☐ Cruise 6.☐ Descent 7.☐ Approach 8.☐ Landing 9.☐ Hover/Maneuver 10.☐ Altitude Of In-Flight Occurrence ____ Feet MSL

Aircraft Information

Registration Mark	Aircraft Manufacturer	Aircraft Type/Model	Serial Number	Cert Max Gross WT
N138BF	Sino Swearingen Aircraft Corp	SJ30-2	S/N 002	13,600

Type Of Aircraft
1.☑ Airplane 2.☐ Helicopter 3.☐ Glider 4.☐ Balloon 5.☐ Blimp/Dirigible 6.☐ Ultralight 7.☐ Gyroplane 8.☐ Specify____

Type Of Airworthiness Certificate
1.☐ Normal 2.☐ Utility 3.☐ Acrobatic 4.☐ Transport 5.☐ Restricted 6.☐ Limited 7.☑ Experimental 8.☐ Specify____

Amateur Built
1.☑ Yes 2.☐ No

Landing Gear
1.☐ Tricycle—Fixed 2.☑ Tricycle—Retractable 3.☐ Tailwheel—Fixed 4.☐ Tailwheel—Retractable 5.☐ Tailwheel—Retractable Mains 6.☐ Amphibian 7.☐ Skid 8.☐ Limited 9.☐ Specify____

No. Of Seats
Flight/Cabin Crew 2
Pax 1

Stall Warning System Installed
1.☑ Yes 2.☐ No

IFR Equipped
1.☑ Yes 2.☐ No

Engine Type
1.☐ Reciprocating—Carburetor 2.☐ Reciprocating—Fuel Injected 3.☐ Turbo Prop 4.☑ Turbo Jet 5.☐ Turbo Fan 6.☐ Turbo Shaft

Engine Manufacturer	Engine Model/Series	Engine Rated Power	Type Of Fire Extinguishing System Used
Williams/Rolls	FJ44-2A	1. ~~2300~~ ~~Horsepower~~ 2. 2300 Lbs Thrust	1. None 2. Specify HALON

Engine(s)	Date of Mfg.	Mfg. Serial No.	Total Time	Time Since Inspection	Time Since Overhaul
Engine No. 1	2002	401	310 Hours	n/a Hours	n/a Hours
Engine No. 2	2002	402	310 Hours	n/a Hours	n/a Hours
Engine No. 3			Hours	Hours	Hours
Engine No. 4			Hours	Hours	Hours

Type Of Maintenance Program
1.☐ Annual 2.☑ Manufacturer's Inspection Program 3.☐ Other Approved Inspection Program(AAIP) 4.☐ Continuous Airworthiness 5.☐ Specify____

Type Of Last Inspection
1.☐ Annual 2.☐ 100 Hours 3.☐ AAIP 4.☑ Continuous Airworthiness

Date Last Inspection Performed 1-28-2003 (M/D/Y)
Time Since Last Inspection 60 Hours
Airframe Total Time 284.2 Hours

Emergency Locator Transmitter (ELT) SEAT MOUNTED	ELT Manufacturer	Model/Series	Serial Number	Battery Date (M/D/Y)
	ACR	Mini B	15545	??

Switch: 1.☐ On 2.☐ Off 3.☑ Armed
Operated: 1.☐ Yes 2.☐ No ?
Aided In Accident Location: 1.☐ Yes 2.☐ No ?

Registered Aircraft Owner	Address
Sino Swearingen Aircraft Corp.	1770 Sky Place Blvd, San Antonio, TX 78216

Operator Of Aircraft	Address
1.☑ Same As Registered Owner 2. Name 3. DBS:	1.☑ Same As Registered Owner 2.____

NTSB Form 6120.1/2 (11/87) This Form replaces NTSB Forms 6120.1 (rev. 10/77) and 6120.2 (Rev.10/77)

Owner / Operator Information (cont.)

Operator (Certificate Number)	Operator Designator (4 Letter Designator)
N/A	N/A

Purpose Of Flight And Type Of Operation

Regulation Flight Conducted Under
1.[x] FAR91 (only) 4.☐ FAR 121 7.☐ FAR 133
2.☐ FAR91D 5.☐ FAR 125 8.☐ FAR 135
3.☐ FAR 103 6.☐ FAR 129 9.☐ FAR 137

Purpose of Flight
1.☐ Personal 6.☐ Aerial Observation
2.☐ Business 7.[x] Other Work Use
3.☐ Educational 8.☐ Public Use
4.☐ Executive/Corporate 9.☐ Ferry
5.☐ Aerial Application 10.☐ Positioning

Operator Authority
FAR121
1.☐ Domestic
2.☐ Flag
3.☐ Supplemental
FAR 135
4.☐ On Demand
5.☐ Commuter
FAR 133
6.☐ Rotorcraft External Load
FAR125
7.☐ Large Aircraft
FAR 129
8.☐ Foreign
N/A

FAR 121, 125, 127, 129, 135 Revenue Operations
1.☐ Scheduled
2.☐ Non Scheduled
3.☐ Domestic
4.☐ International
5.☐ Passenger
6.☐ Cargo
7. Specify ______
N/A

Pilot Information

Pilot Name	Pilot Certificate No.	Address	Nationality
CARROLL BEELER		BOERNE, TX 78006	U.S.

Certificate (s)
1.☐ Student 3.☐ Commercial 5.[x] Flight Instructor 7.☐ Military 9.☐ None
2.☐ Private 4.[x] Airline Transport 6.☐ Flight Engineer 8.☐ Foreign 10.Specify ______

Rating (s)
1.☐ None 6.☐ Helicopter
2.[x] Single Engine Land 7.☐ Glider
3.☐ Single Engine Sea 8.☐ Free Balloon
4.[x] Multiengine Land 9.☐ Airship
5.☐ Multiengine Sea 10.☐ Gyroplane

Instrument Rating (s)
1.☐ None
2.[x] Airplane
3.☐ Helicopter

Instructor Rating (s)
1.☐ None 6.☐ Instrument Airplane
2.☐ Airplane S.E. 7.☐ Instrument Helicopter
3.☐ Airplane M.E. 8.☐ Ground Instructor
4.☐ Helicopter 9.☐ Specify ______
5.☐ Glider

Type Ratings/Student Endorsements

Date Of Biennial Flight Review or Equivalent (M/D/Y)

BFR Aircraft
1. Make ______
2. Model ______

Medical Certificate
1.☐ None 3.[x] Class 2
2.☐ Class 1 4.☐ Class 3

Date Of Last Medical (M/D/Y) 7-3-2002

Limitations

Waivers

Date Of Birth (M/D/Y)

Degree Of Injury
1.☐ None
2.☐ Minor
3.☐ Serious
4.[x] Fatal

Seat Occupied
1.[x] Left 4.☐ Front
2.☐ Right 5.☐ Rear
3.☐ Center

Person At Controls At Time Of Accident
1.[x] Pilot In Control 4.☐ Non-Pilot
2.☐ Second Pilot 5.☐ No One
3.☐ Both Pilots

Seat Belt Available
1.[x] Yes
2.☐ No

Seat Belt Used
1.[x] Yes
2.☐ No

Shoulder Harness Available
1.[x] Yes
2.☐ No

Shoulder Harness Used
1.[x] Yes
2.☐ No

Source Of Pilot Flight Time Information
1.☐ Pilot Logbook 4.☐ Company
2.☐ Operators Estimate 5.☐ Specify ______
3.☐ FAA Records

Flight Time	All A/C	This Make & Model	Airplane Single Engine	Airplane Multiengine	Night	Instrument Actual	Instrument Simulated	Rotorcraft	Glider	Lighter Than Air
Total Time										
Pilot In Command (PIC)										
Instructor										
This Make & Model										
Last 90 Days										
Last 30 Days										
Last 24 Hours										

Second Pilot Information N/A

Second Pilot Responsibilities At The Time Of Accident
1.☐ Co-Pilot 2.☐ Dual Student 3.☐ Safety Pilot 4.☐ Check Pilot 5.☐ None (Pilot-Rated Passenger)

Pilot Name	Pilot Certificate No.	Address	Nationality

Certificate (s)
1.☐ Student 3.☐ Commercial 5.☐ Flight Instructor 7.☐ Military 9.None ______
2.☐ Private 4.☐ Airline Transport 6.☐ Flight Engineer 8.☐ Foreign 10.Specify ______

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Second Pilot Information (cont.)

Rating (s)	Instrument Rating (s)	Instructor Rating (s)
1.☐ None 2.☐ Single Engine Land 3.☐ Single Engine Sea 4.☐ Multiengine Land 5.☐ Multiengine Sea 6.☐ Helicopter 7.☐ Glider 8.☐ Free Balloon 9.☐ Airship 10.☐ Gyroplane	1.☐ None 2.☐ Airplane 3.☐ Helicopter	1.☐ None 2.☐ Airplane S.E. 3.☐ Airplane M.E. 4.☐ Helicopter 5.☐ Glider 6.☐ Instrument Airplane 7.☐ Instrument Helicopter 8.☐ Ground Instructor 9.☐ Specify______

Type Ratings/Student Endorsements	Date Of Biennial Flight Review or Equivalent (M/D/Y)	BFR Aircraft 1. Make______ 2. Model______

Medical Certificate	Date Of Last Medical (M/D/Y)	Limitations / Waivers	Date Of Birth (M/D/Y)
1.☐ None 2.☐ Class 1 3.☐ Class 2 4.☐ Class 3			

Degree Of Injury	Seat Occupied	Seat Belt Available
1.☐ None 2.☐ Minor 3.☐ Serious 4.☐ Fatal	1.☐ Left 2.☐ Right 3.☐ Center 4.☐ Front 5.☐ Rear	1.☐ Yes 2.☐ No

Seat Belt Used	Shoulder Harness Available	Shoulder Harness Used	
1.☐ Yes 2.☐ No	1.☐ Yes 2.☐ No	1.☐ Yes 2.☐ No	1.☐ Pilot Logbook 2.☐ Operators Estimate 3.☐ FAA Records 4.☐ Company 5.☐ Specify______

Flight Time	All A/C	This Make & Model	Airplane Single Engine	Airplane Multiengine	Night	Instrument Actual	Instrument Simulated	Rotorcraft	Glider	Lighter Than Air
Total Time										
Pilot In Command (PIC)										
Instructor										
This Make & Model										
Last 90 Days										
Last 30 Days										
Last 24 Hours										

Other Personnel

	Name	Seat	Address (City & State)	Crew	Non-Revenue	Revenue	Non-Occupant	FAA	Fatal Serious Minor None
1.									
2.									
3.									
4.									
5.									
6.									

Flight Itinerary Information

Last Departure Point	Time Of Departure	Destination	Flight Plan Filed
1. Airport ID SAT 2. City/Place SAN ANTONIO 3. State TEXAS	1. Time 0911 2. Time Zone CDT	1. Airport ID SAT 2. City/Place SAN ANTONIO 3. State TEXAS	1.☐ None 2.☐ VFR 3.☑ IFR 4.☐ VFR/IFR 5.☐ Company (VFR) 6.☐ Military (VFR)

If Weather Was Involved, State If Weather Briefing Was Obtained or If Weather Reports Were Checked And How It Was Accomplished

Fuel On Board At Last Takeoff	Fuel Type
3527 Gallons or Pounds	1.☐ 80/87 2.☐ 100 Low Lead 3.☐ 100/130 4.☐ 115/145 5.☑ Jet A 6.☐ Automotive 7. Specify______

Other Services, If Any, Prior to Departure

N/A

Weather Information At The Accident Site

Source Of Weather Information (Pilot/Operator, Weather Observation)	Light Condition	Visibility	Temp (°F)
WEATHER OBSERVATION RECORDED AT DEL RIO, TX	1.☐ Dawn 2.☑ Daylight 3.☐ Dusk 4.☐ Bright Night 5.☐ Dark Night	UNLIMITED Miles	?

Weather Information At The Accident Site (cont.)

Dew Point	Altimeter Setting	Sky/Lowest Cloud Condition
— (°F)	— "Hg	1.☒ ~~Clear~~ 2.☐ Scattered ____ Feet AGL 3.☐ Broken ____ Feet AGL 4.☐ Overcast ____ Feet AGL 5.☐ Partial Obscuration 6.☐ Obscured

Wind Information	Restriction To Visibility	Type Precipitation	Intensity Of Precipitation
1. Direction 330 2. Velocity 10 Kts 3. Gusts — Kts	clear	—	1.☐ Light 2.☐ Moderate 3.☐ Heavy 4. Specify NONE

Turbulence (Multiple Entry)
1.☐ None 2.☐ Light 3.☐ Moderate 4.☐ Severe 5.☐ Extreme 6.☒ ~~Clean Air~~ 7.☐ In Clouds

Damage To Aircraft And Other Property

Degree Of Aircraft Damage
1.☐ None 2.☐ Minor 3.☐ Substantial 4.☒ Destroyed

Fire
1.☐ ~~Yes~~ 2.☒ ~~No~~ 3.☐ In-Flight 4.☐ On Ground

Description Of Damage To Aircraft And Other Property

TOTAL DESTRUCTION OF AIRCRAFT
NO PROPERTY DESTRUCTION ON GROUND.

Mechanical Malfunction Failure

1.☐ No
2.☐ Yes List The Name Of The Part, Manufacturer, Part No., Serial No. And Describe The Failure

Total Time
On Part ____ Hours
At Overhaul ____ Hours

Collision Accident

If Collision Accident Occurred, Complete The Information For Other Aircraft

Registration Mark	Aircraft Manufacturer	Aircraft Type/Model	Degree Of Aircraft Damage
			1.☐ Destroyed 2.☐ Substantial 3.☐ Minor 4.☐ None

Registered Aircraft Owner	Address

Pilot Name	Address	Pilot Certificate No.

Evacuation Of Aircraft

Assistance Received
1.☐ Outside Person (s) 2.☐ Auxiliary Lighting 3.☐ Slide 4.☐ Rope 5.☐ Ladder 6.☐ Specify ____

Method Of Exit (State Approximate Number Of Persons Using Each Of The Following
1. Main Door ____ 2. Auxiliary Door ____ 3. Emergency Exit ____

Recommendation (How Could This Accident Have Been Prevented)

Operator/Owner Safety Recommendation (Optional Entry)

Additional Flight Crew Members				
For Each Additional Flight Crew Member, Exclusive Of Cabin Attendants Complete The Following Information				
Name	FAA Certificate No.	Address ______	Title	
Certificate(s) 1.☐ Student 2.☐ Private	3.☐ Commercial 4.☐ Airline Transport	5.☐ Flight Instructor 6.☐ Flight Engineer	7.☐ Foreign 8.Specify ______	
Ratings/Endorsements		Total Flight Time	Flight Time This Accident	
Name	FAA Certificate No.	Address ______	Title	
Certificate(s) 1.☐ Student 2.☐ Private	3.☐ Commercial 4.☐ Airline Transport	5.☐ Flight Instructor 6.☐ Flight Engineer	7.☐ Foreign 8.Specify ______	
Ratings/Endorsements		Total Flight Time	Flight Time This Accident	
Name	FAA Certificate No.	Address ______	Title	
Certificate(s) 1.☐ Student 2.☐ Private	3.☐ Commercial 4.☐ Airline Transport	5.☐ Flight Instructor 6.☐ Flight Engineer	7.☐ Foreign 8.Specify ______	
Ratings/Endorsements		Total Flight Time	Flight Time This Accident	

Narrative History Of Flight

Describe What Occurred In Chronological Order, The Circumstances Leading To The Accident And The Nature Of The Accident. Describe The Terrain and Include a Sketch Of Wreckage Distribution If Pertinent. Attach Extra Sheets If Needed. State Point Of Departure, Time Of Departure, Intended Destination And Services Obtained.

DEPARTED SAT @ 0911 CDT on 26 April, 2003. Was on a flight to test High Speed Flutter and was scheduled to Return to SAT.

AT approximately 10:05 CDT SJ30-2 sn 002 TEST AIRCRAFT and its Lone Pilot were Lost during High Speed Flutter testing. THE TEST Plan called for a dive to 0.884 MACH AT 32,000 FT, Followed by a series of Control Raps. The chase plane reported that The AIRCRAFT ENDED THE TEST POINT in a slight Right Bank. The TEST AIRCRAFT then began a slow Right wing down Roll. After Two Revolutions, the pilot Reported he could not stop the roll. the Test aircraft Rolled approximately Five more Times (Period of 6 to 8 seconds) in a steep Descent impacting the Ground near Loma ALTA, Texas

The aircraft impacted almost vertically as indicated by the debris field which was distributed 360° around the impact point.

I Hereby Certify That The Above Information Is Complete And Accurate To The Best Of My Knowledge

Date Of This Report	Signature Of Pilot/Operator
8.27.09	[signature] VP Quality Assurance, SSAC

Signature Of Person Filing Report Other Than Pilot/Operator

1. Signature ______

2. Type Or Print Name ______

3. Title ______

For NTSB Use Only

NTSB Accident No.	Reviewed By NTSB Office Located At	Name Of Investigator	Date Report Received
FTW04MA049	MARA	COX	8-31-04

NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

July 8, 2003

Systems Group Chairman's Factual Report
IAD03MA049

A. ACCIDENT

Location:	Near Loma Alta, Texas
Date:	April 26, 2003
Time:	1005 Local Time (CDT)
Aircraft:	Sino-Swearingen SJ30-2, N138BF

B. GROUP

Chairman:	Tom Jacky National Transportation Safety Board Office of Aviation Safety (AS-40) Washington, DC
Member:	Rick Simmons Federal Aviation Administration (FAA) ASW-170 Fort Worth, TX
Member:	J. Roger Wilson Sino Swearingen Aircraft Corporation San Antonio, TX

C. SUMMARY

On April 26, 2003, at 1005 central daylight time, a Sino-Swearingen SJ30-2, N138BF, was destroyed when it impacted terrain near Loma Alta, Texas. The certificated airline transport pilot was fatally injured. Visual meteorological conditions prevailed for the flight, which was operating on an instrument flight rules flight plan. The experimental test flight departed San Antonio International Airport (SAT), San Antonio, Texas, at 0911, and was being conducted under 14 CFR Part 91.

The systems group met at the accident site from April 28, 2003 to April 29, 2003, to document the airplane wreckage. As part of the investigation, the group met at the Sino Swearingen facility at San Antonio, Texas on April 27, 2003 for familiarization with an airplane similar to the accident airplane.

Relevant airplane systems were documented at the accident scene. Airplane components were recovered and identified by group members at the wreckage site. Several pieces of wreckage were removed from the accident site for further examination. The airplane parts and components removed from the wreckage and retained by the National Transportation Safety Board were identified as:

1. Speedbrake/Spoiler Actuator
   Part number: 40179-800-?R-14
2. Speedbrake/Spoiler Actuator
   Part number: 40179-1000-1
3. Gurney Flap, no part number
4. Pitch Trim Actuator, part number unreadable
5. Portion of crushed laptop computer, part number unreadable
6. Two unidentified components

Pieces from each of the primary and secondary flight control systems were identified. There was no evidence of in-flight breakup or loss of airplane structure prior to impact with the ground. No evidence of system malfunction prior to impact was found in the recovered wreckage.

D. DETAILS OF INVESTIGATION

Accident Airplane, N138BF

The airplane wreckage was located on a ranch near Loma Alta, Texas. The airplane was completely destroyed by ground impact and post-crash fire. The recovered wreckage displayed signs consistent with extremely high speed impact with the ground.

The impact area was searched for pieces of the airplane. The recovered airplane pieces were examined for identification and documentation. The pieces identified as part of a relevant airplane system were documented and considered for further investigation.

The accident airplane was documented according to the following categories:

1. Airframe

The airplane was destroyed by impact with the ground. Multiple pieces of unidentifiable airplane skin and internal structure were found in the wreckage. A piece of a clip used to tie stringers to fuselage frames in the center fuselage section, part number 30-22208-1, was identified in the wreckage.

A piece of the inboard edge of the wing to fuselage attachment was identified in the wreckage.

2. Air Conditioning

No portion of the air conditioning system was identified in the wreckage.

3. Auto Flight

An autopilot servo, part number 30-44114, was identified in the wreckage. No assessment of indication could be determined. No other portion of the auto flight system was identified in the wreckage.

4. Communications

The faceplate from a communication unit, a Honeywell RCZ-83 Comm Unit, serial number 00014825, part number 7510700-768, was recovered and identified in wreckage. The faceplate was crumpled and separated from the unit. The remainder of the unit was not identified in the wreckage.

No other portion of the communication system was identified in the wreckage.

5. Electrical Power

Two pieces of electrical shunts were identified in the wreckage. Several small segments of electrical cable were identified. No other portions of the electrical power system were found.

6. Equipment & Furnishings

A portion of cabin entry door gearing, used as part of the emergency egress system, was found in the wreckage. No assessment of door position was possible.

The emergency escape hatch external door handle was also found. No assessment of door position was possible.

Portions of the test pilot's parachute were identified in the wreckage.

Several pieces of cabin flooring were located in the wreckage.

7. Fire Protection

No portion of the fire protection system was identified in the wreckage.

8. Flight Controls

All primary flight controls are manually operated by a set of dual controls and actuated through push-pull rods and cables. The pilot and copilot control wheels, columns and rudder pedals are mechanically linked to operate in unison.

The primary flight control cables are 1/8-inch plated stainless steel and pulleys or bellcranks are used to change cable direction if more than 3° is required. Turnbuckles are used for cable rigging and adjustment, and the pulleys have guards to prevent cable misplacement. The last bellcrank or sector in each control system has mechanical stops attached to limit control surface travel.

Each of the primary flight control surfaces (e.g. ailerons, elevators, and rudder) is mass balanced.

Due to impact and fire damage to the airplane, the continuity of the primary flight control cables could not be accomplished.

Multiple pieces of unidentified flight control system push/pull rods were located in the wreckage. No attempt was made to determine the specific identification of the pieces.

Three pieces of flight control surface balance weights, part number 30-44?? ECP31, were identified in the wreckage.

8.1 - Pitch Control and Pitch Trim Systems

The elevator control system and a horizontal stabilizer provide pitch control of the airplane. The pilot and copilot control columns are mechanically linked through a torque shaft beneath the flight deck floor. Movements of the control columns translate into longitudinal movement of push-pull tubes beneath the cabin floor. A bellcrank located forward of the wing translates the motion into a control sector, which translates the motion into control cables. The control cables route through the fuselage to a series of bellcranks and push-pull tubes that provide the appropriate motion to the elevator control surface.

The elevators are located at the trailing edge of the horizontal stabilizer and extend the entire length of the horizontal surface from the vertical stabilizer. The elevator has an aerodynamic surface area of about 4 square feet and can travel between 24.1° trailing edge up (TEU) to 19° trailing edge down (TED).

Movement of the horizontal stabilizer provides pitch trim from 1.7° leading edge up to 14.3° leading edge down. Pitch trim switches are located on the pilot and copilot control wheels and on the aft pedestal. The trim switches drive primary and secondary electric motors, which in turn drives a dual screw jack electrical actuator.

The captain's and first officer's control columns were not identified in the airplane wreckage. No flight deck pitch trim control was identified in the wreckage.

Due to the damage of the airplane, no assessment of the elevator control cable continuity was possible.

The left and right elevators were identified in the wreckage. The wreckage included a partial part number 30-44114, which indicated the piece as a portion of the elevator flight control surface assembly. Both elevators were fractured and crushed by impact forces. No assessment of position of the elevators was possible.

The pitch trim actuator was identified in the wreckage. No part number was identifiable on the actuator. The attachment rod fittings were fractured and sheared. The actuator was almost fully extended, which indicates a nearly full nose up horizontal stabilizer position. Photographs of the pitch trim actuator are included in Attachment 1 as figures 1-1 and 1-2.

The horizontal torque tube assembly was identified in the wreckage. Segments of the left and right pitch trim arm attachments were attached to the torque tube. No part number could be determined. No assessment of horizontal stabilizer position was possible.

8.2 - Lateral Control and Lateral Trim Systems

Roll control is provided by an aileron control surface located on the outboard portion of the trailing edge of each wing. The pilot and copilot's control wheels are mechanically linked to the ailerons and to each other. The control wheel output is translated into longitudinal movement by a series of cables and a torque shaft to an aft cable sector located behind the center wing section. The sector converts the cable input into a series of push-pull tubes and bellcranks that provide motion to the aileron.

Each aileron has approximately 4 square feet of aerodynamic area and can travel between 16.5° TEU and 10.3° TED.

The flight crew selects aileron trim via a switch on each pilot's control wheel. The trim input drives a motor that sets aileron trim through a force bias spring system. The spring tension balances the aileron and relieves the necessity for control wheel pressure.

An "L-shape" gurney flap of approximately 10" long with ½" legs was identified and recovered from the wreckage. The airplane manufacturer indicated that a gurney flap was installed on the accident airplane's right wing to assist and balance aileron trim forces. The gurney flap was installed on the airplane the day prior to the accident. The gurney flap was attached to the underside of the right wing, near the trailing edge, outboard of the aileron. The flap was attached using rivets and aerodynamic tape.

The gurney flap was found at the wreckage site fully separated from the wing. It was bent about the longitudinal center of the flap. Aeronautical speed tape was found on the flap, but no rivets were noted. Photographs of the gurney flap, as found, are included in Attachment 1 as figures 1-3 and 1-4.

The captain's and first officer's control wheels were not located in the airplane wreckage. No flight deck aileron trim input was identified in the wreckage. Due to the damage to the airplane, no assessment of the continuity of the aileron control cables from the flight deck inputs to the ailerons was possible.

Fractured and crushed pieces of the left and right ailerons were identified in the wreckage.

Several pieces of aileron torque tubes and/or push/pull tubes were identified in the wreckage. The pieces are noted as follows:

1. Aileron push/pull rod with attachments, part number 30-70021-12(?).
2. Aileron push/pull rod with attachment, part number 30-70021-72(?)
3. Aileron push/pull rod with sheared ends, part number 30-70021
4. Aileron push/pull rod with sheared ends, part number 30-70021-127
5. Aileron push/pull rod, crushed, part number 30-70021-18

A photograph of several selected aileron push/pull rods is included in Attachment 1 as figure 1-5.

Included in the recovered aileron push/pull rods were two "dog-bone" linkages. The airplane has two dog-bone linkages, one in each wing. The linkage is bent in the center of the linkage for clearance inside the wing. One recovered dog-bone linkage's part number was discernable, 30-71017-5, and was bent in the middle of the linkage. The other rod did not have a discernable part number, but had one attachment with castellated nut and cotter pin. A photograph of the recovered dog bone linkages is included in Attachment 1 as figure 1-6.

A piece of the aileron trim spring assembly was found in the wreckage. No assessment of actuation was possible.

8.3 - Rudder Control and Rudder Trim Systems

Airplane yaw control is provided by the airplane's vertical stabilizer and rudder control surface system. A separate ventral rudder system is incorporated into the airplane's directional control system, but is not connected in any way to the rudder on the vertical stabilizer.

The pilot and copilot's rudder pedals are mechanically linked to operate in unison. The pedals are attached to a torque shaft that translates motion to a system of push-pull tubes under the cabin floor. A bellcrank located forward of the wing translates the motion of the push-pull tubes to a control sector and control cables. The control cables connect to a control sector in the aft fuselage. The control sector is mounted to a torque tube at the rudder. The rudder has an aerodynamic area of about 7.4 square feet and can travel 27.5° trailing edge left and right.

Rudder trim is input via a rotary switch mounted aft of the engine throttles on the center pedestal. The switch activates an electric motor that moves dual screw jacks and a rudder trim tab located on the lower aft portion of the rudder's trailing edge.

The airplane's ventral fin incorporates a ventral rudder. The ventral rudder has an aerodynamic surface area of 1.7 square feet and can travel 30° trailing edge left and right. The ventral rudder is controlled by the autopilot and does not provide feedback into the flight control system. The ventral rudder is used to augment yaw control in cases of sensed uncommanded yaw. The airplane manufacturer indicated that, for the accident flight, the ventral rudder system was deactivated.

A portion of a rudder pedal was identified in the wreckage. No other portion of the flight deck rudder input system was identified in the wreckage. No components of the flight deck rudder trim input system were located in the wreckage.

Pieces of the rudder control surface were located in the wreckage. The rudder surface pieces were crushed and fractured. The rudder trim attachment was also located in the wreckage. No assessment of rudder control surface or rudder trim position was possible.

The ventral rudder torque tube and attach fitting were located in the wreckage. The composite ventral fin control surface was broken off the fitting. The torque tube was fractured at the top of the fin.

8.4 - Trailing Edge Flaps

The airplane's trailing edge flaps are electro-mechanically driven via an electric motor and torque shafts. The flaps are actuated by a flap control lever on the center control pedestal, aft of the engine throttles, in the flight deck. The flight deck controls have preset positions relating to flap positions of 0°, 10°, 20°, and 31°. The airplane has one trailing edge flap on each wing. The flaps are mechanically linked via gearboxes and a universal crossover box and tube.

No flight deck trailing edge flap control components were recovered. No assessment of the position of the flap selector was possible.

Several pieces of each trailing edge flap surface were identified in the wreckage. Two fractured flap roller carriages were identified in the wreckage. One was an assembly identified as part number 30-32131-5. A portion of a flap drive fitting, part number 30-32220-4, and a flap drive attachment, part number 30-32221-8, were identified in the wreckage. A portion of a flap drive torque tube was identified in the wreckage. No part number was indicated.

Several pieces of flap tracks were identified in the wreckage. One recovered piece with flap roller track did not indicate any trailing edge flap extension. Another piece was located with the track fairing fractured. Several pieces of the composite flap track fairings were found in the wreckage; one piece was marked as "right center" flap track fairing.

8.5 - Leading Edge Slats

The airplane's leading edge slat is a single piece unit located along the leading edge of each wing. Each slat rides on four tracks and rollers attached to the leading edge of the wing. The slats have two positions – fully retracted (zero activation) and fully extended to 25°, and are activated via the flap control lever. Any selection of trailing edge flaps beyond the zero/retracted position actuates the slats. The slats are actuated via 2 hydraulic actuators per wing and the system includes a solenoid valve interconnect to coordinate slat activation.

No flight deck input components of the leading edge slats (the flap lever) were identified in the wreckage.

Several pieces of the leading edge slats were identified in the wreckage. Three slat tracks were located in the wreckage. Another slat track was identified with slat structure attached to the track. Another leading edge portion of a slat was located, with the top butterfly roller and lower roller attached. A piece of the hydraulic flow regulator for slat extension was also located in the wreckage. No indication of part numbers was noted and no assessment of slat position indication was possible.

8.6 - Speedbrakes

The airplane has one speed brake on each wing, forward of the trailing flap. The speed brakes are hydraulically activated and can rotate upwards to a maximum of 35° TEU. The manufacturer indicated that for the flight test the speed brake actuators were outfitted with an internal sleeve stop that limited speed brake travel to about 20°. A switch lever located on the control pedestal in the flight deck controls the speed brakes. The switch is configured to provide extend and retract positions and the pilot can select the amount of speed brake extension or retraction by the length of time of switch activation.

Several pieces of speedbrake surface panels were identified in the wreckage. A speedbrake hinge was also identified in the wreckage. No part numbers were identified on the speedbrake pieces.

Two speedbrake actuators were identified in the wreckage. The indicated part numbers were 40179-800-?R-14 and 40179-1000-1. For each actuator, both actuator rods were noted as retracted.

9. Fuel

Pieces of three fuel jet pumps were identified in the wreckage. The portions of the pumps did not include part numbers. Several under wing fuel access panels, part number 30-38322-17, were identified in the wreckage. Pieces of unidentifiable wing fuel tanks were found in the wreckage.

10. Hydraulic Power

A hydraulic accumulator/reservoir was identified in the wreckage. No determination of part number could be made.

Two unidentified hydraulic valves were identified in the wreckage. No determination of part number could be determined.

11. Ice & Rain Protection

No portion of the ice and rain protection system was identified in the wreckage.

12. Indicating/Recording Systems

No identifiable portions of the instrument panels were recovered from the wreckage.

One loose, unidentified gauge was found in the wreckage. The gauge was broken and crushed; no assessment of indication was possible.

Three portions of avionics equipment were identified in the wreckage. Two pieces were black avionics boxes with faceplates missing. Both boxes were crushed beyond recognition. The third piece was an unidentified avionics box rear plate, painted black with "Video Product" painted on the plate.

A housing or shelf for avionics equipment was identified in the wreckage. The piece was identified as part number MT604SS-0011A.

The airplane was equipped with on-board flight test instrumentation used for measuring, recording and telemetering aircraft performance data for the flight test program. The equipment was mounted on two racks located in the aft main cabin, at approximately fuselage station (FS) 292 and 320. The test equipment included two data acquisition computers, one flight test equipment computer, a Hi-8 mm videocassette recorder, and associated power supplies and integrated wiring. The airplane was equipped with a Honeywell data acquisition unit, installed in the aft equipment center

Portions of the two data acquisition computers were identified and recovered from the wreckage. The computers were retained for further examination. The videocassette recorder was not identified in the wreckage. Pieces of the test instrumentation stand and racks were identified in the wreckage. Pieces of ballast weight steel plates were identified in the wreckage. The data acquisition unit was not located in the airplane wreckage.

Pieces of the flight test trailing cone assembly and attachment tubing were located in the wreckage.

The airplane was not equipped with a flight data recorder (FDR) or cockpit voice recorder (CVR).

13. Landing Gear

Pieces of composite gear doors were identified in the wreckage. The pieces were crushed and broken, and several were damaged by fire.

Pieces of the nose gear structure were located in the wreckage. No part numbers were identified. The nose gear steering actuator was identified in the wreckage. No part number or actuator position assessment could be determined.

Pieces of the main landing gear structure were found in the wreckage. The gear was broken; no part number was identified. An assessment of gear position was not possible.

A piece of the alternate gear extension valve was identified in the wreckage.

14. Lights

No portion of the airplane lighting system was identified in the wreckage.

15. Navigation

A piece of the automatic direction finder (ADF) antenna was identified in the wreckage. No other portion of the navigation system was identified in the wreckage.

16. Oxygen

A small segment of a flight crew oxygen hose was located in the wreckage. The oxygen indicator system overpressure relief disk was identified in the wreckage.

17. Pneumatic

No portion of the pneumatic system was identified in the wreckage.

18. Vacuum

No portion of the vacuum system was identified in the wreckage.

19. Water/Waste

The airplane was not equipped with a water or waste system.

20. Central Maintenance System

The airplane was not equipped with a central maintenance system.

21. Airborne Auxiliary Power

The airplane was not equipped with an auxiliary power system.

N138BF Sister Airplane, N30SJ

The group met at the Sino Swearingen facility in San Antonio, Texas on April 27, 2003 to examine an additional Sino Swearingen SJ30-2, serial number 003, N30SJ. The group examined the airplane for familiarity of the flight control systems, flight deck instrumentation, and general airplane layout.

Thomas R. Jacky
Aerospace Engineer

ATTACHMENT 1

Photographs of Aircraft Wreckage


Figure 1-1: Pitch Trim Actuator


Figure 1-2: Pitch Trim Actuator

Figure 1-3: Gurney Flap

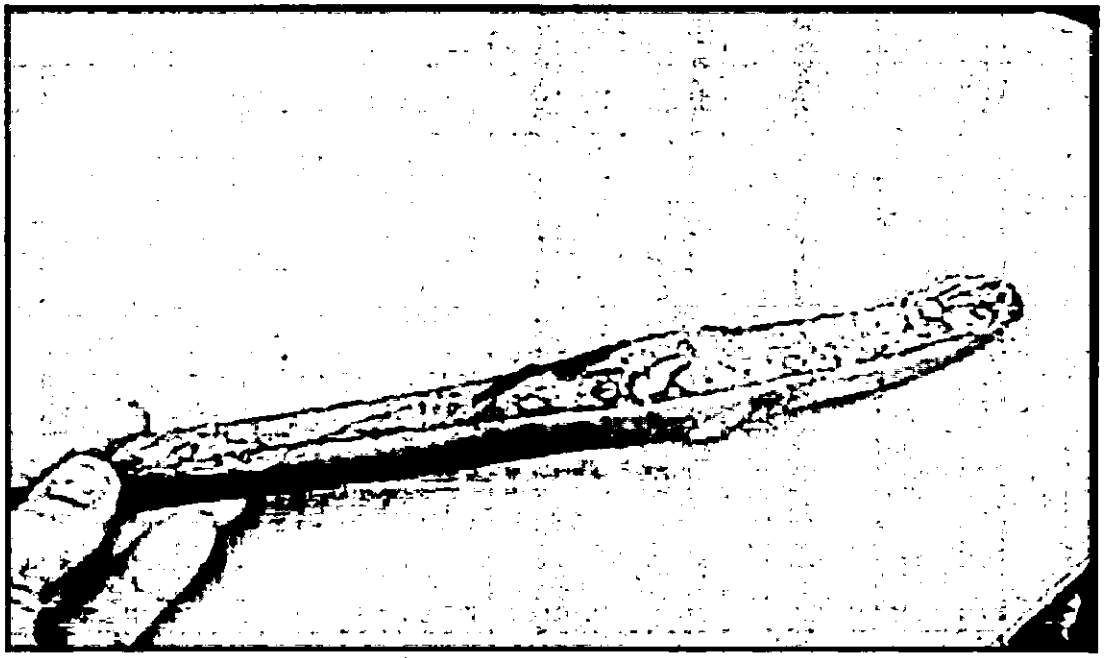


Figure 1-4: Gurney Flap

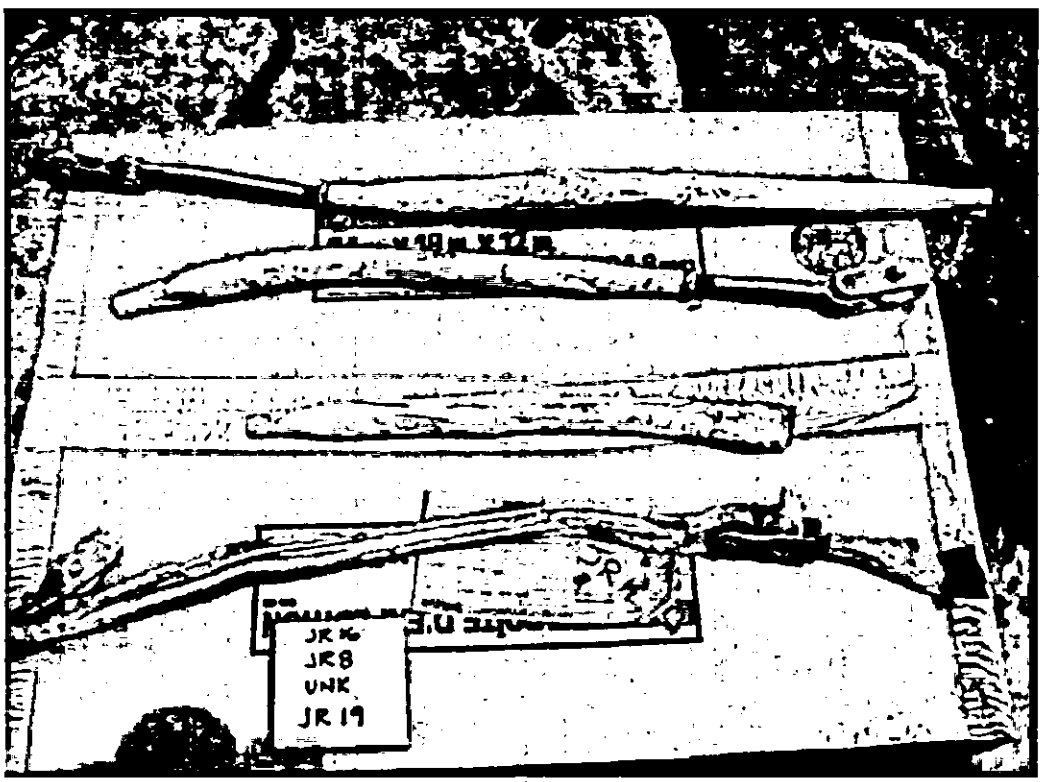


Figure 1-5: Various Recovered Aileron Control Push-Pull Rods

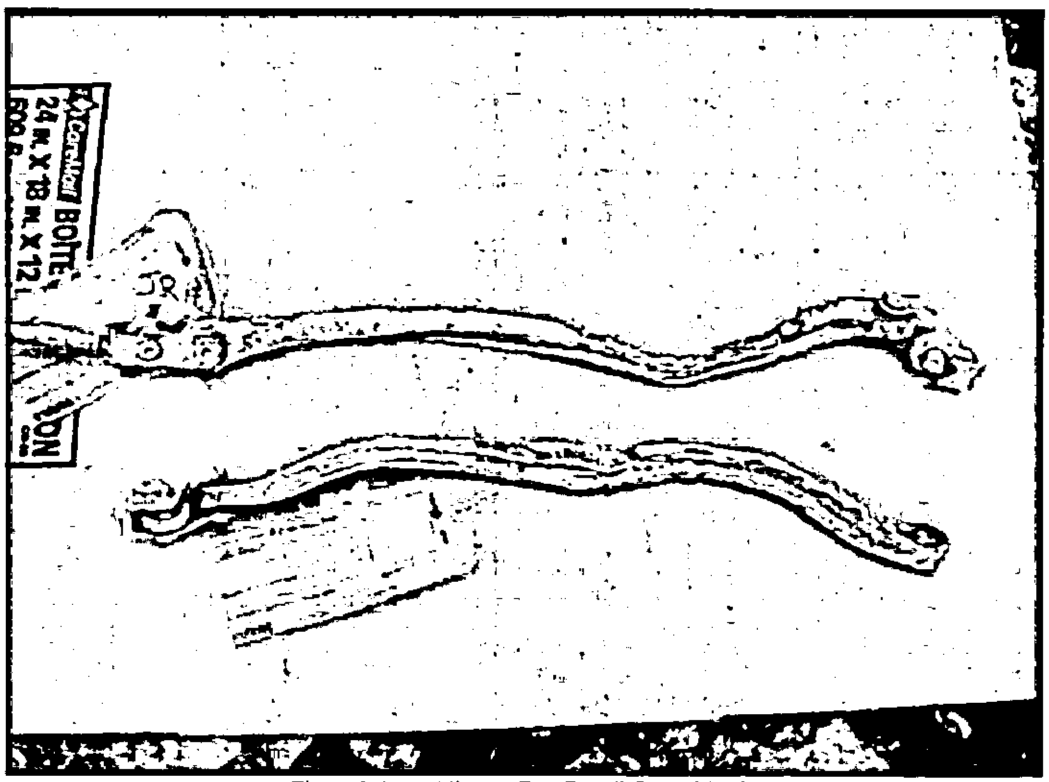


Figure 1-6:   Aileron "Dog Bone" Control Rods

NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594
September 8, 2003

STRUCTURES GROUP CHAIRMANS FACTUAL REPORT

IAD03MA049

A. ACCIDENT

Location:	Approximately 35 miles north of Del Rio, Texas
Date:	April 26, 2003
Time:	Approximately 1000 local time (CDT)
Aircraft:	Sino-Swearingen SJ30-2, N138BF

B. STRUCTURES GROUP

Chairman:	Brian Murphy National Transportation Safety Board Office of Aviation Safety (AS-40) Washington, DC
Member:	Robert Romero Federal Aviation Administration (FAA) Fort Worth, TX
Member:	John Vieger Sino Swearingen Aircraft Company San Antonio, TX
Member:	Jim Henderson Sino Swearingen Aircraft Company San Antonio, TX

C. SUMMARY

On April 26, 2003, at 1004 central daylight time, a Sino Swearingen SJ30-2, N138BF, crashed during an experimental test flight. The airplane wreckage was located in a remote area 35 miles north of Del Rio, Texas. The airplane diverted from controlled flight while at approximately 32,000 feet altitude and was subsequently destroyed by impact and post-crash fire. The sole occupant of the airplane, the pilot, was killed.

The structures group met at the accident site from April 28, 2003 to April 29, 2003, to document the airplane wreckage. As part of the investigation, the group met at the Sino Swearingen facility at San Antonio, Texas on April 27, 2003 to inspect the accident airplane's sister ship.

The group documented the wreckage distribution while at the scene. The group recovered and identified relevant airplane structural components for possible further investigation. The components were identified, tagged, photographed and left at the accident site for later recovery. The group also examined and documented the airplane's relevant structural items.

The group was able to identify portions of the fuselage, wings, empennage and all control surfaces in the debris field. There was no evidence of in-flight breakup, loss of airplane structure or in-flight fire prior to impact.

D. DETAILS OF THE INVESTIGATION

1.0 Aircraft Description

N-number:	N138BF
Aircraft Serial Number:	002
Aircraft Manufacturer:	Sino-Swearingen
Model:	SJ30-2
Engine Manufacturer:	Williams International
Model:	FJ44-2A
Aircraft Year:	2000
Airworthiness Certificate:	Special
Approved Operations:	N/A
Aircraft Type:	Fixed Wing Multi-Engine
Engine Type:	Turbo fans
Aircraft Category:	Experimental R&D
Number of Engines:	2
Number Seats:	7 (3 @ time of accident for flight test configuration)
Max. Gross Weight:	13,500 lbs
Total Time:	313.6 hrs

2.0 Airworthiness

The airplane was completely destroyed by impact with the ground and post-crash fire. A large portion of the aircraft remained unidentifiable. It was not possible to identify the four corners of the aircraft. The entire aircraft fractured into small to medium size pieces[1] of debris upon impact. Portions of the fuselage, wing skins, engines, landing gear and, empennage structure were identified along with all of the control surface structure. However a determination of the pre-crash integrity and functionality could not be established due to the extent of the damage. In addition, no evidence of an in-flight fire or in-flight failure of the structural elements was noted and all of the fracture surfaces that were examined exhibited evidence of static overload.

3.0 Accident Site

The geographic coordinates of the accident were N 29 52.368 latitude and W 100.57.651 longitude at an elevation of 1741 feet on a plateau with ravines on three sides. The accident site was essentially barren with low level scrub brush and no trees. The impact resulted in a crater that measured 31 feet in length along a 265-085 degree heading. The crater measured 5 feet in width at east and west ends and 13 feet at the center and measured 2 feet in depth along the entire 31 feet of length. Additionally, there was no ground scaring present in the area of the crater from any direction. In addition, the earth's composition at the location of the impact crater was primarily solid rock. (see Attachment A Figure 8)

4.0 Wreckage Debris (see Attachment A pages 3 thru 12)

Wreckage was dispersed over an approximate thirteen-acre area around 360 degrees of the main impact site. An aerial search of the accident site did not reveal any aircraft parts outside of this area.

The debris area was divided into four quadrants about the crater midpoint using north-south and east-west lines, after which the relevant structural items were surveyed, and photographed. The wreckage was left at the accident site and will be recovered at a later date.

5.0 Fire Damage

A post crash examination revealed the presence of a post crash fire in the area of the impact crater and along a northerly[2] path from the impact crater. Pieces of structure in these areas were burned and/or charred. Soot was consistently found on the external surfaces of structure located in this area and no evidence or any patterns like those typically associated with a moving fire were identified. No bright scratch marks, scuffs and/or smears were noted in any soot patterns examined. No melted or splattered aluminum was observed on the structure in this area. Several normally adjacent sections of structure were found both

[1] Small approximately 6 in. by 6 in. up to 12 in. by 12 in., medium 12 in. by 12 in. up to 24 in. by 24 in. and large approximately 24 in. by 24 in. up to 48 in. by 48 in.

[2] Direction of the prevailing winds on the day of the accident as reported by the deputy who arrived first to the site.

with and without fire damage.

6.0 Structure

6.1 Fuselage

The fuselage structure was largely identifiable. Portions of the fuselage skins, frames and stringers were found throughout the debris field. The largest piece of fuselage structure recovered was a portion of the skin above the wing and measured approximately 2 feet by 2 feet. (see Attachment A Figure 9) Small pieces of the flight test equipment racks (orange in color) were identified throughout the debris field. Several large steel floorboards were identified at the main impact site along with several of the seven aft mounted ballast weights. A reconstruction of the fuselage was not possible due to the severity of the impact damage. (Reference wreckage diagram)

6.2 Doors

The main cabin door handle and a gear from the internal door mechanism were recovered at the accident site. (see Attachment A Figure 10) Additionally a portion of the emergency exit (overwing) door was identified along with main gear door hinges with attached door structure. The remainder of the main cabin door, emergency exit, baggage, nose and main landing gear doors were unidentifiable amongst the wreckage in the debris field.

6.3 Wings

Both left and right wings fractured into numerous pieces. The largest portions of the wing recovered were portions of the upper and lower wing skins. Both left and right skin panels were identified at the site. The largest of these measured approximately 2 feet by 2 feet. Portions of the movable leading (slat tracks) and trailing edge (flap tracks) structure were recovered at the accident the site. The only portions of the front and rear spars that were identified were those attached to the leading and trailing edge devices or the systems push/pull linkages for controlling the ailerons. No internal ribs were identified. A reconstruction of the wings was not possible due to the extent of the damage.

6.4 Empennage

Both the horizontal and vertical stabilizers fractured into numerous pieces on impact. The largest piece identified was the horizontal stabilizer torque tube and control arm structure. (see Attachment A Figure 11) Numerous small pieces of horizontal and vertical stabilizer main box structure (skins, ribs & spars) were identified in the northeast quadrant of the debris field. A reconstruction of the empennage was not possible due to the severity of the impact damage.

6.5 Control Surfaces

All of the movable control surfaces were located in the immediate debris field and identified at the accident site. The elevator and rudder structure were recovered in the northeast quadrant. Both the left and right flap (flap & flap tracks) and speed brake structure were located in the immediate vicinity of the main impact site along with the ventral rudder leading edge and torque tube. Both the right and left hand ailerons were located on the north side of the main impact site along with the right wing gurney flap. Slat tracks were identified at the main impact site however no slat structure was identified in the debris field. (see Attachment A Figures 12 thru 20)

6.6 Landing Gear

Portions of the main and nose landing gear were identified at the accident site. The gear structure was located in the immediate area and to the south of the main impact site. Tires, wheels and brake components were spread over the southern area of the debris field along with a large portion of the main gear. A small piece of the nose gear cylinder was recovered under a boulder in the impact crater.

6.7 Flight Control Continuity

Flight control continuity could not be confirmed due to the severity of the impact damage.

Brian K. Murphy
Aerospace Engineer

NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

STRUCTURES GROUP CHAIRMANS FACTUAL REPORT

IAD03MA049

Attachment A
Figures & Photographs

3 View Diagram

SJ30-2

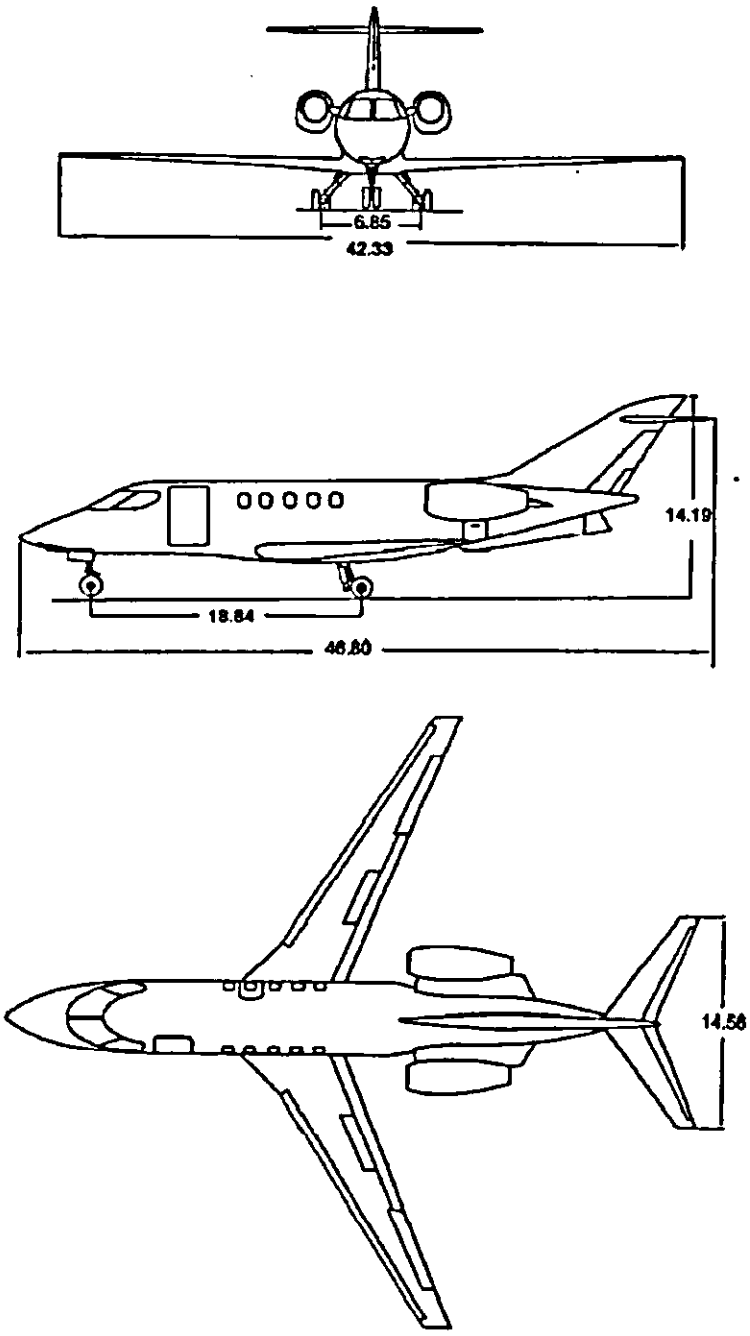
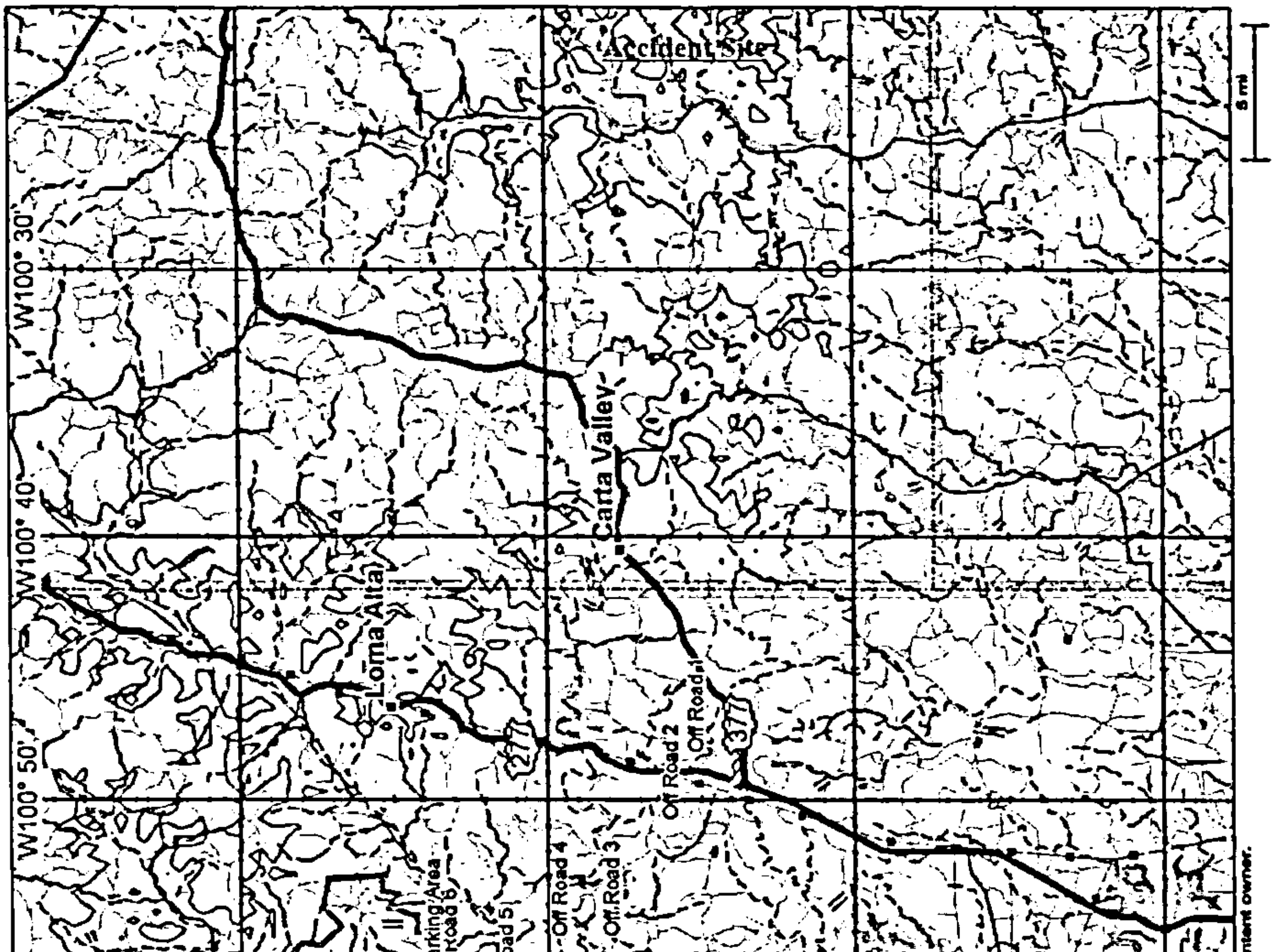


Figure 1


Accident Site
5 mi
Carta Valley
Loma Alta
Off Road 1
Off Road 2
Off Road 3
Off Road 4
Off Road 5
Parking Area
Off Road 6
Devils River
Comstock
277
377
163
406
90
W100° 30'
W100° 40'
W100° 50'
W101° 0'
W101° 10'
W101° 20'
N30° 0'
N29° 50'
N29° 40'
N29° 30'
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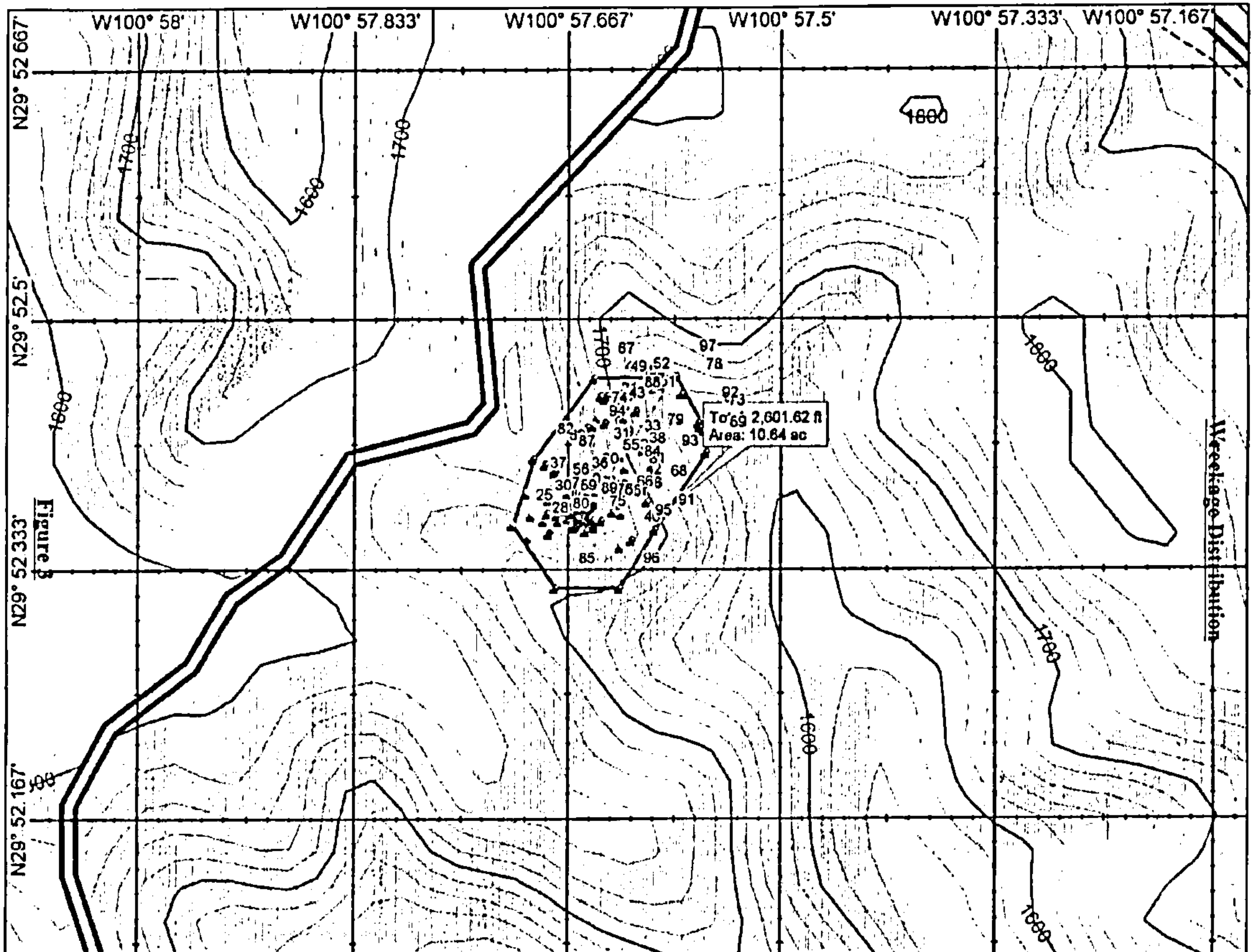
Scale: 1 : 400,000 Map Rotation: 0° Magnetic Declination: 7.4°E

Figure 2

Figure 3

Weekage Distribution



Scale: 1 : 6,400 Map Rotation: 0° Magnetic Declination: 7.4°E

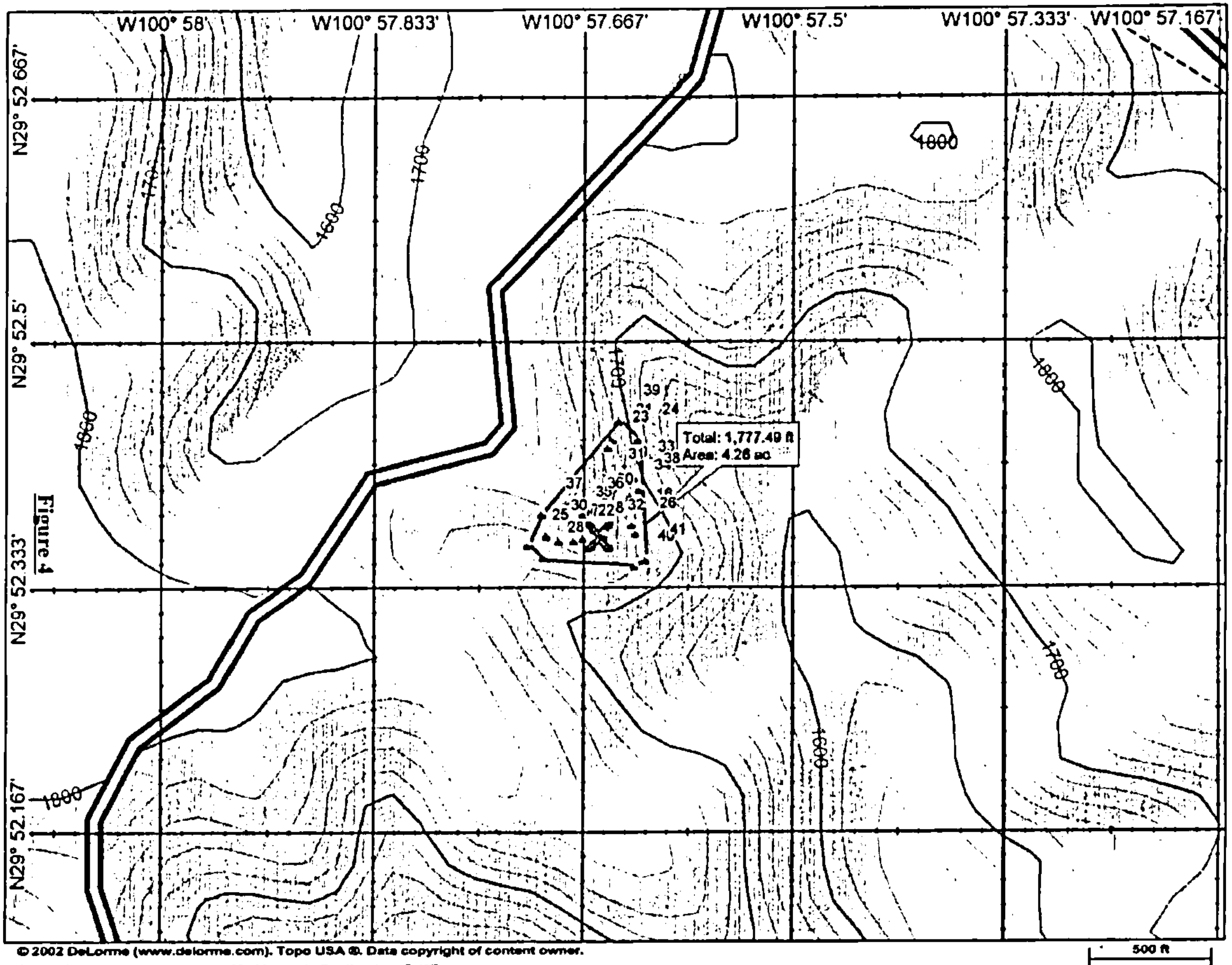
IAD035IA049

Control Surface Structure

Latitude	Longitude	Identifier	Structure Description
29.8728	-100.96092	X	Crater
29.87295	-100.96045	16	Aileron
29.87277	-100.96142	17	Aileron Bent Pushrod / Speed Brake
29.8728	-100.9611	18	Elevator 6'3" - Elevator Balance Weight
29.87342	-100.96078	19	Elevator
29.87312	-100.96097	20	Elevator
29.8739	-100.96072	21	Elevator / Rudder Trim Tab
29.87277	-100.96122	22	Elevator Control Horn
29.87382	-100.96077	23	LH Elevator
29.8739	-100.96037	24	RH Elevator
29.87272	-100.96183	25	Flap
29.87285	-100.9604	26	Flap
29.87295	-100.96118	27	Flap
29.87258	-100.96162	28	Flap - 2 Pieces
29.87227	-100.95982	29	Flap / RH, PN: 30-3221_-4
29.87283	-100.96158	30	Flap Fairing
29.8734	-100.96082	31	Horizontal Stab Torque Tube / Aileron
29.87283	-100.96083	32	LH Aileron and Flap
29.87348	-100.96042	33	LH Aileron - outboard
29.87327	-100.96047	34	RH Aileron
29.87298	-100.96125	35	Speed Brake Hinge
29.87307	-100.9611	36	Speed Brake Surface
29.87307	-100.96165	37	Speed Brake Surface
29.87335	-100.96035	38	Speed Brake and Emergency Cabin Door
29.87412	-100.96062	39	Rudder Trim Attachment
29.87248	-100.96042	40	Flight Control Section (Rudder)
29.87255	-100.96027	41	Ventral Rudder attach fitting

Table 1

Figure 4

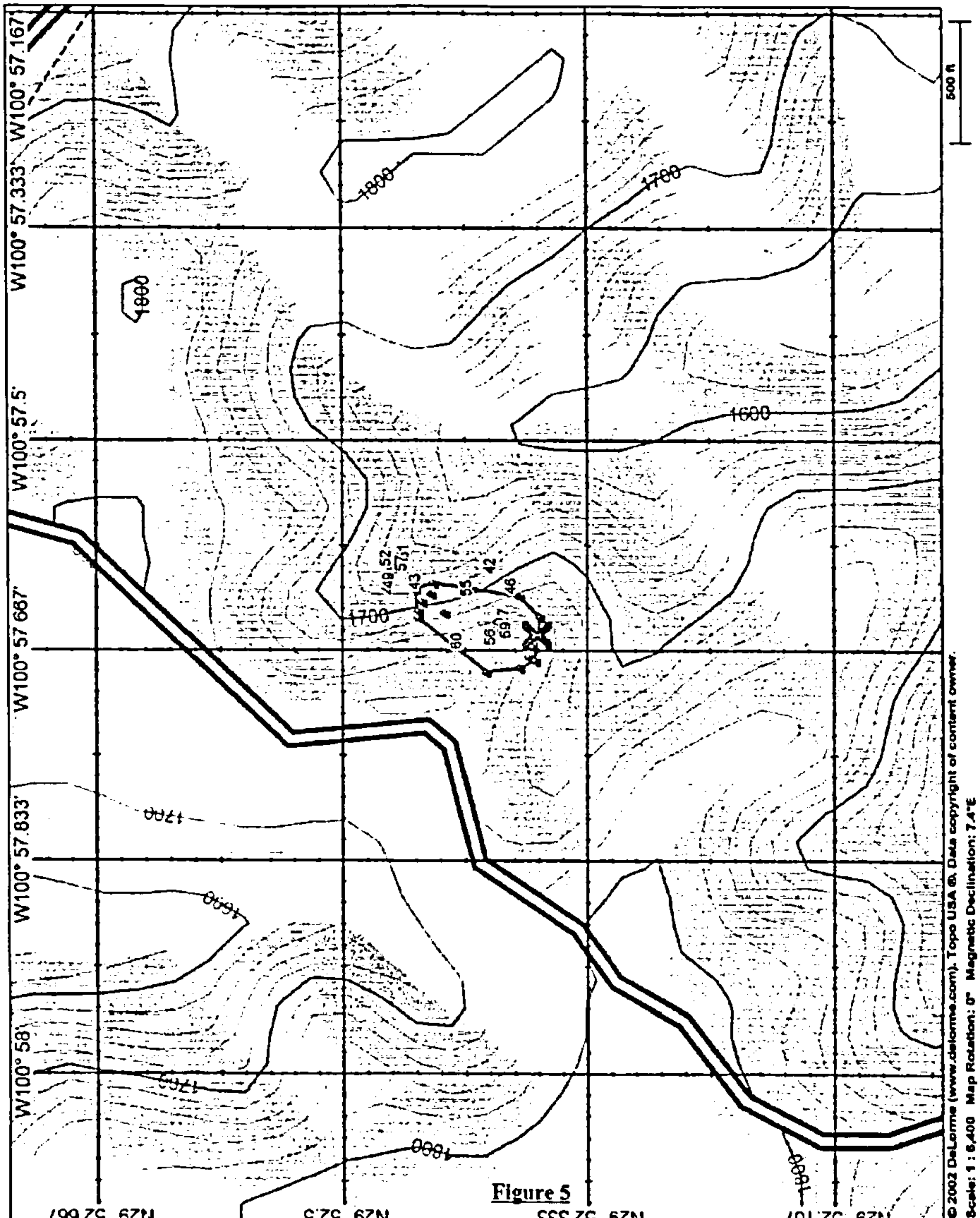


Scale: 1 : 6,400 Map Rotation: 0° Magnetic Declination: 7.4°E

Systems Components

Latitude	Longitude	Identifier	Structure Description
29.8728	-100.96092	X	Crater
29.873	-100.9604	42	Aileron Control Rods
29.87385	-100.96062	43	Avionics Tray
29.87415	-100.96068	44	Circuit Boards
29.8741	-100.96047	45	Computer Case w/components
29.87277	-100.96067	46	Control Pieces
29.87285	-100.96107	47	Control Rod - 30-70021-(127)
29.87317	-100.96123	48	Control Wheel (Aileron Cables), Control Pulley Lateral
29.87415	-100.9606	49	CPU Assembly
29.8729	-100.9612	50	Flight Control Bracket (30-70005-7)
29.87398	-100.96022	51	Hard Drive & Computer Case
29.87418	-100.9603	52	Low Speed Computer
29.87198	-100.9609	53	Lower Wing, Aileron Trim
29.87378	-100.9591	54	Motor, Flap Drive
29.87327	-100.9607	55	Pitch Trim Actuator
29.873	-100.96135	56	PN 30-70021-? / Control Rod
29.874	-100.96037	57	Signal Conditioner/ Vertical Stab
29.87283	-100.96125	58	Speed Brake Actuator
29.87283	-100.96125	59	Spoiler Actuator
29.87338	-100.9614	60	Trim Actuator / PN: 30-840549

Table 2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W100° 57.333'
W100° 57.5'
W100° 57.667'
W100° 57.833'
W100° 58'
N29° 52.667'
N29° 52.5'
N29° 52.333'
N29° 52.167'
1800
1700
1600
500 ft
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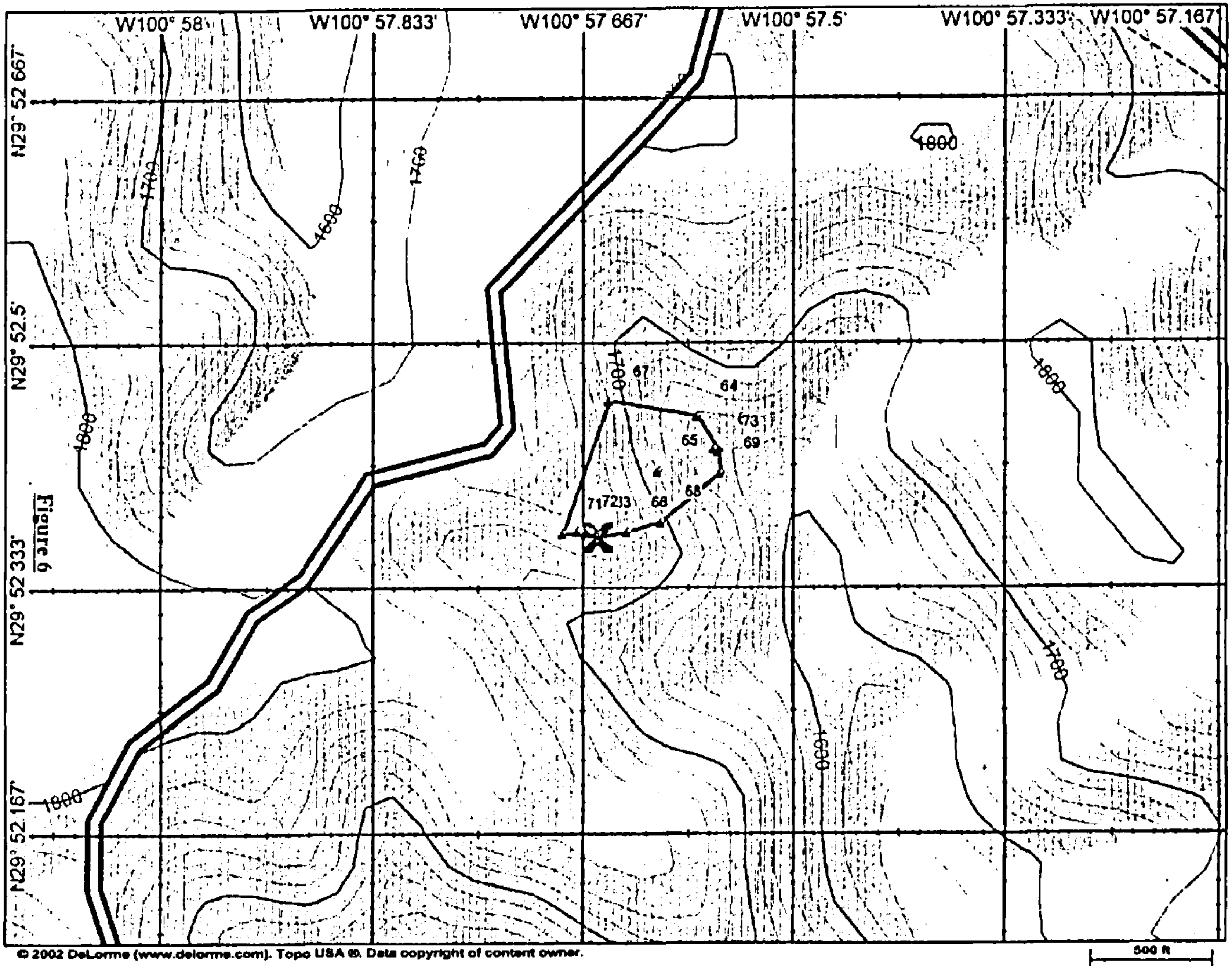
Scale: 1 : 6,400 Map Rotation: 0° Magnetic Declination: 7.4°E

Figure 5

Engine Structure

Latitude	Longitude	Identifier	Structure Description
29.8728	-100.96092	X	Crater
29.8738	-100.95938	61	2nd LP Turbine
29.87288	-100.96105	62	Aft engine mount
29.87287	-100.961	63	Combustor
29.87417	-100.9596	64	Diffuser & First LPT
29.87355	-100.9601167	65	Engine Part 1
29.87286667	-100.9605167	66	Engine Part 2
29.87435	-100.9607667	67	Engine Part 3
29.87298	-100.96007	68	Engine Igniter
29.87352	-100.9593	69	Engine Oil Cooler
29.87398	-100.95943	70	Fan Case, N1
29.87285	-100.96137	71	HP Turbine Module / Wing skin plank
29.87288	-100.96117	72	HP Turbine Nozzle Sub Assy.
29.87377	-100.95932	73	Rear Housing & 1st/2nd LP Nozzles

Table 3



Scale: 1 : 6,400 Map Rotation: 0° Magnetic Declination: 7.4°E

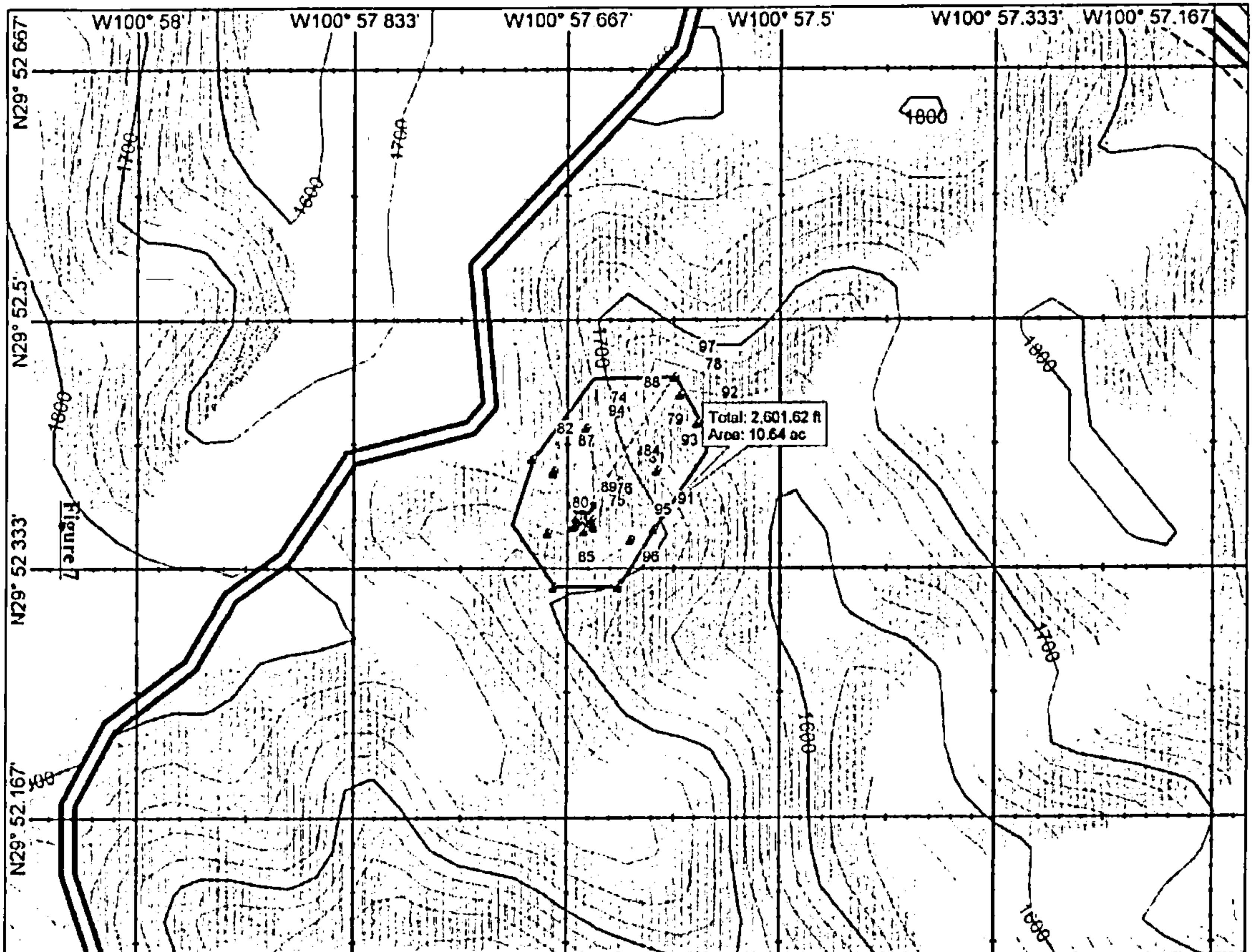
Figure 6

Other Identified Structure

Latitude	Longitude	Identifier	Structure Description
29.8728	-100.96092	X	Crater
29.8738	-100.96085	74	ADF Antenna Top Fuselage
29.87265	-100.96087	75	Ballast Plate (Co Pilot)
29.87278	-100.96078	76	Brake Disks
29.87243	-100.96187	77	Center Wing Butt Line 0, Lower Splice
29.87417	-100.95962	78	Egress Air Deflector
29.87355	-100.96012	79	Elevator Transfer Mech
29.87263	-100.96135	80	Fixed Trailing Edge
29.87312	-100.96035	81	Fuselage 2' x 2'
29.87345	-100.96155	82	Fuselage Skin
29.87382	-100.96053	83	Fuselage, Below Escape Panel
29.8732	-100.96042	84	Large Fuselage Skin
29.87202	-100.96127	85	Main Landing Gear Upper Trunion
29.8733	-100.96128	86	N Number from Nacelle
29.87332	-100.96128	87	Nacelle N-Number
29.87397	-100.96042	88	National INST SCXI Signal Cond.
29.8728	-100.96098	89	Piece of nose landing gear
29.87252	-100.96022	90	RH Lower Fuse Center Flap Track, A/C Compressor
29.87267	-100.95997	91	Section of Keel
29.87385	-100.9594	92	Skin Splice
29.87332	-100.95993	93	Structure w Rotating Transfer Mech
29.87365	-100.96088	94	Tail Cone Camera Access Panel
29.87255	-100.96027	95	Ventral Rudder attach fitting
29.87202	-100.96043	96	Wing Skin (Right Wing)
29.87437	-100.9597	97	Wing Plank-INBD

Table 4

Figure 7



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Main Impact Crater

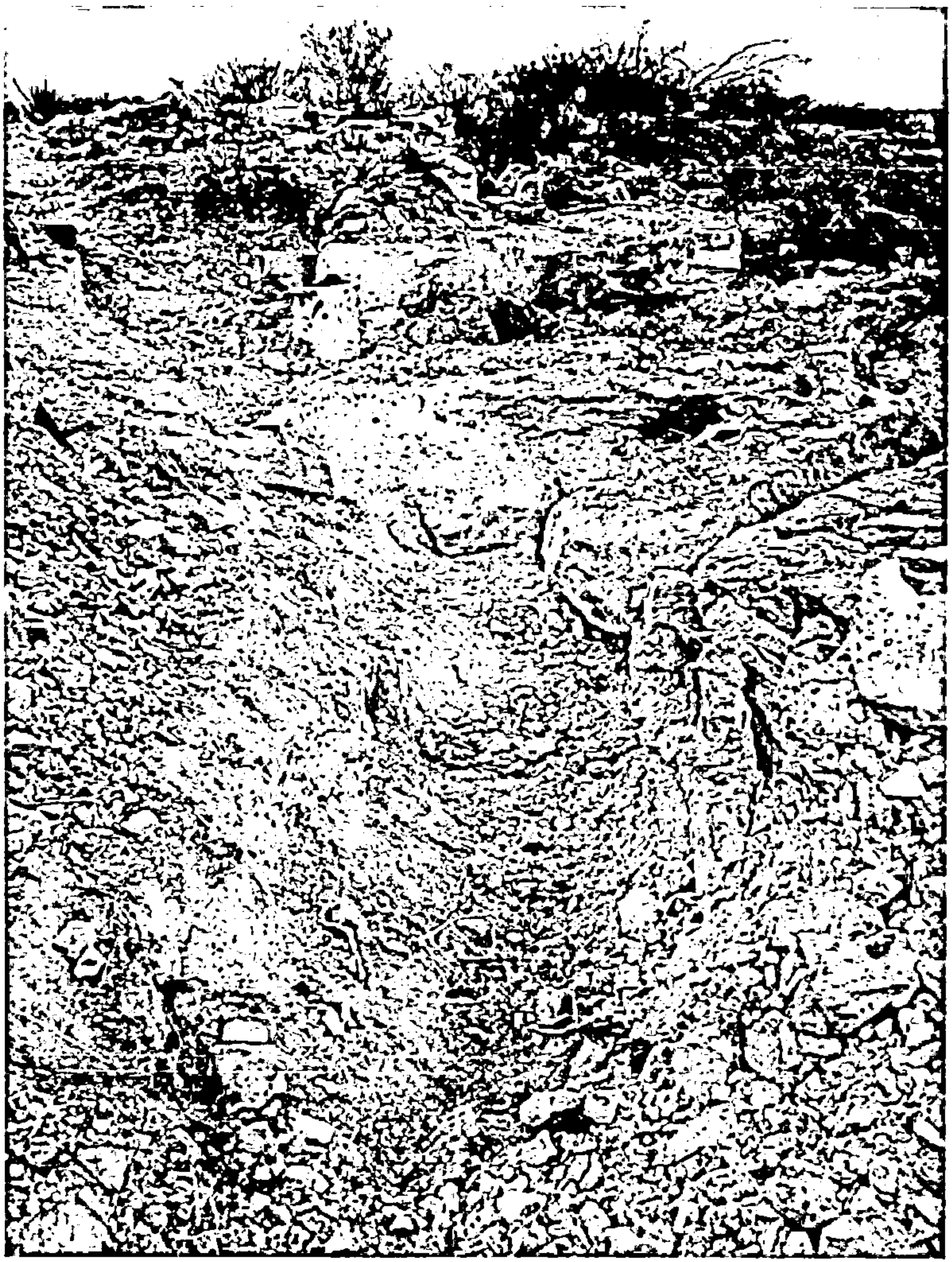


Figure 8

Fuselage Skin

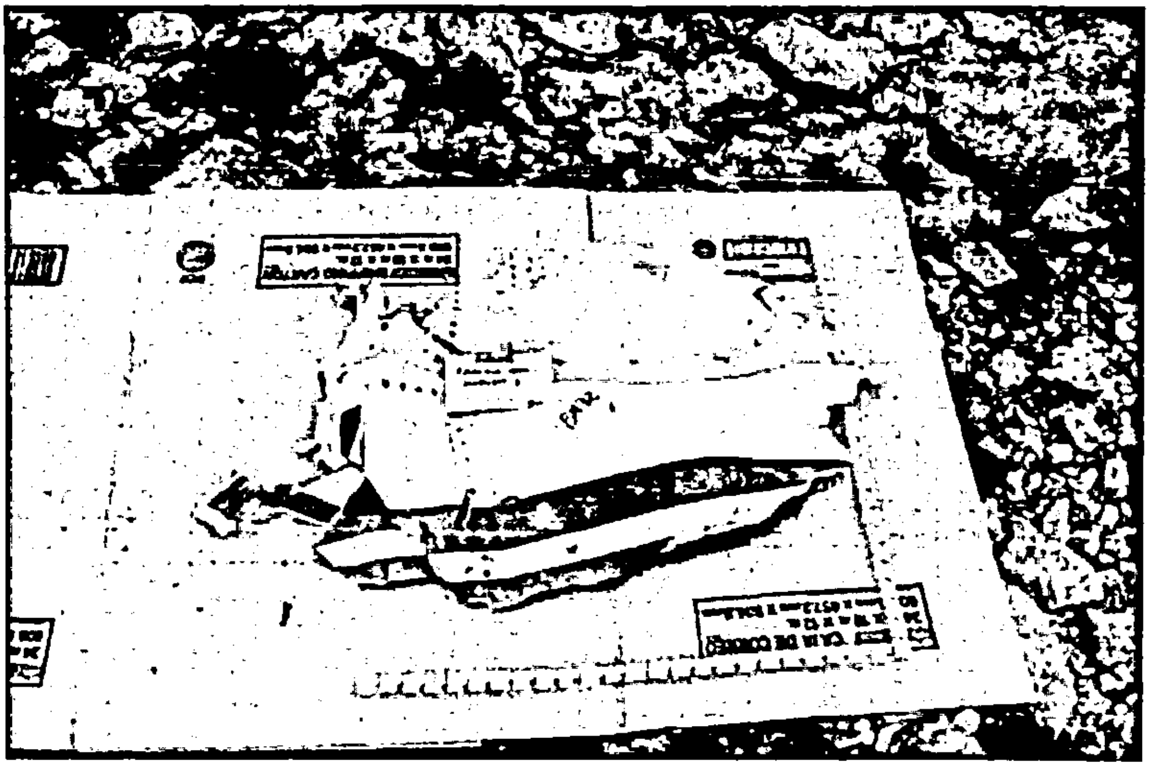


Figure 9

Door Handle

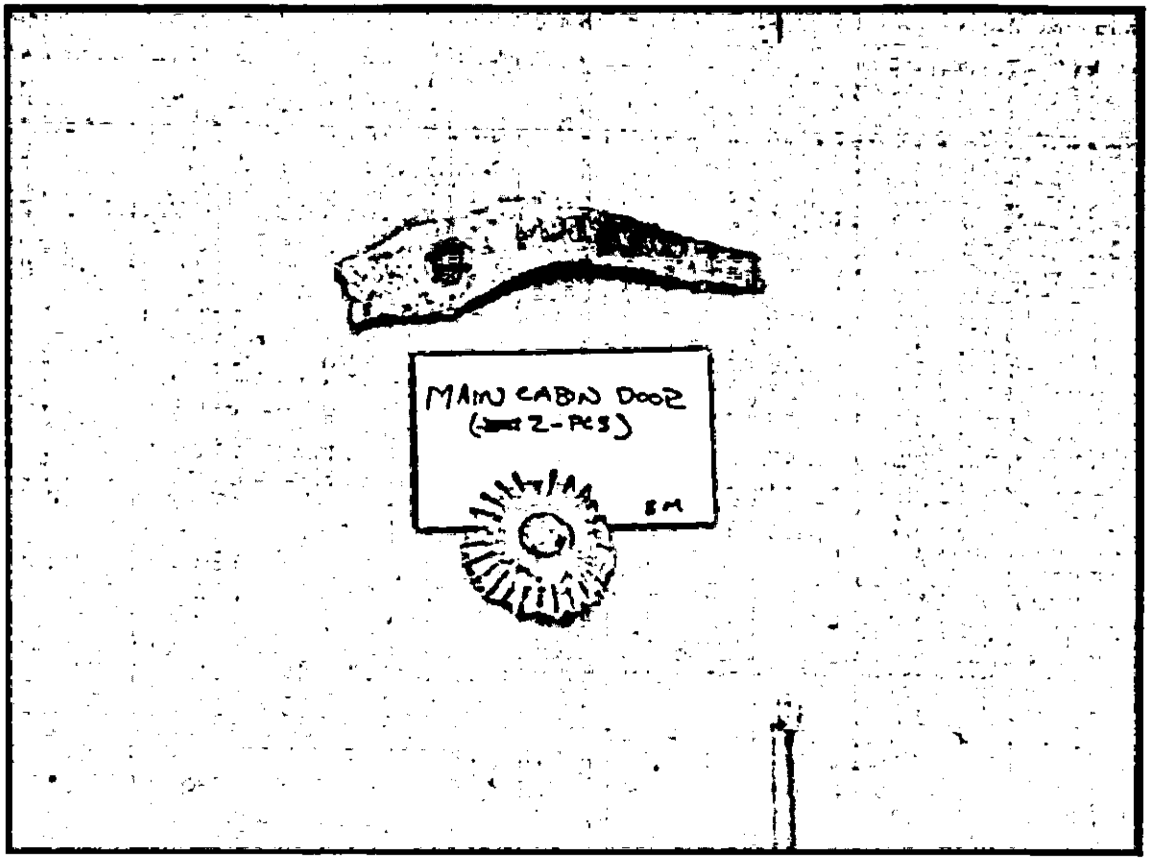


Figure 10

Horizontal Stabilizer Torque Tube

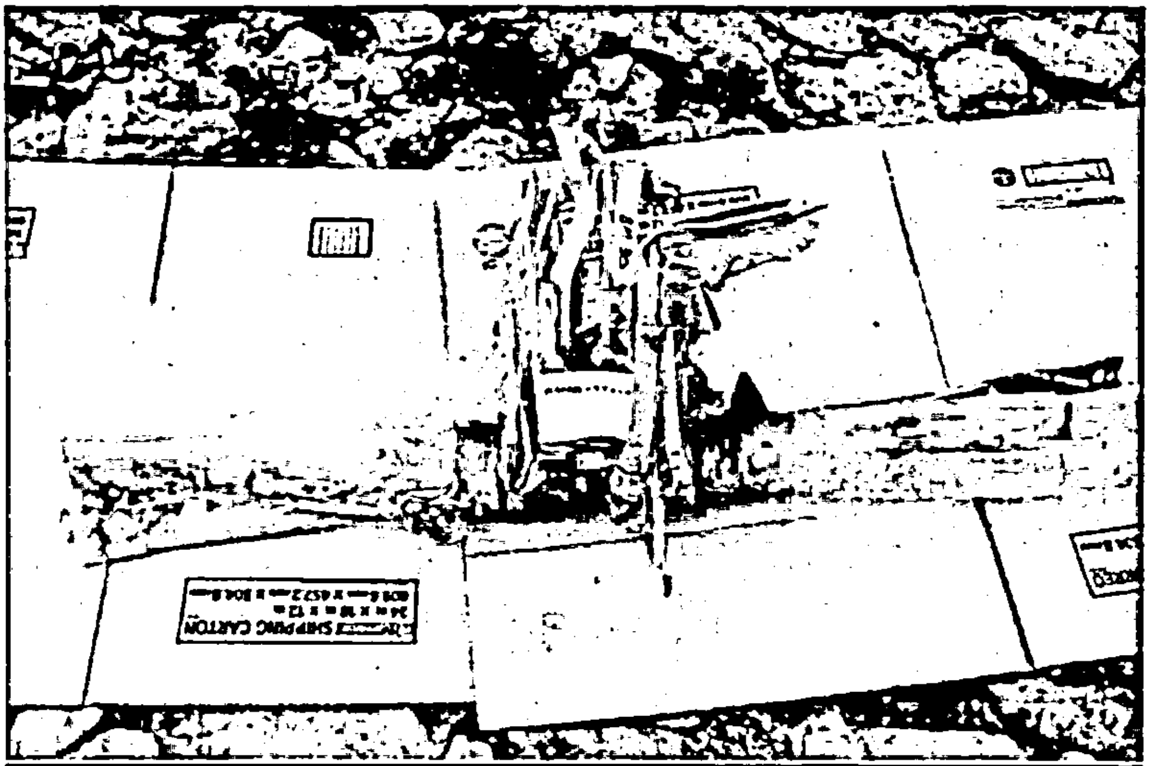


Figure 11

Left Hand Elevator

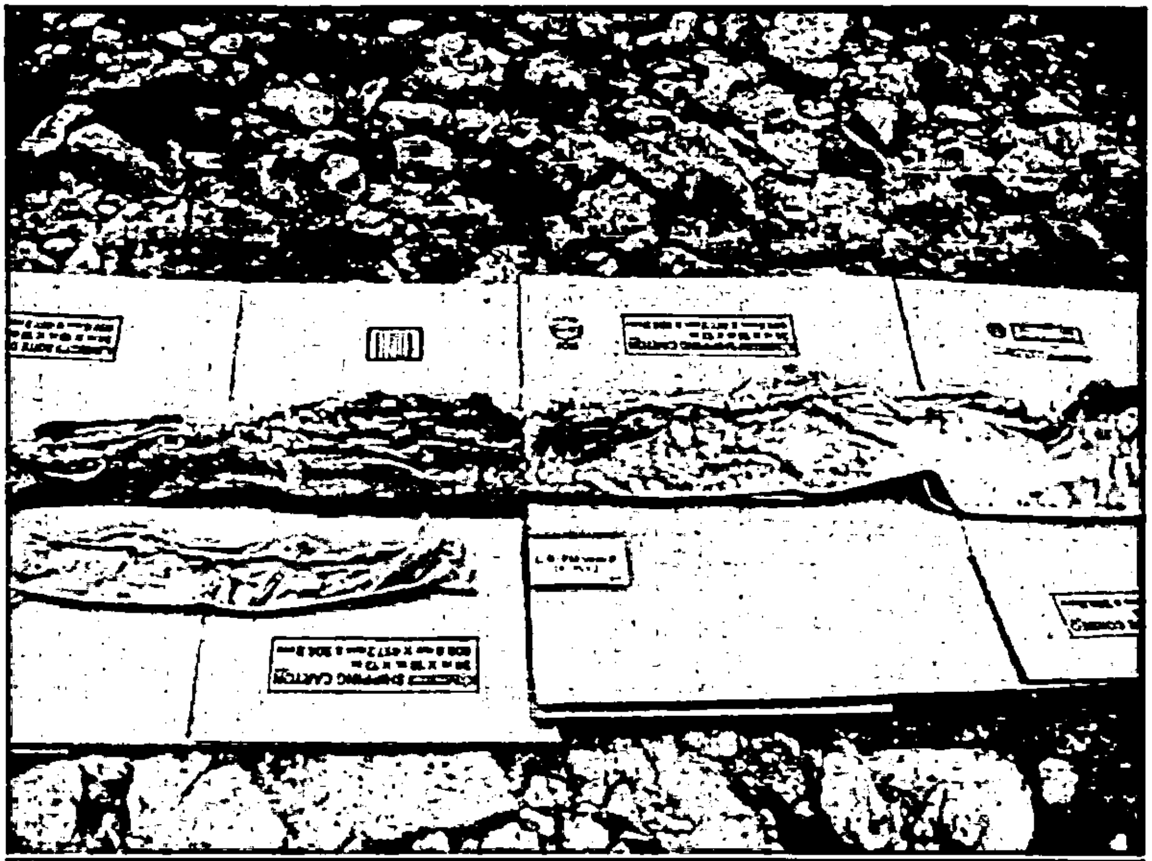


Figure 12

Right Hand Elevator

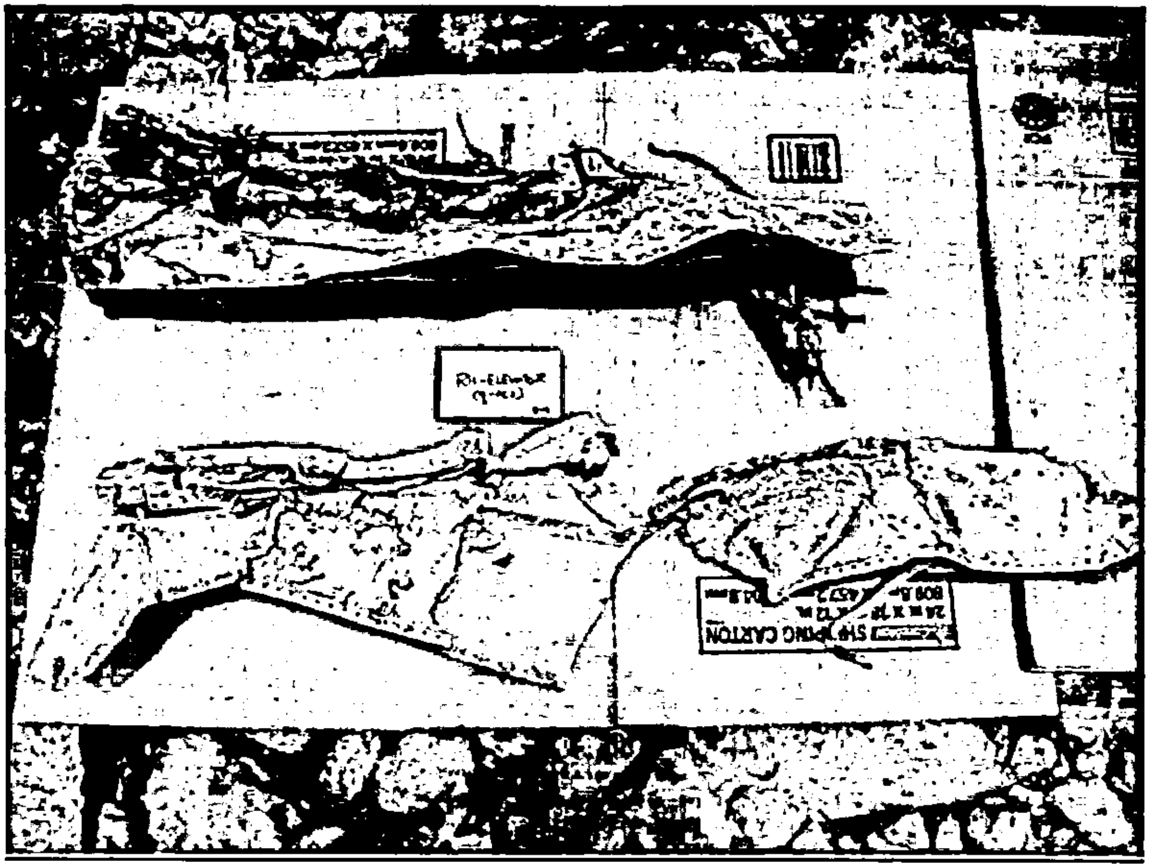


Figure 13

Left Hand Aileron

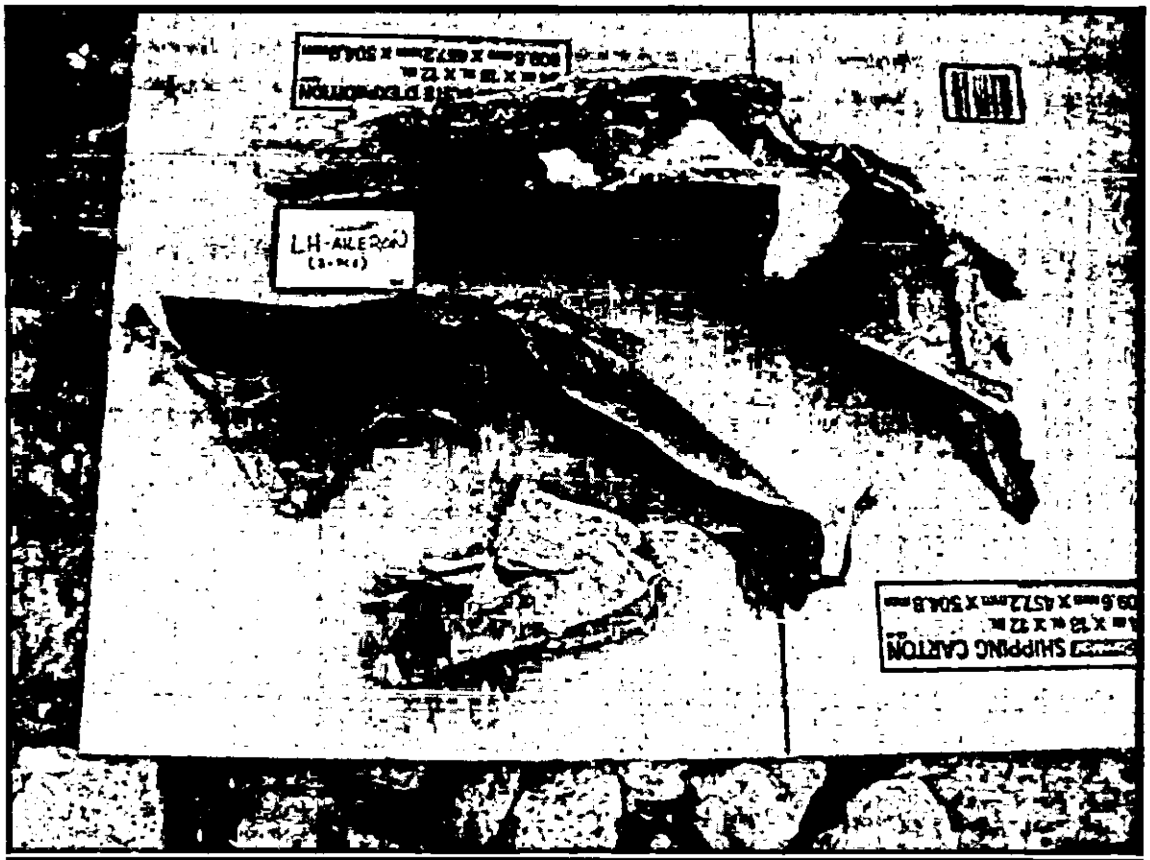


Figure 14

Right Hand Aileron

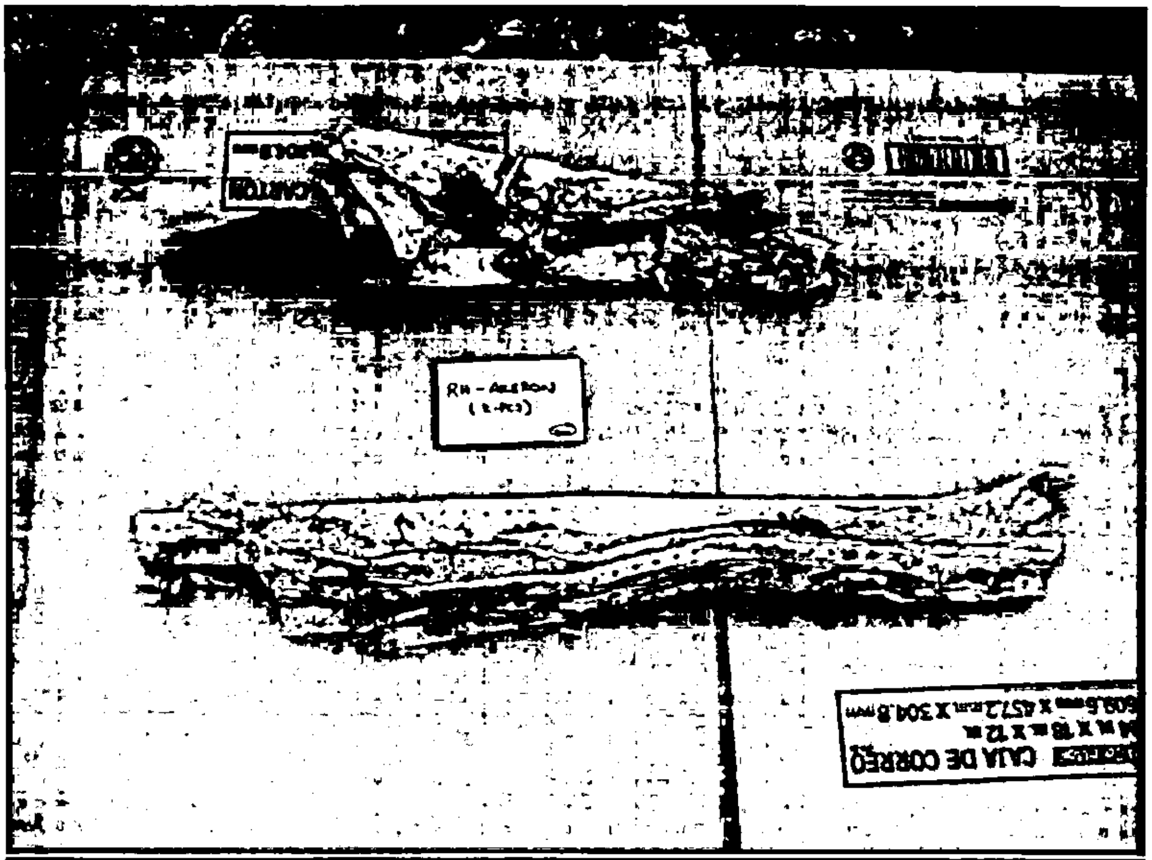


Figure 15

Ventral Rudder Torque Tube

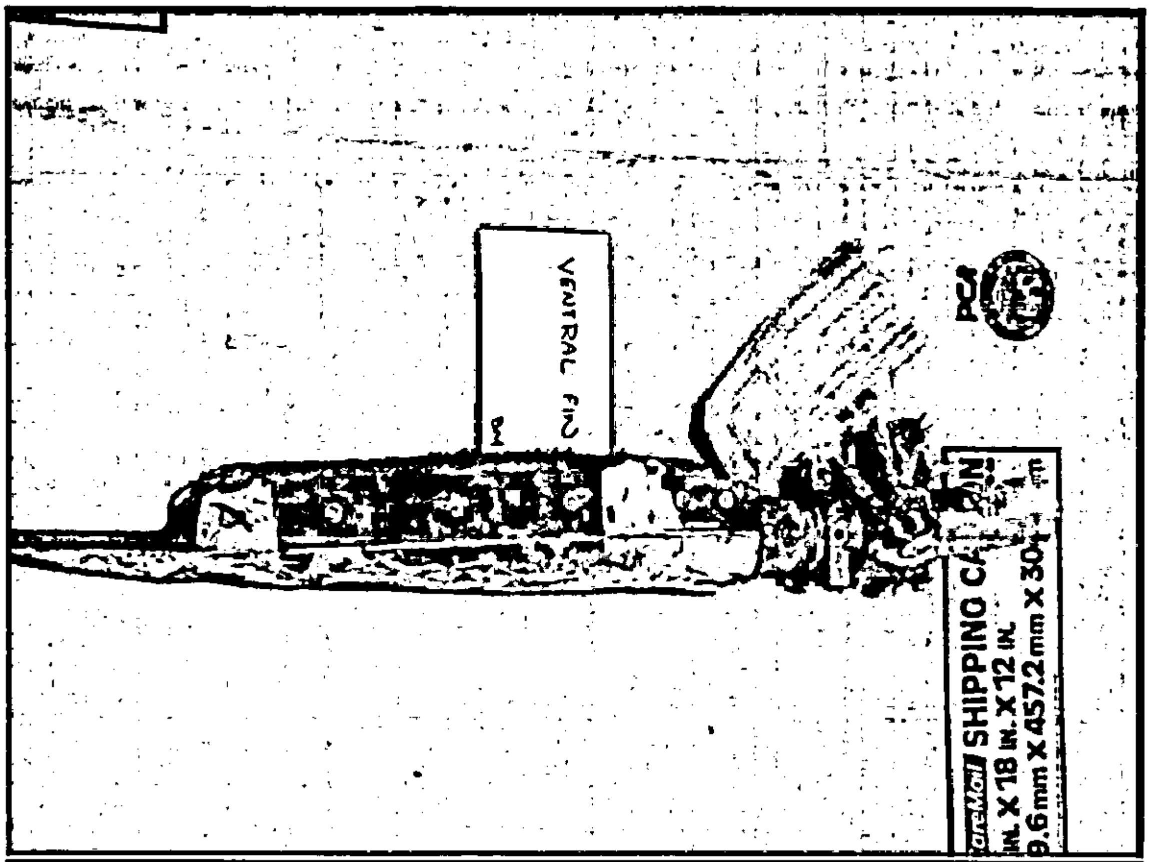


Figure 16

Rudder & Rudder Trim Tab

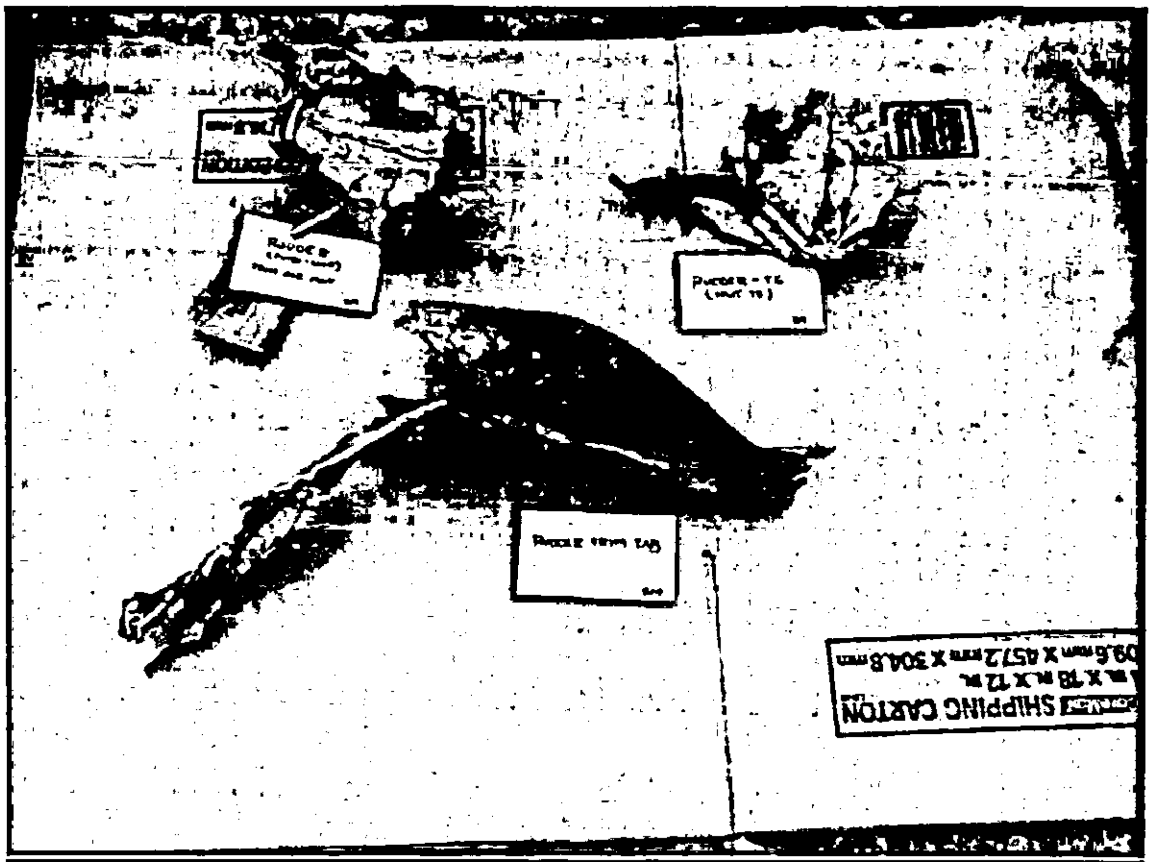


Figure 17

Flaps

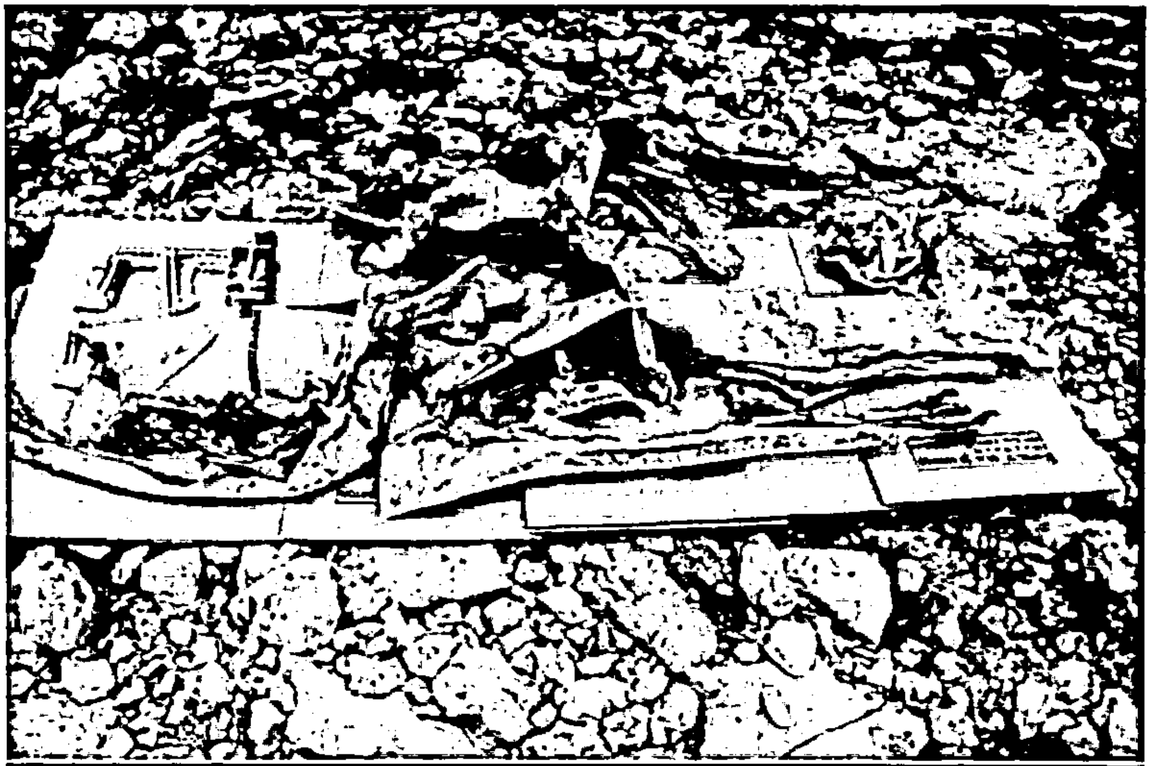


Figure 18

Gourney Flap

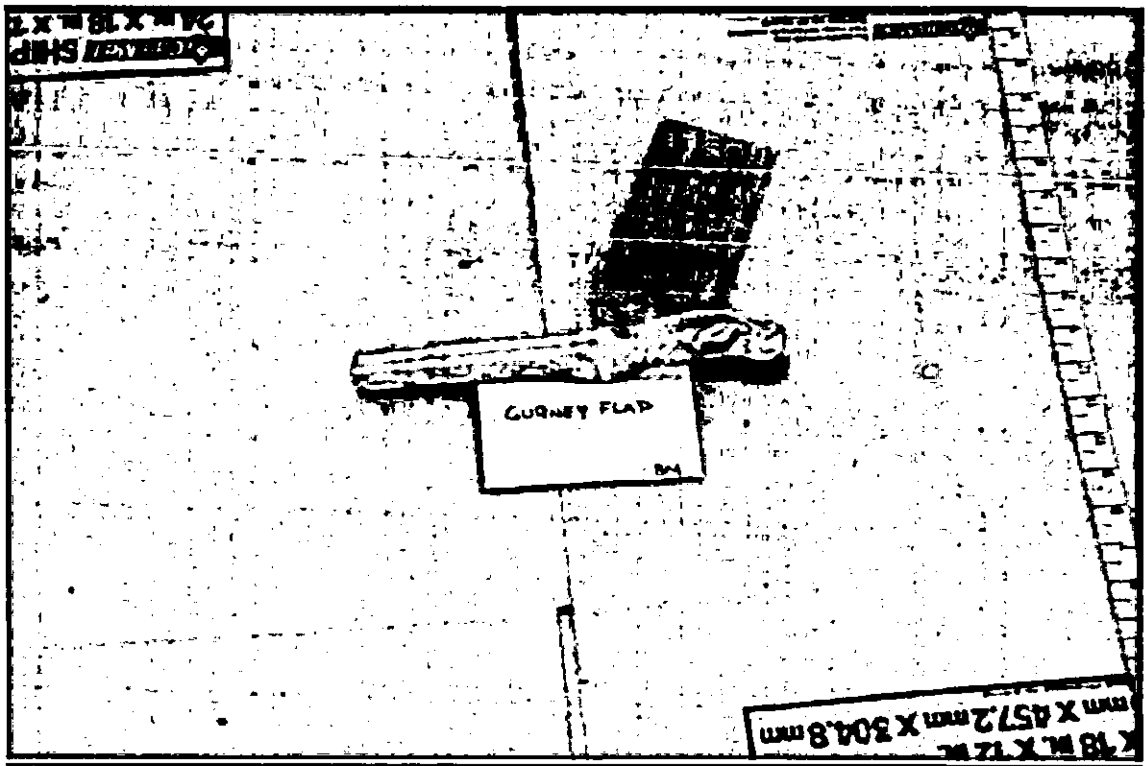


Figure 19

Speed Brakes

Figure 20

NATIONAL TRANSPORTATION SAFETY BOARD
South Central Regional Office
624 Six Flags Drive, Suite 150
Arlington, Texas 76011

Powerplants Field Notes:

ACCIDENT:

Aircraft: Sino Swearingen SJ30-2, N138BF
Location: Del Rio, Texas
Date: April 26, 2003

GROUP:

Group Chairman: Jason A. Ragogna
NTSB

Member: Rick Gorry
Federal Aviation Administration

Member: Chris Green
Williams Engines

ON-SCENE EXAMINATION:

Engine (serial # XXX) - Nearest to accident site.

Intake and Fan
One fan blade was found.

High Pressure Compressor
Not identified.

Diffuser Section
The diffuser displayed shadow marks, consistent with

the pattern on the combustor cover. A portion of the vein section was recovered and showed impact related damage.

Combustion Section

The combustor assembly was compressed and displayed impact damage. The HP turbine nozzle subassembly was identified; it was twisted and deformed. The fuel slinger and manifold were not identified. Remnants of the HP veins were identified. The balance piston exhibited rotational score marks.

Turbine Section

The HP turbine disk was identified. All of the blades were missing, except for 7 blades that were separated at the root. Approximately ½ of the curvic coupling gear teeth exhibited impact damage. Rotational scoring was evident on both sides of the HP disk.

The LP shaft fracture surface displayed a 45-degree sheer lip.

The #1 & #2 LP turbine disk/blade assemblies displayed impact damage. The #1 LP turbine blades were bent, fractured at various lengths, and some were missing. The #1 LP nozzle veins were missing. A portion of the housing (support structure) behind the #1 LP turbine housing blade displayed a section of rotational scoring. The rear housing (from exhaust section) was crushed over the #2 LP turbine and was not accessible, therefore no observations were made.

The LP trip leaver was not identified.

Exhaust Section

The exhaust nozzle (inner & outer skin) were identified. It displayed sooting and exhibited impact damage. The heat exchanger and bypass duct were not identified.

Accessory Section

The HMU, starter, fuel pump, & lubrication and scavenge pump were identified at the accident site.

Engine (serial # XXX) - Located in Ravine

Intake and Fan

Three fan blades were found. No other parts were identified.

High Pressure Compressor

The compressor was identified; however, all of the blades were missing. Rotational scoring was observed on the back face of the compressor.

Diffuser Section

A portion of the diffuser vein was identified. The fuel manifold was not identified.

Combustion Section

A section of the combustor cover was identified. A piece of the combustor primary plate was identified. The HP turbine nozzle assembly was not identified.

Turbine Section

The HP Turbine was not identified. The #1 LP turbine was not identified. The #2 LP turbine assembly was identified. The #2 LP turbine blades were bent opposite direction of rotation, and some of the blades were fractured at various lengths. Portions of the #1 and #2 turbine nozzles were identified; however, displayed impact damage. The LP trip lever was not identified.

Exhaust Section

The rear housing and mixer exhibited impact damage and were compressed. The heat exchanger and bypass duct were not identified.

Accessory Section

No accessories were identified.

<u>STATEMENT OF PARTY REPRESENTATIVES TO NTSB INVESTIGATION</u>

Aircraft Identification

Registration Number N138BF
Make and Model ST-30
Location ALTA LOMA, TX
Date 4-26-03

The undersigned hereby acknowledge that they are participating in the above-referenced aircraft accident or incident investigation (including any component tests and teardowns or simulator testing) on behalf of the party indicated adjacent to their name, for the purpose of providing technical assistance to the National Transportation Safety Board.

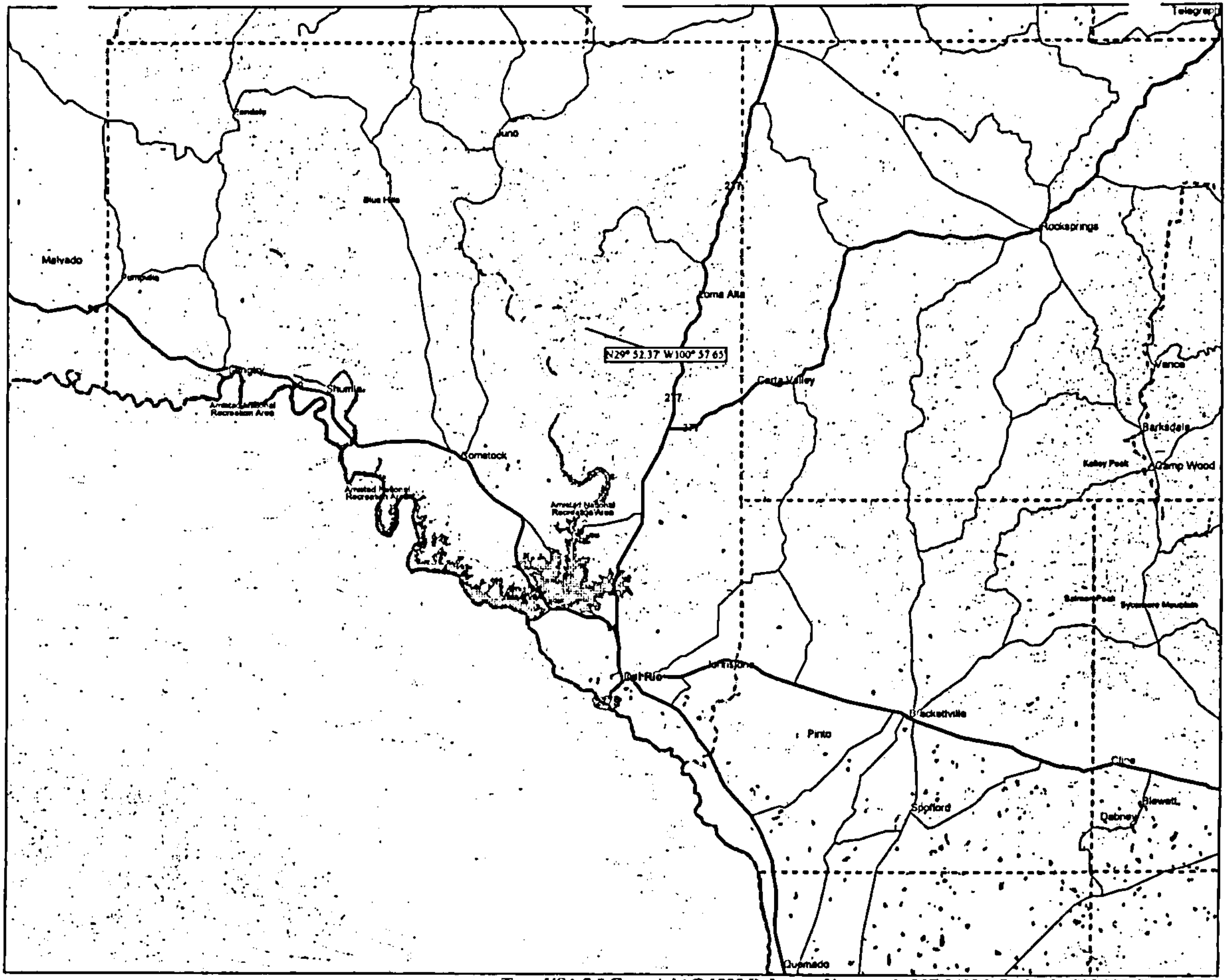
The undersigned further acknowledge that they have read the attached copy of 49 C.F.R. Part 831 and have familiarized themselves with 49 C.F.R. § 831.11, which governs participation in NTSB investigations and agree to abide by the provisions of that regulation.

It is understood that a party representative to an investigation may not occupy a legal position or be a person who also represents claimants or insurers. The placement of a signature hereon constitutes a representation that participation in this investigation is not on behalf of either claimants or insurers and that, while any information obtained may ultimately be used in litigation, participation is not for the purposes of preparing for litigation.

By placing their signatures hereon, all participants agree that they will neither assert, nor permit to be asserted on their behalf, any privilege in litigation, with respect to information or documents obtained during the course of and as a result of participation in the NTSB investigation as described above. It is understood, however, that this form is not intended to prevent the undersigned from participating in litigation arising out of the accident referred to above or to require disclosure of the undersigned's communications with counsel.

SIGNATURE	NAME (Print)	PARTY	DATE
[signature]	Jon C Greene	Williams Int'l	4/27/03
[signature]	Robert Homan	SSAC	4-27-03

(Continued on reverse side)



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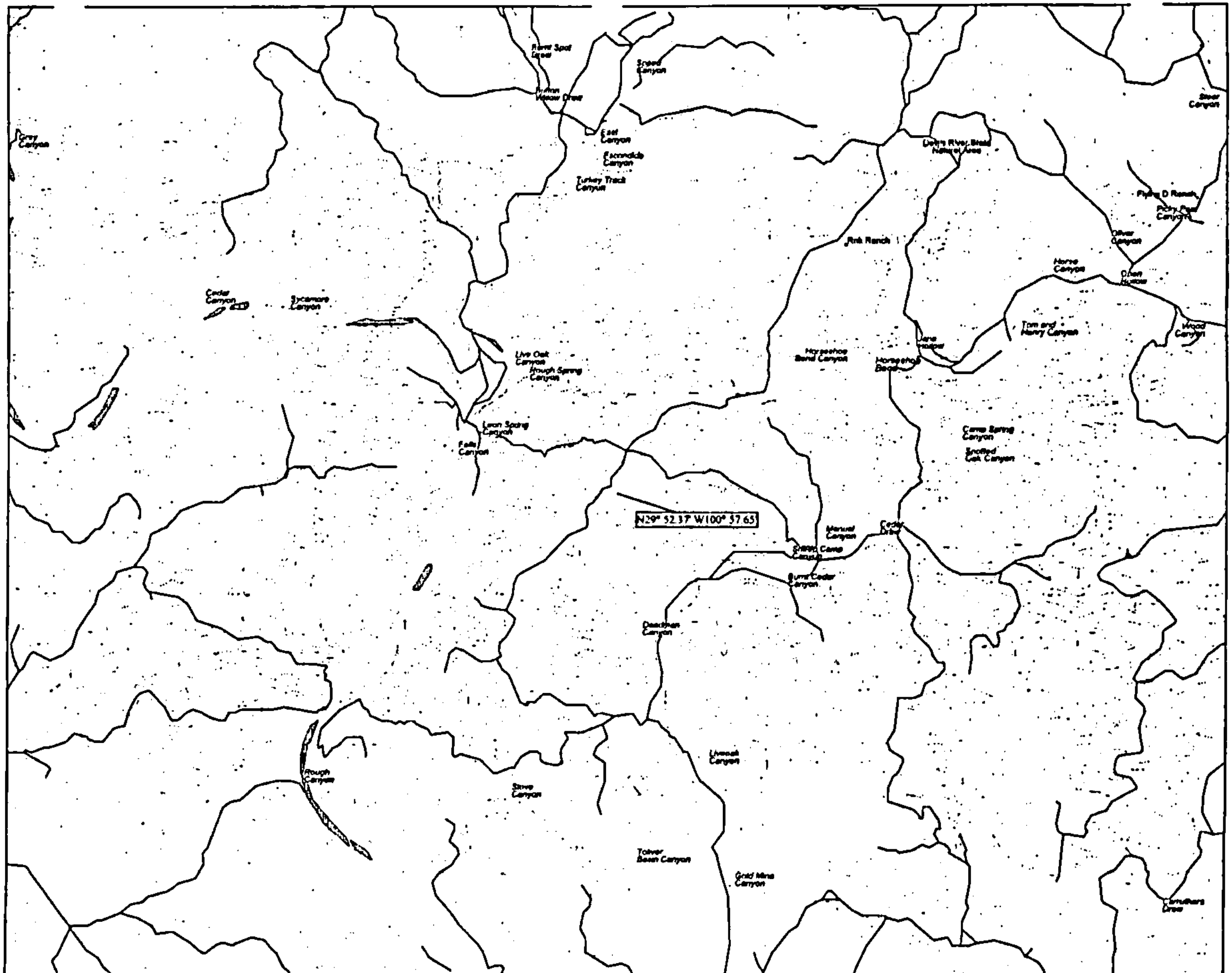

Grey Canyon
Cedar Canyon
Sycamore Canyon
Live Oak Canyon
Rough Spring Canyon
Lemon Spring Canyon
Falls Canyon
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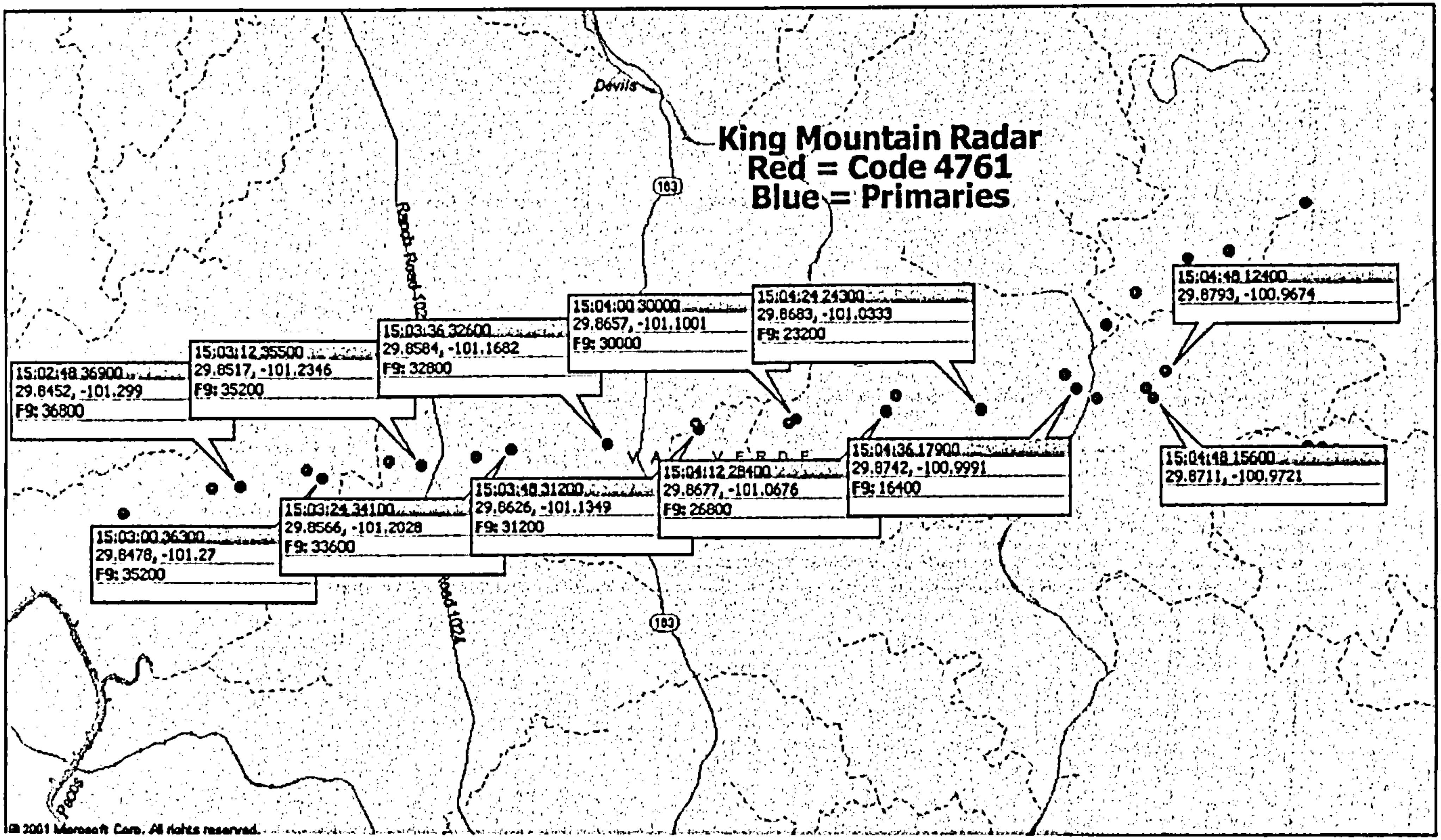
Rough Canyon
Stove Canyon
Tolver Basin Canyon
Gold Mine Canyon
Livesak Canyon
Deadman Canyon
Burnt Cedar Canyon
Manuel Canyon
Cedar Draw
Horseshoe Bend Canyon
Horseshoe Bend
Camp Spring Canyon
Knotted Oak Canyon
Tom and Henry Canyon
Wood Canyon
Horse Canyon
Oliver Canyon
Rnk Ranch
East Canyon
Escondido Canyon
Turkey Track Canyon
Speed Canyon
Steer Canyon
Carruthers Draw



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Blue = Primaries
Devils
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Ranch Road 1024
Road 1024
VAL VERDE
Pecos
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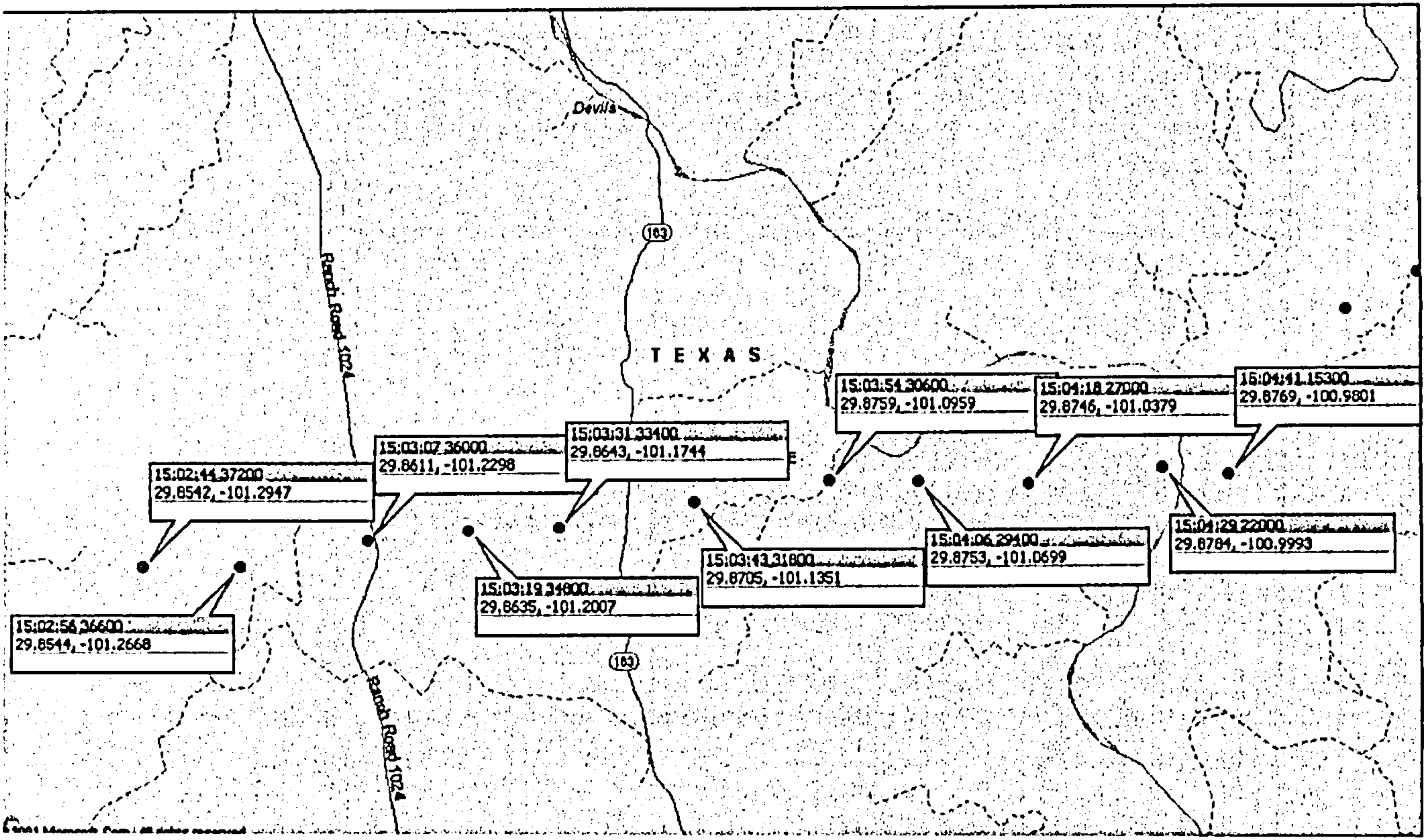
15:04:48.15600
29.8711, -100.9721


Devils
163
Ranch Road 1024
TEXAS
15:02:44.37200
29.8542, -101.2947
15:02:56.36600
29.8544, -101.2668
15:03:07.36000
29.8611, -101.2298
15:03:19.34800
29.8635, -101.2007
15:03:31.33400
29.8643, -101.1744
15:03:43.31800
29.8705, -101.1351
15:03:54.30600
29.8759, -101.0959
15:04:06.29400
29.8753, -101.0699
15:04:18.27000
29.8746, -101.0379
15:04:29.22000
29.8784, -100.9993
15:04:41.15300
29.8769, -100.9801
163
Ranch Road 1024

EGP	29.847	-101.322	15:02:31.96	Reinf	103.25	328.359	3736	37700
EGP	29.8635	-101.201	15:03:19.02	Reinf	100.875	331.699	3774	34800
EGP	29.8643	-101.174	15:03:31.17	Reinf	100.25	332.402	3782	33400
EGP	29.8746	-101.038	15:04:17.78	Reinf	97.625	336.27	3826	27000
EGP	29.8769	-100.98	15:04:41.46	Reinf	96.5	337.939	3845	15300
EGP	29.9179	-100.947	15:07:14.53	Reinf	98.125	339.434	3862	12600
EGP	29.9269	-100.926	15:07:26.37	Reinf	98.25	340.137	3870	13200
EGP	29.9348	-100.907	15:07:38.54	Reinf	98.375	340.752	3877	14100
EGP	29.8542	-101.295	15:02:43.70	Bcn	102.875	329.15	3745	37200
EGP	29.8544	-101.267	15:02:55.66	Bcn	102.125	329.854	3753	36600
EGP	29.8611	-101.23	15:03:07.41	Bcn	101.5	330.908	3765	36000
EGP	29.8705	-101.135	15:03:42.90	Bcn	99.625	333.545	3795	31800
EGP	29.8759	-101.096	15:03:54.43	Bcn	99	334.687	3808	30600
EGP	29.8753	-101.07	15:04:06.18	Bcn	98.375	335.391	3816	29400
EGP	29.8784	-100.999	15:04:29.40	Bcn	97	337.412	3839	22000

KMN	29.8431	-100.909	15:02:23.93	Sch	111.625	140.361	1597	102000
KMN	29.8369	-101.341	15:02:36.28	Sch	99.5	150.645	1714	38000
KMN	29.8536	-100.902	15:02:47.80	Sch	111.375	140.01	1593	102000
KMN	29.8449	-101.309	15:02:48.23	Sch	99.875	149.678	1703	36800
KMN	29.855	-100.908	15:02:59.96	Sch	111.125	140.098	1594	102000
KMN	29.8502	-101.275	15:03:00.07	Sch	100.5	148.711	1692	37200
KMN	29.8548	-100.912	15:03:11.89	Sch	111	140.186	1595	102000
KMN	29.8531	-101.246	15:03:12.10	Sch	101.125	147.92	1683	36400
KMN	29.8558	-100.913	15:03:23.96	Sch	110.875	140.186	1595	12000
KMN	29.8545	-101.215	15:03:24.17	Sch	101.875	147.129	1674	34000
KMN	29.8563	-100.917	15:03:35.81	Sch	110.75	140.273	1596	102000
KMN	29.8644	-101.136	15:03:48.17	Sch	103.625	145.02	1650	31600
KMN	29.8642	-101.103	15:04:00.12	Sch	104.625	144.229	1641	30400
KMN	29.8725	-101.064	15:04:11.96	Sch	105.375	143.174	1629	28400
KMN	29.8793	-100.967	15:04:47.90	Sch	108	140.889	1603	12400
KMN	29.8711	-100.972	15:04:47.92	Sch	108.25	141.152	1606	15600
KMN	29.8741	-100.975	15:05:23.88	Sch	108	141.152	1606	12400
KMN	29.8711	-100.992	15:06:23.89	Sch	107.625	141.592	1611	102000
KMN	29.8788	-101.003	15:06:35.95	Sch	106.875	141.68	1612	12000
KMN	29.8938	-100.989	15:06:47.89	Sch	106.625	141.064	1605	12000
KMN	29.904	-100.978	15:06:59.83	Sch	106.5	140.625	1600	12000

STATEMENT OF
C.B. THORNTON, JR.
26 APRIL 2003

The undersigned was the pilot of Northrop T-38, N638TC call sign "Sino Test Chase" which was contracted to provide safety chase for "Sino Test Two", the test aircraft. The aft seat of the chase aircraft was occupied by Chuck Walls, a Sino Swearingen test pilot.

On this date the test aircraft had successfully completed its first test point several minutes prior to the loss of the aircraft and Carroll Beeler, the test aircraft pilot, had completed a right hand racetrack pattern to reenter the test track (SAT 270° Radial) for the second test point. Upon reaching the second test point target airspeed, the test aircraft was approximately ¼ mile in front of and 1000' below the chase aircraft. At the end of the control input series, the test aircraft was cleared by the company ground test facility to accelerate to the next data point if able. The test aircraft pilot replied, "I can't let go". At this point, the test aircraft appeared to be in a shallow right bank with chase less than 500' above and 500' behind.

Very soon thereafter, the test aircraft began rolling to the right and continued to do so at a rate of approximately 120°/sec ±. This rolling maneuver appeared stable and continued unchanged until impact. The test aircraft appeared intact throughout and no part of the test aircraft was seen departing the aircraft. There was no fire prior to impact. After the test aircraft began to roll communications were approximately as follows:

Test Aircraft:	"I can't stop it"
Chase:	"Get Out"
Chase:	"Carroll, Get Out"
Test Aircraft:	"I can't get out, too many Gs"
Test Aircraft:	"I am going to die"

During the terminal dive of the test aircraft, chase orbited more or less above the test aircraft at a distance from 500' to 8000' at a very high rate of descent. This is a very rough estimate of distance. The undersigned did not observe the impact but did observe a fireball one or two seconds after the test aircraft was last observed. Chase recovered at approximately 10,000' MSL, completed approximately two orbits and departed the area due to fuel considerations. Houston Center and the Company Base were advised of the situation. No parachute was observed and the impact did not appear to be survivable. The chase aircraft returned directly to KSAT.

C.B. Thornton, Jr.
Chase Pilot

C.B. Thornton, Jr.
Chase Pilot

SJ30-2 SN002 Flight 231 4-26-03

Observations by W.Peter Jennings - Flutter DER conducting the flutter test from the remote site telemetry van at Edwards Airport, Rocksprings, TX.

After departing San Antonio the aircraft climbed to approx 39,000 ft above Ft Jackson setting up for a shallow dive along an 090M track for condition 1-14(M=0.884).

Telemetry lock was obtained and the aircraft accelerated smoothly to M=0.875. At this speed the pilot input a single pulse to each control surface, elevator, aileron & rudder. Damping of each pulse was observed and the pilot cleared for the input of the next pulse by the command "GO" from WPJ via the radio link. This condition repeated condition 14A achieved on the previous flight. The level of buffet was reported by the pilot to be lower than that experienced on the previous flight. The pilot also reported the the aircraft tended to roll right. The strip chart has the note "Rt Roll" written at the end.

The aircraft decelerated and climbed to approx 39,000 ft setting up for Condition 1-14, M=0.884 on a 270M track. Following TM lock and steady data signals the aircraft started a shallow dive. Strip recorder was started at M=0.85 and test coodinator,(Pat Carvel) called out the aircraft Mach No from the TM monitor display at approx 0,005 intervals. The strip chart was anotated by hand. At M=0.884 elevator, aileron and rudder pulses were input by the pilot. Responses were well damped. Pilot reported after the aileron pulse that he could not release the wheel. This was assumed to mean that not aileron trim was available. After each pulse was observed clearance for the next pulse was give by the "GO" command. Following the final, (rudder), pulse with good damping records the pilot was cleared to the next test condition of M=0.894.

Pilot then reported "Roll Right. Cannot Stop IT".

Telemetry signal was lost approx 20 seconds after last rudder pulse.

No further radio signals were heard until T38 chase called Sino Base to inform them of the loss of the aircraft and pilot.

At the TM Van all records were secured and the TM data records were backed up by Dave Schweitzer. Following this the TM station was broken down and the crew returned to San Antonio.

W. Peter Jennings

W.P. JENNINGS AND ASSOCIATES, INC.
ENGINEERING CONSULTANTS

W. PETER JENNINGS
FAA DER NM-120
FLUTTER [redacted]

SEATTLE, WA 98116

Observation on flight of SJ30-2, SN002, N138BF, flight number 231, on April 26, 2003

Xing J Zhao

I, a senior dynamics specialist, sat next to Mr. W. Peter Jennings, flutter DER, in the mini van of Sino Swearingen Aircraft Corporation at Edwards Airport, Rocksprings, TX, on April 26, 2003, monitoring telemetry traces on a strip chart for the flight 231.

Flight 231 was planned for the condition 1-14, 32k/0.884, following the completion of conditions 1-12 and 1-13 on the test cards in the previous flight, 230, on April 25, 2003.

After departing SAT, the airplane reached an altitude about 39000 ft before a dive to the condition of 1-14, 32k ft and Mach 0.884. When the airplane reached Mach 0.875, the test pilot called "Mark" on the radio starting pulses unexpectedly. The telemetry traces on the strip chart showed that the modes excited were well damped. After the pulses, the test pilot said that the abrupt roll to the left experienced on the previous flight 230 did not happen and the chase pilot commented that the speed was lower than flight 230 and landing gear doors, etc, were all tight. The airplane started climbing again to about 39,000 ft setting up for a dive to the condition 1-14, Mach 0.884 on the test card.

When the airplane reached Mach 0.884, the test pilot called "Mark" to start pulsing. After the end of each pulse and quickly examining the TM traces on the strip chart, Peter Jennings said "Go" to clear the airplane for next pulse. Three pulses, elevator, aileron, and rudder, were complete and Peter Jennings cleared the airplane for next condition, 1-15, Mach 0.894, if flight condition permitted the test pilot to do so. The test pilot did not acknowledge this. A few seconds later, the test pilot said the airplane rolled and he could not stop it. Several seconds later, I heard on the radio that somebody said "Get out". Nothing was heard on the radio until the test pilot said that we lost the test airplane and test pilot.

Personal Account of SSAC Flight 231 of SJ30-2 Flutter Flight on April 26, 2003

By: David H. Schweitzer, Instrumentation Lead

Position: Telemetry Van at Edwards County Airport, Telemetry Monitoring Station and Manual Antenna Tracking Station

The stations in the van consist of the following:

1) Right front seat facing forward with FTE display: Pat Carvel
2) Right middle seat facing aft: Flutter DER Peter Jennings with critical 8 channel chart recorder.
3) Left middle seat facing aft: SAC Dynamics Engineer, Joe Zhao with second 8 channel strip chart recorder with display to his right, visible to Joe and Peter.
4) TM monitoring and antenna steering with TM monitoring display in back of van on left side facing left with TM equipment rack between Joe and me.

The TM monitoring station has a signal strength meter, a TM data valid LED (Green Valid, Red Invalid), a set of manual antenna steering switches, and an antenna bearing indicator. The TM display contains aircraft heading for tracking purposes and analog TM output voltages for all other channels to trouble shoot possible TM malfunctions and data acquisition D to A problems.

A call was received from Sino Instrumentation indicating the aircraft and chase were airborne at 09:13.

The TM Ground station data file was started at approx 09:30.

TM signal was acquired approximately 5 minutes later as the aircraft approached from the East.

When the SJ30 made the VHF contact call with the TM van, TM signal was good.

The aircraft proceeded West to a position that was farther away than the previous day to allow time for acceleration to the desired mach. TM was lost and acquired several times before the aircraft turned South and reacquired when the aircraft pointed back to the East. When TM was reacquired, the signal was weak but steady (10 micro amps, {m-amp}, in strength)

The test point proceeded with the TM signal weakening as the aircraft descended but no TM dropouts occurred. The mach number reached duplicated the point from the previous day rather than going to the higher mach point briefed that morning. The pilot indicated that he wanted to compare results from the previous day, and resulting aileron trim changes were less than the previous day's flight. As the aircraft approached abeam the TM ground station signal increased to 20 m-amp at the end of the run. The aircraft turned back to the West and gained altitude for the next run. Discussion from the pilot with the ground station indicated that this may be the last point obtained for fuel concerns, especially for the chase aircraft. It was decided that the original point and the next point would be attempted on this run, if the pilot wished, and altitude allowed.

The distance out increased and TM was lost, then reacquired as the pilot turned back to the South. The signal strength was again about 10 m-amp. As the pilot accelerated and the test point begun, signal strength began to drop. The antenna bearing was 245 degrees and the aircraft heading was 050 to 070 degrees. This indicated that the aircraft was headed almost directly at the TM ground station so tracking was not going to be a problem. The Flutter DER cleared the aircraft to the first kick in the test point with a GO command. As the aircraft descended and accelerated, the TM strength continued to drop. A second GO command was issued. A third GO command was issued and the TM strength approached the threshold for Lock-On (about 5 m-amp). The signal strength dropped again and the TM signal dropped out (LED went Green to Red) for several seconds. A fourth GO command was issued and the TM signal reacquired (Red to Green). Sometime after the last GO command, the TM signal dropped out again and was reacquired.

The Flutter DER cleared the aircraft to the next point. TM dropped out again and was reacquired, maybe several times.

The next report from the SJ30-2 pilot was "It's rolling and I can't stop it".

The TM dropped out completely and the next transmission heard was "Carrol, get out".

After an undetermined period (maybe a minute or two), the chase aircraft was heard to transmit "We have lost the aircraft and maybe Carrol".

The TM data file was closed at approximately 10:15.

Two copies of the TM ground station file were made. The file was copied to the removable hard drive (D: to E:) and also to the system partition (D: to C:).

David H. Schweitzer
28 april 2003

David H. Schweitzer
SSAC Instrumentation Lead

april 28, 2003

To whom it may concern,

I was in the back seat of the T-38 Chase aircraft when SJ30, N138BF crashed. The INCIDENT began after the completion of the 2nd test point. The first test point was completed satisfactorily with nothing unusual noted from my position. On the incident test point my chase pilot was out of position and we weren't close enough to see surface positions. I did see the aircraft remain slightly nose low in about a 30° ~~bank~~ right bank after TM control said that the point was complete. After [redacted] few seconds the incident aircraft entered a barrel roll type maneuver (to the right) and continued to roll and increase dive angle until impact. Mr Bell stated he could not stop the roll. Chase stated get out get out, but there was no chance and no chute.

Charles M Wells

MEMORANDUM FOR RECORD

DATE: May 1, 2003   TIME: 1400

NAME OF PERSON CONTACTED: Chuck Walls

AT (location or number): Sino-Swearingen

SUBJECT: IAD03MA049, SSAC SJ30-2, N138BF, 04/26/03

On this date and time the following were discussed:

Mr. Walls was the second company test pilot, and was in the chase T-38 when the accident occurred.

According to Mr. Walls,

Prior to the flight, there was a telephone briefing with the telemetry van personnel. There was a briefing guide in the briefing room, but it was no used for the accident flight. The accident flight was basically the same as the previous day, but at higher airspeeds. Regarding call-offs, Mr. Walls said that Mr. Jennings could call the knock-it-off if he saw something unusual. Carroll could do it too, as could the chase pilot. Peter Jennings would make the call-off if the flutter test was not set up right.

One of the reasons Mr. Walls was on the chase plane was that on the day before, while Mr. Walls was flying test airplane 003, Mr. Beeler thought he experienced an uncommanded roll to the left at Mach 0.875. During the accident flight, Mr. Beeler didn't feel anything, except when he backed out of approximately Mach 0.845. He didn't feel anything or see anything that would have related to what happened the day before.

During the flight, the test point was reached, and Peter Jennings cleared the pilot for point. Carroll then had a discussion with Thornton (the chase pilot), and Thorton advised him that the T-38 was running short of fuel. Mr. Walls didn't think that Mr. Beeler would attempt another point, due to the accident airplane's altitude.

He (the accident pilot) was still in the same position as he ended up from the last test point – right bank, and a little nose low.- a one thousand one, one thousand two, one thousand three and the aircraft did a barrel roll to the right.

The first thing Mr. Walls thought, was "what did he do that for?" The airplane then came around and made another barrel roll. It was not around a point like an aileron roll; and it was not real fast; it looked "lazy." Mr. Thornton then said something to Mr. Beeler, who replied, "I know, I can't stop it." Mr. Beeler didn't say anything else about how the airplane was operating, or what he was doing.

Mr. Walls also noted that Mr. Jennings had previously explained that it was "okay" to have to hold a little wing force to hold the airplane steady.

Mr. Walls stated that he was not a DER; however, he had a lot of flight test experience, first as an Air Force pilot and instructor at Air Force Test Pilot School, and had done flutter tests with the C-17, MD-11, and MD-87, and was the chief test pilot for the C-17 project.

When asked why Mr. Walls didn't do the flutter tests when he had the most experience, Mr. Walls stated that Mr. Beeler felt that because he was the chief test pilot, he should do it. Mr. Walls gave Mr. Beeler training; "I checked him out – he wanted to do it – we went out and I demo'd and he did it. He understood it; he's an F-8 guy. If I had any qualms about it, he wouldn't have been able to do it."

When asked about Mr. Beeler's brief, Mr. Beeler said that if he "felt anything abnormal, I'll bring it home." Mr. Beeler also knew to slow the airplane should he run into any difficulty. "We discussed it a lot (power idle.) We talked and talked about throttles idle. In my mind; I know he did that (throttles idle.)

Regarding gurney flaps: "I've never seen them used for roll control. I don't think that had anything to do with it – should probably had more effect to the left."

Regarding the danger: "Oh yeah – high speed – can't get out."

Paul R. Cox
Air Safety Investigator

PAT CARVEL'S
STATEMENT TO NTSB
ABOUT A/C 002 INCIDENT/ACCIDENT
ON 4/26/2003

1) arrived at Rock Springs Hotel at 7:45 AM
2) Pre flight Briefing over phone at 8:00 AM
We covered the Test Points That were to be Performed

Flutter DER Peter Jennings Said Carroll Is Cleared to Test Point 1-14 Mach .884. flutter test Point

Carroll climbed to ~~30~~ 32K feet, Dove to attain Speed of Mach .874 to perform the flutter Test.
Carroll performed the Test and all Looked Well.

Then he went back to 32K feet and Circled around to get back on the TM Course

Once The Aircraft was On Course and Telemetry was attained, I passed The Communication Microphone to Peter Jennings.
Carroll Began to Dive, I called out Speeds to Peter.
STarted at about .803 → 819 → .82 → 83
→ .84 → .85 → .86 → .87 → .875 → .879 → .881
at this point the Aileron Trim became ineffective
Carroll Beeler Said "Full Aileron Trim and I Can't let go"
Peter Jennings Said "go ahead Carroll"
Then Carroll Continued To Dive and achieved a speed →
.881 → .882 → .88? at This ~~pt~~ Time, The
Telemetry Signal was lost. Then Carol Said "Ok its Back"
Which I took to mean Aileron Trim effectiveness Was back

Next Page.

At the Instant The Telemetry Was Lost,
I Said with Loud Abrupt Voice
"TM off"
"TM off"
"TM off"
This Was Said over a span of 2 → 3 Seconds at Most
as I said "TM off" for the Third Time, Maybe Slightly after,
I Before Carroll Said "MARK" which is the Start of the Test input
Peter Jennings Said
"Go Ahead Carroll" or Something to That effect

after a lapse of 2 – 3 Seconds, at Most 5 Seconds
Carroll SAid "It's Rolling and I Can't Stop It" →
~~very~~ With a very Strained Voice, high Pitch.
1 second Later I heard Chuck Walls Say
"Get out"
After I heard "Get out", Communication Was lost
for about 1 to 2 minutes

It should be Noted That I do Not believe
the AirCraft Attained a Speed ~~of~~ higher than
.882 before My Tm (Telemetry) Signal Was Lost

NTSB ITEM # 104
8-31-04

Flight Experience/Ratings

Commercial Pilot - Single Engine/Multi-Engine - Land, SE/MEL; Airline Transport Pilot; ATP (1970)
FAA Airframe & Powerplant Mechanic (1977) With Inspection Authorization (IA) 1992
FAA Flight Engineer - Turbojet (1969)

Aircraft	Hours (PIC)	Copilot	Remarks
B-747-100	300	300	Flying Test Bed (FTB); Experimental Engine Test
MD-11		5	Familiarization (GE Engine Cert. Flight)
B-707-300	225	250	FTB; Experimental Engine Test CFM-56 Series
B-707/727	Flt. Engineer	250	CAL/PSA Line operations/Revenue Service
AirBus A-300	130	100	FTB Experimental Test; CF-6 Series; Laminar Nacelle
MD-80,81,82,83,87	Jump Seat		Flight Test Engineer (Approx. 250 Hrs.)
T-45A		1	Lead Flight Test Engineer
Lear 23,25,35	55	130	Douglas Chase; T-45; KC-10; MD-80 UHB
F-4 Phantom B,J,N*	800	20	Instructor; Tactics; FCF/Depot Maint Test
F-8 Crusader J,K,L*	850		Strike/Flight Leader; LSO, Combat, FCF/Maint Test
A-3 Skywarrior T,EK*	450	25	Instructor, LSO, FCF/Depot Maint. Test
A-1 Skyraider E,F,H,J	1100	50	Instructor, LSO, Combat, FCF/Maint. Test
A-4 Skyhawk B,C,E,F,T	150	50	Attack Pilot, Instrument Chk's
T-34B	100	15	Student; Navy training
T-28 B,C	200	10	Student Navy training
T-1 Sea Star A	5	10	Proficiency, Instrument Chk's
T-39 Sabreliner	5	10	Radar Operations training
T-38 Talon	35	5	TopGun, Chase
S-2/C-1 TRacker/Trader	575	100	Student, Instructor, LSO, Maint. Test
C-131 Samaritan	5	15	Transition training
Mooney Single Engine	30	5	Charter
Cessna Single Engine	1200	15	STOL Test/Demo, Agriculture, Pleasure/Personal
Cessna Multi-Engine	35	1	Personal Aircraft
Beech Single Engine	50	5	ATP Training
OV-10 Bronco	5	10	Combat, USAF Exchange, Fwd. Air Control
F-51 Mustang	2	1	Air Show Training
T-6/SNJ	15	5	Air Show Preparation
Christen Eagle	2	1	Acrobatics
Stearman 220-600 Hp.	250	15	Agriculture Training & Flying
G-164 AgCat A,B	3500		Agriculture Flying; Day & Night
Thrush 600/Turbine	1500		Agriculture Dlying; Day & (1000+) Night
AT-301 Air Tractor 600	700		Agricultur Flying; Day & (600+) Night
Helo; H-2/Hiller	10	5	Familiarization

Summary: 11,000+ Hrs. Multiple types and models; Light & Heavy; Civil & Military; Navy Carrier & Tactical Instructor; Airline Experience; Experimental Test Pilot; Flight Test Engineer; Turbojet Flight Engineer; *= Simulator Instructor

(2)

NTSB #49 5-1-03

SJ30-2 Flutter Program Operation Roles

The SJ30-2 flutter test program was conducted in accordance with standard Sino Swearingen operating procedures and any applicable procedures as defined by the Flutter Safety Review Board (SRB) (and associated safety/hazard assessments) and the specific flight test briefings.

The aircraft, N138BF was based along with the chase T-38 out of San Antonio, Tx (KSAT). The test conductor team was based at the Rocksprings airport (69R).

The aircraft was flown single pilot in order to minimize mission risk. All flights were flown by Carroll Beeler, Chief Test Pilot. The T-38 was flown by Chuck Thornton. The T-38 aircraft is owned and operated by Thornton Aircraft Company, Suite 636 523 West Sixth Street, Los Angeles, CA 90014 tel: 213-629-3867. During the flight that resulted in the fatal accident Chuck Walls (SSAC – Flight Test Pilot) was in the back seat of the T-38.

The test conductor team consisted of Mark Fairchild (SSAC - Senior Flight Test Engineer), Pat Carvel (SSAC - Flight Test Engineer), Peter Jennings (consultant - Flutter DER), Joe Zhao (SSAC - Structural Dynamics Engineer), and David Schweitzer (SSAC – Flight Test Instrumentation). On the day of the accident Pat Carvel was the flight test engineer. The telemetry check and first flutter flight was conducted by Mark Fairchild.

Flight Test Procedure:

Prior to the flight a mission briefing was conducted via conference call with both the San Antonio based flight test team and the test conduct team in Rocksprings in attendance. During this briefing all of the flight test cards were briefed including the test limitations, test set-up, test points, weight and balance, airspace operational considerations, aircraft limitation, maintenance actions since last flight, instrumentation status, and chase aircraft procedures.

After the briefing the flight crews prepared for the flight (i.e. filed flight plans and manned aircraft, etc) and the test conduct team went to the airport to set-up up the telemetry station.

Once the aircraft took off the telemetry van was telephoned to let them know the aircraft were airborne and enroute.

When the test aircraft was in range the test pilot made positive radio contact with the test control via the flight test engineer on the company radio frequency. Once a telemetry lock was established with the aircraft the flight test engineer confirmed that with the pilot of the test aircraft.

After the test pilot established that he had obtained the airspace block required for the test with the various controlling agencies he reported it to the flight test engineer. At this time the test pilot confirmed with the flight test engineer the next test point and then began to get established on the point. With telemetry lock confirmed, test point confirmed, and fuel state required for the point confirmed the test pilot was cleared to test and the radio was then passed to the Flutter DER.

Once on the test point the test pilot radioed "Mark", he then proceeded with the control rap, and the Flutter DER responded "Go" (assuming no flutter) which cleared the pilot to begin his next control surface rap for flutter excitation. After each rap, the Flutter DER would respond "Go" to clear him to the next rap and the test pilot would respond "Mark" prior to rapping. The test pilot in accordance with the test cards rapped elevator, ailerons, then rudder.

Upon the successful completion of a Mach/speed point the flight test engineer took back the radio in order to run the operational side of the test and to note any comments from the pilot. The flight test engineer also monitored fuel load during the test in order to maintain full wing tanks.

During the test the flight test engineer monitored fuel load, airspeed/mach, and altitude.

Once the pilot got back on point for the next test point the radio was given back to the Flutter DER and the process was repeated.

During the test the Flutter DER was responsible for terminating the test due to flutter or anything else he saw on the data that he didn't like. As pilot in command the test pilot always had the authority to terminate the test for any reason. In addition the chase pilot/rear seat pilot in the T-38 in addition to the flight test engineer had the authority to call off the test if they saw something they didn't like.

Upon the conclusion of the testing the flight test engineer confirmed that the aircraft was enroute back to base and then the test conduct team would telephone San Antonio base to let them know the aircraft was on its way back.

If there are any questions on this procedure please feel free to contact me.

Mark Fairchild

Mark Fairchild
Senior Flight Test Engineer
Aircraft 002

05.01.03

NTSB #57 5-1-03

The fatal crash of the SJ30-2 S/N002 on April 26, 2003 occurred while the aircraft was conducting flight flutter testing in accordance with the FAA-approved certification SSAC report no. 30-2222, "Flight Flutter Certification Test Plan for SSAC Aircraft Model SJ30-2".

As for many test flights considered hazardous, flight flutter testing was preceded, over the course of several weeks, by:

1. coordination meetings, both internal to the company and with the outside flutter specialist;
2. at least one Technical Review Board (TRB), to understand, modify (if required) and accept the configuration of the airplane as it related to the specific test to be conducted;
3. at least one Safety Review Board (SRB), to define hazards, cause and effect, and minimizing and emergency procedures.

Usually, coordination meetings are conducted with personnel from many departments including engineering, flight test, quality assurance, procurement, ground operations, etc. as required.

TRBs are usually conducted by engineering, flight test, ground operations and, if asked to participate, quality assurance. Once the aircraft configuration is defined and accepted, the SRB is conducted, which normally involves engineering and flight test only. TRB and SRB are chaired by the company safety officer; the findings of the SRB remain in effect for the duration of the tests.

Flight flutter testing was no exception to the above. In fact, because it involved the participation of an outside flutter engineering consultant and the use of telemetry, additional coordination meetings were conducted by the flight test engineer, the chief test pilot, the company flutter engineer, the outside flutter engineering consultant and the company lead instrumentation engineer. During these meetings, the test cards were briefed in detail and procedures were agreed upon that addressed radio communication between the TM crew on the ground (flight test, instrumentation and flutter engineers) and the pilot.

The agreement was for the pilot to conduct the required maneuver and, after review of the TM-transmitted test data, for the flutter engineers to either clear the aircraft to the next test point, ask the pilot to repeat the maneuver or stop him from proceeding any further (faster). Furthermore, as with any previous test flight, the chief test pilot made repeatedly clear that it was his prerogative to call off any test point at any time if he deemed necessary to do so, either for operational or safety-of-flight reasons. This was fully understood and accepted by all parties involved.

At the request of the chief test pilot, a chase aircraft and pilot were brought in from outside the company to follow the flight test airplane during flight flutter testing. The crew aboard the chase aircraft was to check for visible abnormalities during and after each test point, with a particular emphasis on gear doors, access panels, etc. possibly departing the test airplane as a consequence of the test maneuver. Any coordination between the test and the chase aircraft was handled by the two pilots-in-command. For what resulted in the final flight of S/N002, the crew aboard the chase aircraft consisted of its owner/operator and another SSAC company test pilot, equipped with a pair of binoculars to observe the test aircraft during and after the flutter maneuvers.

The test aircraft was specially equipped with an emergency depressurization valve, and an emergency egress door with associated air deflector. The test pilot was wearing a helmet and a parachute attached to a cypress device.

Due to the nature of the test, per a previous agreement between SSAC and FAA, flight flutter was to be conducted during company pre-TIA testing only, and not to be repeated during FAA TIA testing. Certification recognition was to be given to the results of flight flutter test, during which the airplane-demonstrated freedom from flutter was to be used to initially set V_{DF} and M_{DF}. Hence, prior to ground vibration and flight flutter test, aircraft S/N002 and its test instrumentation were FAA-conformity inspected in accordance with FAA request for conformity no. ACO-163, ACO-164 and ACO-174. The deviations from the conformity requirements were documented in the appropriate discrepancy report (with attached FAA 8100-1 form), reviewed by the cognizant engineer(s) and deemed by the flutter consultant engineer as acceptable for flutter.

[signature], 5/1/03

NTSB F-24 | Mike Cavanaugh 4/29/03

→ SJ30-2 Wing Twist

The SJ30-2 wing is built with approximately 3½° of linear wing twist in the jig. An additional 1½° of twist is present in flight due to aeroelastic effects. The wing is twisted to achieve a desired spanwise lift distribution in flight. This distribution is selected to minimize drag in the cruise condition.

S/N002's wings were built with small twist deviations. The left wing had about 0.6° less twist than the design at the tip. The deviation started about 60" from the tip and linearly increased to the measured 0.6° deviation. This deviation resulted in a lateral imbalance requiring full left wing down trim at Vmo (320 KEAS). This imbalance is equivalent to approximately 9 pounds of control wheel force at Vmo. This is a small fraction of the aircraft's available roll control at Vmo.

The gurney flap was sized to put the lateral trim back to neutral at Vmo. Test flight 229 showed that the trim was about 42% LWD at Vmo (50% being neutral). More trim authority was available, so the remaining LWD trim was deemed acceptable to continue on to flutter testing.

As a side note, the SJ30-2 aileron trim system is a force based system (spring). Because of this, aerodynamic imbalance, like differential wing twist, require continual retrimming with speed. That is why the increasing lateral trim requirement with speed (up to Vmo) was not unexpected. The gurney flap is an aerodynamic device so it fixes aerodynamic imbalances at all speeds. No retrimming is required.

!O-SWEARINGEN
Aircraft Co.

Model: SJ30 Flight: 230
Reg No: N138BF Date: ______
Ser No: 002 Cards:

NTSB # 30 4-8-03

Purpose of Flight:
Flutter Testing - [Report 30-2222]

Test Limitations / Hazards:	Circuit Breakers Collared:
See Attached TTAL Summary Monitor Brake Temperatures TAKEOFF– 500° F MANUAL FUEL SYSTEM OPERATION FOR DIVERTER VALVE 6 PSID PRESSURIZATION VALVES INSTLD CABIN ALT WARN - 13840 FT+0/-1300 FT AILERON CONTROLS MODIFIED - TRAVELS +16° / -11°. FLIGHT CONTROLS BALANCE TO AFT LIMIT SPEEDBRAKES LIMITED TO ½ TRAVEL Test Specifics: NOSE BOOM INSTALLED EGRESS DOOR INSTALLED TM ANTENNA INSTALLED RAD ALT REMOVED EMERGENCY DUMP VALVE INSTALLED GURNEY FLAP INSTALLED Standby static heat - disconnected L / R WAI Door Control Circuit Breakers – IN L/ R WAI Door Operational via WAI Switch/FTE Cntl Stick shaker elevator servo & column pusher motor – connectors/wiring are capped/stowed AFT 3500#	Non Ess Bus L/R Ldg Light Cabin Reading/Ovhd FSB / No Smoke Emer Exit Cabin Press Column Pusher Ice Detect Cont / Pwr Hor Stab L/R Wing Ice Protection L/R WAI Pwr L/R AOA Ice Protection Rud Bias AP Servos L/R AOA Cmptr Wx Rdr Cont / Pwr TCAS, Flt Phone, Toilet Hot Cup 1 & 2, Comp Outlet Entertain System Total Pilot Side = 18 Total Copilot Side = 11

24 1054

LH

(1.3)
EA

Takeoff	Flight Crew	Flight Time
T.O. G.Wt ______	Pilot Beeler	Taxi ______
	Co-Pilot / FTE ______	Takeoff ______
T.O. N1 ______	FTE / Observer ______	Land

:INO-SWEARINGEN
Aircraft Corp.
Reg No: N138BF Ser No: 002

Flight: ______
Date: ______

1/12

Test Purpose:	PRE-START
Test Procedure:	
INSTRUMENTATION:	DISPLAYS ON & OPERATING
EGRESS DOOR:	INSTALL AND LATCH (COORDINATE WITH GRND CREW) PIN ENGAGEMENT (6)
SYSTEM CONNECTIONS:	SEAL & ELECTRICAL
SYSTEM CHECKS:	OVERHEAD DOOR UNLOCK SW ~~GUARDED / SAFE~~ ARM SWITCH -- ON ILLUMINATED
OVERHEAD DUMP HANDLE:	STOWED / UNPINNED
DEFLECTOR:	EXTEND / UNPINNED
CYPRESS DEVICE:	ATTACHED
PILOT EVENT:	DEPRESSED (1 SEC) TOD: 1035 19

1310

Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Bleeds	Optional

'INO-SWEARINGEN Aircraft Corp.

Reg No: N138BF Ser No: 002

Flight:

Date: 2/1.

Test Purpose: FLIGHT CONTROL SWEEP

Test Procedure:

1) START THE RIGHT ENGINE
2) CHECK COMS WITH CHASE / BASE AS REQUIRED
3) FOR EACH AXES PERFORM A SLOW FLIGHT CONTROL ROLLOUT
4) ~~FOR EACH AXES RUN A TRIM CONTROL SWEEP~~
5) SET STABILIZER TO 7 DEGREES
6) SELECT/VERIFY: PILOT AIR DATA REVERSION – NORMAL

Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Bleeds	Optional
1A	AR	Field	EXT / 20	EXT	AR / AR	OFF / OFF	

1456
TO 1340
1.16
1.16

ST LH 1458
1335
1:23
1.3

RH 1504
1317
1:47
RH 1.8

Block 1056
1330
1:27

INO-SWEARINGEN
Aircraft Corp.
Reg No: N138BF Ser No: 002

Flight:
Date: 3/12

2955

Test Purpose: FLAPS 20 TAKEOFF

Test Procedure:

1) TAXI TO HOLD SHORT OF RUNWAY
2) PILOT TO CLEAR GROUND CREW FOR TRAILING CONE DEPLOYMENT
3) PERFORM A CROSS-START OF THE LEFT ENGINE.
4) SELECT/VERIFY: YAW DAMPER – ON
5) PERFORM A NORMAL FLAPS 10 TAKEOFF

NOTE: GROUND CREW VERIFIES TRAILING CONE REMAINS ON AIRCRAFT. CROSS CHECK VSPEEDS AND POWER SETTING WITH BASE.

V1 109

VR 119

V2 124

TO N1 ______

TAKEOFF TIME ______

Rollin

149.5 030/19
TD

19K
23/04
29.30

FL135
TD

√150Z

Radio

SAT 83 CET
R56 JC
120 JT
5000
125.01
4702

Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Bleeds	Optional
2A	AR	Field	EXT / 10	EXT	TO / TO	OFF / OFF	

'INO-SWEARINGEN
Aircraft Corp.
Reg No: N138BF Ser No: 002

Flight:
Date: 4/1

TO :34

Test Purpose: CHASE JOIN UP / TELEMETRY DATA CHECK

Test Procedure:

ENROUTE TO THE TEST AREA

1) SELECT/VERIFY: PILOT AIR DATA REVERSION TO PILOTS TC ADC

TM - ON

IN THE TEST AREA AT TEST ALTITUDE

1) CHECK COMMS BETWEEN ALL AIRCRAFT AND BASE
2) VERIFY TELEMETRY DATA RECEPTION
3) GROUND STATION TO VERIFY PROPER INSTRUMENTATION OPERATION

Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Bleeds
3A	A/R	AR	RETR / RETR	RETR	TFLF / TFLF	AR / AR

INO-SWEARINGEN
Aircraft Corp.
Reg No: N138BF Ser No: 002

Flight:
Date: 5/12

Test Purpose: FLUTTER TEST– 30-2222

Test Procedure:

1) SELECT / VERIFY: YAW DAMPER – OFF
2) TRIM FOR STRAIGHT LEVEL FLIGHT AT THE CONDITIONS NOTED
3) CROSS CHECK NOSEBOOM AIR DATA WITH COPILOT AIR DATA
4) FTE VERIFIES OK FOR TEST POINT

FLUTTER TEST

6) APPLY ELEVATOR CONTROL RAP, REPEAT OTHER DIRECTION
7) APPLY AILERON CONTROL RAP, REPEAT OTHER DIRECTION
8) APPLY A RUDDER KICK (LEFT OR RIGHT), REPEAT OTHER DIRECTION
9) RAPIDLY DEPLOY SPEEDBRAKE FULL (HOLD 2-3 SECONDS), RETRACT
10) AT THE COMPLETION OF TEST DECEL TO PREVIOUSLY CLEARED POINT, UNTIL FLUTTER COORDINATOR CLEARS TO NEXT TEST POINT.

NOTE: HIGH SPEED POINTS MAY REQUIRE A SHALLOW DIVE.
THE TOLERANCE BAND FOR THE TEST IS +/- 1000 FT.

NOTE: ON FTE CALL OR ADVERSE CHARACTERISTICS
PERFORM ABORT MANUEVER.

Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Bleeds

INO-SWEARINGEN
Aircraft Corp.
Reg No: N138BF Ser No: 002

Flight:
Date: 6/12

Test Purpose: FLUTTER TEST POINTS							
Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Yaw Damper	
~~12A~~	~~0.834~~	32k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-12	0.844	32k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
~~13A~~	~~0.854~~	32k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-13	0.864	32k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
~~14A~~	~~0.874~~	32k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-14	0.884	32k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-15	0.894	32k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-16	0.904/Mdf	32k	RETR	RETR	TFLF/TFLF	OFF	Full Wing

2000

.835 RT Roll

.855 Rumble

ABRUPT LH Roll

Rudder input?

38000

2

INO-SWEARINGEN
Aircraft Corp.
Reg No: N138BF Ser No: 002

Flight:
Date: 7/12

Test Purpose: FLUTTER TEST POINTS

Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Yaw Damper	
44A	321	18k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
44B	331	18k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-44	341	18k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
45A	351	18k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-45	361	18k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-46	371	18k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-47	376	18k	RETR	RETR	TFLF/TFLF	OFF	Full Wing

INO-SWEARINGEN
Aircraft Corp.
Reg No: N138BF Ser No: 002

Flight:
Date: 8/12

Test Purpose: FLUTTER TEST POINTS

Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Yaw Damper	
1-28	0.784	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
29A	0.794	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-29	0.804	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
30A	0.814	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-30	0.824	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
31A	0.834	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-31	0.844	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing

SINO-SWEARINGEN
Aircraft Corp.
Reg No: N138BF Ser No: 002

Flight:
Date: 9/12

Test Purpose: FLUTTER TEST POINTS

32A	0.854	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-32	0.864	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
33A	0.874	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-33	0.884	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
34A	0.894	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-34	0.894	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-35	0.904/Vdf	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing

SINO-SWEARINGEN
Aircraft Corp.
Reg No: N138BF Ser No: 002

Flight:
Date: 10/1-

Test Purpose: EXITING TEST AREA

Test Procedure:

EXITING TEST AREA

1) SYSTEM CHECKS: OVERHEAD DOOR -GUARDED / SAFE
ARM SWITCH – OFF

2) OVERHEAD DUMP HANDLE: STOWED / PINNED

3) DEFLECTOR: RETRACT / PINNED

4) SELECT/VERIFY: PILOT AIR DATA REVERSION - NORMAL

Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Bleeds
	A/R	A/R	RETR / RETR	RETR	TFLF / TFLF	AR / AR

INO-SWEARINGEN Aircraft Corp.

Reg No: N138BF Ser No: 002

Flight:
Date: 11/1_

Test Purpose: LANDING

Test Procedure:

1) ALERT BASE APPROXIMATELY 10 MINUTES BEFORE LANDING
2) CONDUCT A NORMAL FLAPS 31 LANDING
3) TAXI TO END OF RUNWAY, TURN OFF, SHUTDOWN LEFT ENGINE
4) GROUND CREW TO SECURE TRAILING CONE
5) TAXI TO RAMP; TURN ON GROUND POWER, SHUTDOWN THE RIGHT ENGINE. MAINTAIN ELECTRICAL POWER FOR DATA SYSTEM.

VAP ______________

VREF ______________

LANDING TIME ____________________

Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Bleeds
	1.3Vs +5	Field	EXT / 31	EXT	AR / AR	AR / AR

T/D
1456

LH SD 1457

1509 SD RH

'INO-SWEARINGEN
Aircraft Corp.
Reg No: N138BF Ser No: 002

Flight: ______
Date: ______ 12/1?

Test Purpose: DISARM STALL CHUTE & BLAST DEFLECTOR

Test Procedure:

1) CYPRESS DEVICE - DISCONNECT

2) DOOR:

DISCONNECT SEAL & ELECTRICAL

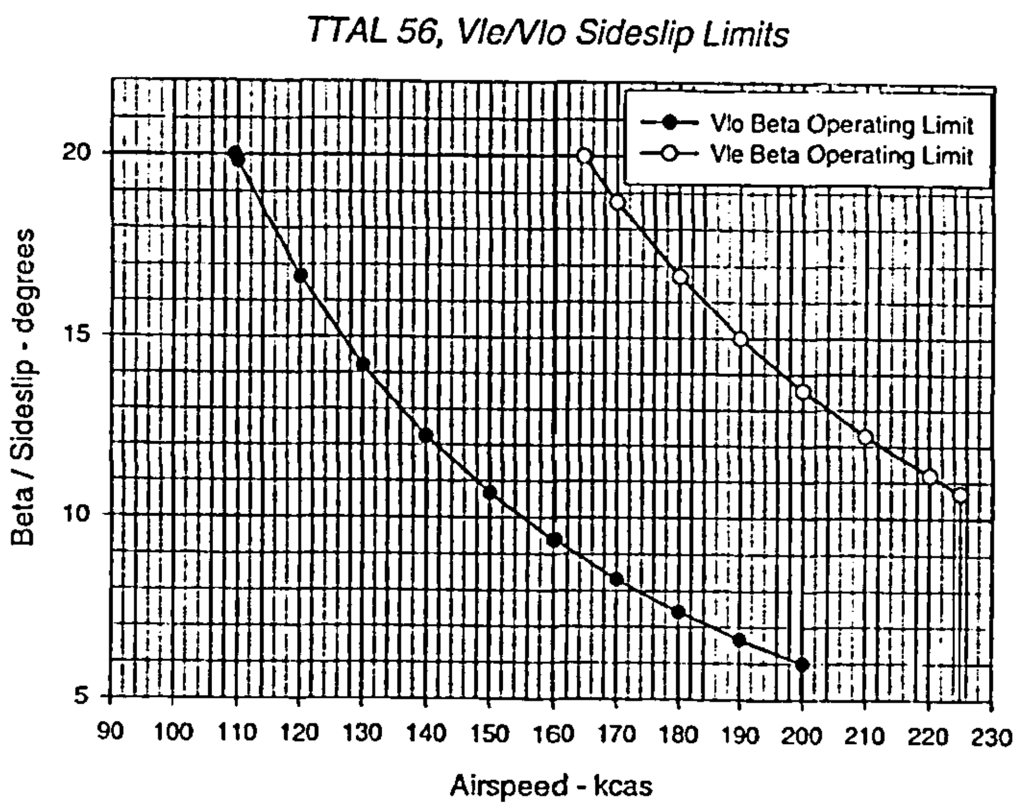
DOOR: ROTATE HANDLE
(COORDINATE WITH GRND CREW)

Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Bleeds
--	< 160	> 5k ft	EXT/0	RETR	TFLF	OFF

Aircraft S/N 002
Temporary Test Aircraft Limitation Summary

					TTAL No
Weight:		Maximum Takeoff	AFM Limits		
		Maximum Landing	AFM Limits		
Load Factor:		Clean	0.0g to 2.0g (trimmed), 0 to 2.0g (mistrimmed)		10,55,..
		Flaps 10, 20, 31	0.0g to 2.0 g		8,55
		Gear Operation	1g ± 0.25g		56
Altitude:		Maximum	AFM Limits		
Speeds:		Vmo/Mmo	320 knots / 0.83 Mach		7
		Vfe(10, 20)	180		8
		Vfe(31)	150		8
		Vlo / Vle	200 / 225		56
Yaw:		Gear Operating	Function of Airspeed (See Attached) 6°at 200 knots		56
		Gear Down / Locked	Function of Airspeed (See Attached) 10.7° at 225 knots		56
Operation:		VMC conditions ONLY, IMC Operation Prohibited			54, 63,
		Takeoff / Alternate airports and enroute must meet VFR requirements or as dictated by the PIC.			66
		Crosswind TO / Ldg	10 knots		58
Pilot Forces:		Elevator: 200 lbs	Monitor Forces where large sideslips, pilot control forces or g is expected.		55
		Aileron: 85 lbs			
		Rudder: 225 lbs			
Performance:	*Takeoff*		*Flaps 10*	***Flaps 20 Prohibited***	18, 68
		MTOW	AFM – 250 lbs	AFM – 650 lbs	18, 68
		TOFL	AFM + 550 ft	AFM + 600 ft	18, 68
		Speeds	AFM + 5	AFM + 5	18, 68
		1st Segment	AFM – 0.5%	AFM – 0.5%	18, 68
		3rd Segment Dist	AFM + 0.9 NM	AFM + 2.0 NM	18, 68
	Landing	MLW	AFM – 200 lbs		18
	Flaps 31	LFL	AFM + 275 ft		18
		Speeds	AFM + 5		18
		Brake Energy	(Hp<2kft) AFM +0.55 Million / ~~(2k<Hp<4kft) +1.6 Million~~		18
		Appr Grad (F10)	AFM – 0.5%		18
		Balked Ldg Climb	AFM – 2.0%		18
Systems:		Cabin Delta P	6 Psid 6 Psid Valves Installed		23, 59
		Wing Anti-Ice	Prohibited		1
		Engine Anti-Ice	Prohibited		2
		Autopilot Use	Prohibited		5,16
		Flight Director	Restricted (Uncoupled)		13
		Rudder Bias	Prohibited		16, 44
		Stick Pusher	Prohibited		6, 33
		Landing Light	Prohibited		57
Other:		No Flight into known heavy turbulence or forecasted greater than moderate			10
		No Flight into known Icing			4, 31
		No Full or Rapid Control Elevator Reversals (Exception Flutter)			10
		No intentional engine manual reversions in flight above idle.			11
		Takeoffs / Landing Gear Retraction prohibited when Brake Temps > 500°F			39
		Repeated Accel-Stops require to allow the entire brake assembly to cool to less than 100°F as noted by instrumentation or handheld brake temp device			39
		Landing Gear Warning Tone is disabled for Flaps less than landing			40
		Aileron Trim restricted to 20% and 80% of DAU indications (~ 20% remaining)			62
		Standby Static Source Heat Disconnected, Standby Pitot-Static Instruments may be affected in icing conditions			66
		Single Glidesope use Localizer Only Minimums, Dual Glideslopes tuned and monitored can use normal published minimas			72

Note: These limitations supersede those contained with the Preliminary AFM until lifted as detailed in Engineering Procedures EP-008. For limitations not listed refer to the Preliminary AFM.


TTAL 56, Vle/Vlo Sideslip Limits
Vlo Beta Operating Limit
Vle Beta Operating Limit
Beta / Sideslip - degrees
20
15
10
5
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
Airspeed - kcas

SINO-SWEARINGEN AIRCRAFT CO.

AIRPLANE LOADING MANIFEST

AIRCRAFT S/N: 002 S/N: N138BF
FLT No.: DATE: REV: D

Item Description	Weight lb	Fus. Sta. in	C.G. % Mac	Comments	Mom lb-in/1000
Basic Empty Weight	9111	350.92	34.99	BEW determined FTWO 02-5162	3197
Occupants					
Pilot	210	186.5		CB - 210, CW - 165, MS - 195, SH - 190, JB - 170, I	39
Test Conductor / Co-Pilot		186.5			
Flight Test Analysis		275.0			
Second Observer	0	222.1		Two Locations Possible FS 221.2 or FS 293	0
Cockpit					
Parachutes	16.5	198		Parachutes 16.5 lbs / ea	3
Seat Cushions	0	198		Each Cushion 1.5 lbs / ea	0
Main Cabin					
Repositionable Ballast Box	0	236.8		Location can vary from FS 205- 349 @ 95 lbs	0
Ballast	0	236.8		Add 6 lbs for Rack when total Ballast+Rack>450 lbs	0
Aft Baggage Compartment					
Ballast	280	427.2		Maximum Weight - 440 lbs / ea. rack	120
Ballast Rack (2)	118	426.0		Aft Racks - 59 lbs ea	50
Other					
	0	0.0		Add 9,223 in-lbs / 1000 for Gear	0
	0	0.0		Retracted Moment Calculation	0
Unusable Fuel, lb					
Unusable Fuel, lb				Included in BEW Build Up	
ZERO FUEL WEIGHT (MAX 10,100 LB):	9735	350.2	33.85		3409
Fuel, lb					
Fuel Quantity	3500	344.7		Max = 458 gal, 3066 lb	1206.5
RAMP WEIGHT (MAX 13,600 LB):	13235	348.8	31.48		4616

Loading Summary

Total Occupant Load (LB): 210 lbs
Total Fuel Load (LB): 3500 lbs
Total Payload (LB): 398 lbs
Ramp C.G. (%MAC): 31.48

Wheel Loading Reactions

Nose	*Main*
951	*12285*

T.O. C.G. Limits: Fwd = 18.44, Aft = 34.85

Prepared by
Flight Test Operations

Checked / Approved by
Flight Crew Member

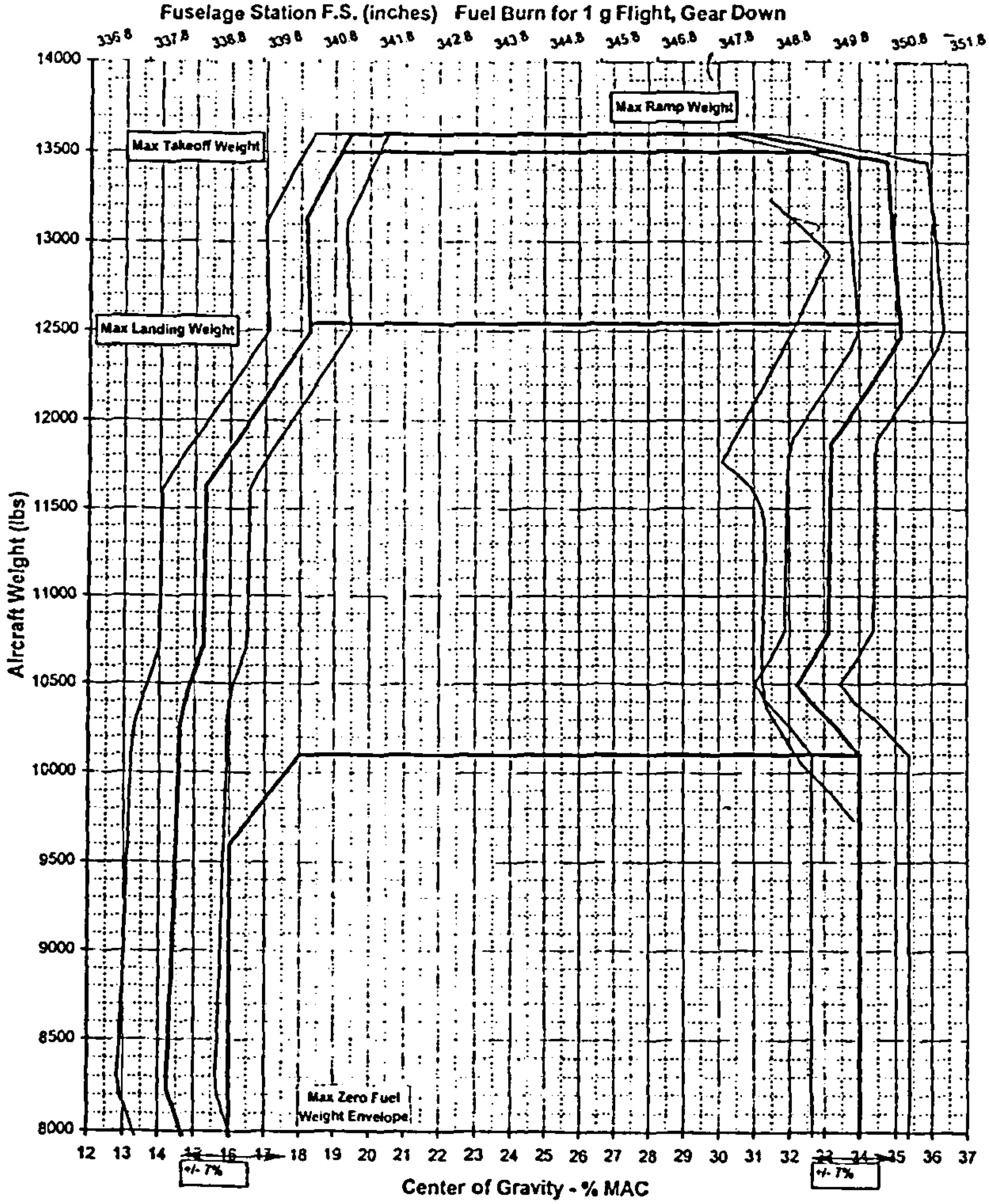
Approved by
Manager Test Operations

SINO-SWEARINGEN AIRCRAFT CO.

AIRPLANE LOADING MANIFEST

AIRCRAFT S/N: 002 S/N: N138BF

FLT No.: DATE: REV: D



SINO SWEARINGEN
AIRCRAFT CORPORATION

AIRCRAFT RELEASE FORM

FLT. NO. 230
DATE: APR 25, 2003

A/C TYPE: SWEARINGEN SJ30-2 A/C S/N: 002 REG. NO. N138BF

REFERENCE LASTEST SSAC APPROVED "AIRCRAFT INSPECTION / RELEASE AUTHORIZATION" DOCUMENT FOR LISTING OF AUTHORIZED PERSONNEL TO RELEASE THIS AIRCRAFT

1. AIRCRAFT PREFLIGHT:

THIS AIRCRAFT HAS BEEN INSPECTED IN ACCORDANCE WITH THE LATEST FAA APPROVED VERSION OF SSAC INSPECTION PROCEDURES "QA-INSPECTION-500". BASED ON THE FLIGHT PLAN FILED *[VFR, VFR NIGHT, OR IFR]*, THE APPLICABLE INSTRUMENTS & EQUIPMENT SPECIFIED IN FAR §91.205 ARE OPERATIONAL.

THE AIRCRAFT IS READY FOR GROUND AND/OR FLIGHT TEST[S].

AIRCRAFT CREW CHIEF SSAC QUALITY ASSURANCE

2. CONFIGURATION/MAINTENANCE:

THIS AIRCRAFT WAS BALLASTED AND FUELED IN ACCORDANCE WITH *FTWO NO.* 2-5223

FTWOs ISSUED SINCE LAST GROUND/FLIGHT TEST HAVE BEEN CLOSED WITH THE EXCEPTION OF THE FOLLOWING:

DEFERRED FTWOs: REFERENCE ATTACHED FTWO STATUS REPORT

RELEASED & ACCOMPLISHED "SPECIAL INSPECTIONS" THAT WERE REQUIRED SINCE LAST FLIGHT

LEAD, FLT TEST GROUND OPS SSAC QUALITY ASSURANCE

3. INSTRUMENTATION:

INSTRUMENTATION SYSTEM FUNCTIONAL/CALIBRATION CHECKS HAVE BEEN ACCOMPLISHED IN ACCORDANCE WITH APPROPRIATE FTWO[S] AND/OR SSAC REPORTS AND IS SATISFACTORY

ADDITIONAL REMARKS: ______

LEAD, INSTRUMENTATION

4. TEST CARD / LIMITATIONS:

AIRCRAFT AND INSTRUMENTATION ARE ACCEPTABLE FOR TEST(S) PRESCRIBED ON TEST CARD.

ADDITIONAL LIMITATIONS: ______

MANAGER, TEST OPERATIONS

5. AIRCRAFT ACCEPTANCE:

I HAVE REVIEWED THE CONFIGURATION CHANGES [FTWOs] THAT WERE MADE TO THIS AIRCRAFT SINCE THE LAST TEST AND ACCEPT THE AIRCRAFT FOR THE SPECIFIED GROUND AND/OR FLIGHT TEST.

PILOT-IN-COMMAND

SINO-SWEARINGEN AIRCRAFT INC.

Flt No. 230

Reg. No: N138BF | Serial No: 002 | Observer: | Date:

Time	Run	AS	ALT	TAT	ITT		WT	CG
	1-13							
13		290	35000			.875/.934 airframe rumble		
131600		245	37000			uncommanded roll to the left .845		
16			25000			.845 left roll increase in rumble		
131500 — stop								

John Doe

SINO-SWEARINGEN AIRC... .FT INC.

Reg. No: N138BF Serial No: 002 Observer: ____ Flt No. 230 Date: ____

Time	Run	AS	ALT	TAT	ITT		WT	CG
123730	Take off		NOTE	~~DAS~~	TIME		ZFW	9735 / 2000 / 11735
124516 ~~[illegible]~~	TM LOCK					@ 1:50 ON STATION		
		GW = 12775		2990 lbs fuel				
		236	23351					
	1-13							
130330	M1							
0338	M2							
0342	M3							
0349	M4	L Roll		,835/.84	~~airframe noise - left roll about 1/2~~ right point ~~now L wing~~ Full			
0405	M5	Rudy						
0411	M6			Carroll	- airframe noise from right roll about 1/2 way thru point			
0418	M7	SP			- now using FULL AILERON TRIM			
		clean						
130428	stop			Peter Jennings				
		GW 12332			- Mach buffet			

SINO-SWEARINGEN
Aircraft Co.

Model: SJ30 Flight: 23
Reg No: N138BF Date: 4/24
Ser No: 002 Cards:

Purpose of Flight:
Flutter Testing - [Report 30-2222]

Test Limitations / Hazards:
See Attached TTAL Summary

Monitor Brake Temperatures
TAKEOFF– 500° F

MANUAL FUEL SYSTEM OPERATION
FOR DIVERTER VALVE

6 PSID PRESSURIZATION VALVES INSTLD
CABIN ALT WARN - 13840 FT+0/-1300 FT

AILERON CONTROLS MODIFIED -
TRAVELS +16° / -11°.

FLIGHT CONTROLS BALANCE TO AFT LIMIT

SPEEDBRAKES LIMITED TO ½ TRAVEL

Test Specifics:

NOSE BOOM INSTALLED
EGRESS DOOR INSTALLED
TM ANTENNA INSTALLED
RAD ALT REMOVED
EMERGENCY DUMP VALVE INSTALLED
GURNEY FLAP INSTALLED
Standby static heat - disconnected

L / R WAI Door Control Circuit Breakers – IN
L/ R WAI Door Operational via WAI Switch/FTE Cntl

Stick shaker elevator servo & column pusher motor
– connectors/wiring are capped/stowed

Circuit Breakers Collared:

Non Ess Bus
L/R Ldg Light
Cabin Reading/Ovhd
FSB / No Smoke
Emer Exit
Cabin Press
Column Pusher
Ice Detect Cont / Pwr
Hor Stab
L/R Wing Ice Protection
L/R WAI Pwr
L/R AOA Ice Protection
Rud Bias
AP Servos
L/R AOA Cmptr
Wx Rdr Cont / Pwr
TCAS, Flt Phone, Toilet
Hot Cup 1 & 2, Comp Outlet
Entertain System

Total Pilot Side = 18
Total Copilot Side = 11

Takeoff		*Flight Crew*		*Flight Time*	
T.O. G.Wt		Pilot	Beeler	Taxi	
T.O. N1		Co-Pilot / FTE		Takeoff	
		FTE / Observer		Land	

SINO-SWEARINGEN
Aircraft Corp.
Reg No: N138BF *Ser No:* 002

Flight: ______
Date: ______

1/1

Test Purpose:	PRE-START
Test Procedure:	
INSTRUMENTATION:	DISPLAYS ON & OPERATING
EGRESS DOOR:	INSTALL AND LATCH (COORDINATE WITH GRND CREW) PIN ENGAGEMENT (6)
SYSTEM CONNECTIONS:	SEAL & ELECTRICAL
SYSTEM CHECKS:	OVERHEAD DOOR UNLOCK SW -GUARDED / SAFE ARM SWITCH – ON ILLUMINATED
OVERHEAD DUMP HANDLE:	STOWED / UNPINNED
DEFLECTOR:	EXTEND / UNPINNED
CYPRESS DEVICE:	ATTACHED
PILOT EVENT:	DEPRESSED (1 SEC) TOD: ________________

Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Bleeds	Optional

SINO-SWEARINGEN
Aircraft Corp.
Reg No: N138BF Ser No: 002

Flight:
Date:

2/ :

Test Purpose: FLIGHT CONTROL SWEEP

Test Procedure:

1) START THE RIGHT ENGINE
2) CHECK COMS WITH CHASE / BASE AS REQUIRED
3) FOR EACH AXES PERFORM A SLOW FLIGHT CONTROL ROLLOUT
4) SET STABILIZER TO 7 DEGREES
5) SELECT/VERIFY: PILOT AIR DATA REVERSION – NORMAL

Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Bleeds	Optional
1A	AR	Field	EXT / 10	EXT	AR / AR	OFF / OFF	

SINO-SWEARINGEN
Aircraft Corp.

Reg No: N138BF Ser No: 002

Flight:
Date:

3/1

Test Purpose: FLAPS 10 TAKEOFF

Test Procedure:

1) TAXI TO HOLD SHORT OF RUNWAY
2) PILOT TO CLEAR GROUND CREW FOR TRAILING CONE DEPLOYMENT
3) PERFORM A CROSS-START OF THE LEFT ENGINE.
4) SELECT/VERIFY: YAW DAMPER – ON
5) PERFORM A NORMAL FLAPS 10 TAKEOFF

NOTE: GROUND CREW VERIFIES TRAILING CONE REMAINS ON AIRCRAFT. CROSS CHECK VSPEEDS AND POWER SETTING WITH BASE.

V1 ______________

VR ______________

V2 ______________

TO N1 ______________

TAKEOFF TIME ______________

Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Bleeds	Optional
2A	AR	Field	EXT / 10	EXT	TO / TO	OFF / OFF	

SINO-SWEARINGEN
Aircraft Corp.
Reg No: N138BF Ser No: 002

Flight:
Date: 4/1

Test Purpose: CHASE JOIN UP / TELEMETRY DATA CHECK

Test Procedure:

ENROUTE TO THE TEST AREA

1) SELECT/VERIFY: PILOT AIR DATA REVERSION TO $\boxed{\text{PILOTS TC ADC}}$

IN THE TEST AREA AT TEST ALTITUDE

1) CHECK COMMS BETWEEN ALL AIRCRAFT AND BASE
2) VERIFY TELEMETRY DATA RECEPTION
3) GROUND STATION TO VERIFY PROPER INSTRUMENTATION OPERATION

Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Bleeds
3A	A/R	AR	RETR / RETR	RETR	TFLF / TFLF	AR / AR

SINO-SWEARINGEN
Aircraft Corp.
Reg No: N138BF Ser No: 002

Flight:
Date: 5/1

Test Purpose: FLUTTER TEST– 30-2222

Test Procedure:

1) SELECT / VERIFY: YAW DAMPER – OFF
2) TRIM FOR STRAIGHT LEVEL FLIGHT AT THE CONDITIONS NOTED
3) CROSS CHECK NOSEBOOM AIR DATA WITH COPILOT AIR DATA
4) FTE VERIFIES OK FOR TEST POINT

FLUTTER TEST

6) APPLY ELEVATOR CONTROL RAP, REPEAT OTHER DIRECTION
7) APPLY AILERON CONTROL RAP, REPEAT OTHER DIRECTION
8) APPLY A RUDDER KICK (LEFT OR RIGHT), REPEAT OTHER DIRECTION
~~9) RAPIDLY DEPLOY SPEEDBRAKE FULL (HOLD 2-3 SECONDS), RETRACT~~
10) AT THE COMPLETION OF TEST DECEL TO PREVIOUSLY CLEARED POINT, UNTIL FLUTTER COORDINATOR CLEARS TO NEXT TEST POINT.

NOTE: HIGH SPEED POINTS MAY REQUIRE A SHALLOW DIVE.
THE TOLERANCE BAND FOR THE TEST IS +/- 1000 FT.

NOTE: ON FTE CALL OR ADVERSE CHARACTERISTICS
PERFORM ABORT MANUEVER.

Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Bleeds

SINO-SWEARINGEN
Aircraft Corp.

Reg No: N138BF Ser No: 002

Flight:
Date: 6/1

Test Purpose: FLUTTER TEST POINTS

Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Yaw Damper	
12A	0.834	32k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-12	0.844	32k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
13A	0.854	32k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-13	0.864	32k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
14A	0.874	32k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-14	0.884	32k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-15	0.894	32k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-16	0.904/Mdf	32k	RETR	RETR	TFLF/TFLF	OFF	Full Wing

SINO-SWEARINGEN
Aircraft Corp.
Reg No: N138BE Ser No: 002

Flight:
Date: 7/.

Test Purpose: FLUTTER TEST POINTS

Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Yaw Damper	
44A	321	18k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
44B	331	18k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-44	341	18k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-45A	351	18k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-45	361	18k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-46	371	18k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-47	376	18k	RETR	RETR	TFLF/TFLF	OFF	Full Wing

SINO-SWEARINGEN
Aircraft Corp.

Flight:
Date: 8/1

Reg No: N138BE Ser No: 002

Test Purpose: FLUTTER TEST POINTS

Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Yaw Damper	
1-28	0.784	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
29A	0.794	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-29	0.804	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
30A	0.814	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-30	0.824	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
31A	0.834	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-31	0.844	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing

SINO-SWEARINGEN
Aircraft Corp.
Reg No: N138BF Ser No: 002

Flight:
Date: 9/12

Test Purpose: FLUTTER TEST POINTS

1-32A	0.854	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-32	0.864	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-33A	0.874	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-33	0.884	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-34A	0.894	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-34	0.894	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing
1-35	0.904/Vdf	26.1k	RETR	RETR	TFLF/TFLF	OFF	Full Wing

SINO-SWEARINGEN
Aircraft Corp.
Reg No: N138BF Ser No: 002

Flight:
Date: 10/

Test Purpose: EXITING TEST AREA

Test Procedure:

EXITING TEST AREA

1) SYSTEM CHECKS: OVERHEAD DOOR -GUARDED / SAFE
ARM SWITCH -- OFF

2) OVERHEAD DUMP HANDLE: STOWED / PINNED

3) DEFLECTOR: RETRACT / PINNED

4) SELECT/VERIFY: PILOT AIR DATA REVERSION - NORMAL

Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Bleeds
	A/R	A/R	RETR / RETR	RETR	TFLF / TFLF	AR / AR

SINO-SWEARINGEN
Aircraft Corp.
Reg No: N138BF Ser No: 002

Flight:
Date:

11/

Test Purpose: LANDING

Test Procedure:

1) ALERT BASE APPROXIMATELY 10 MINUTES BEFORE LANDING
2) CONDUCT A NORMAL FLAPS 31 LANDING
3) TAXI TO END OF RUNWAY, TURN OFF, SHUTDOWN LEFT ENGINE
4) GROUND CREW TO SECURE TRAILING CONE
5) TAXI TO RAMP; TURN ON GROUND POWER, SHUTDOWN THE RIGHT ENGINE. MAINTAIN ELECTRICAL POWER FOR DATA SYSTEM.

VAP ____________

VREF ____________

LANDING TIME ________________

Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Bleeds
	1.3Vs +5	Field	EXT / 31	EXT	AR / AR	AR / AR

SINO-SWEARINGEN
Aircraft Corp.

Reg No: N138BF Ser No: 002

Flight: ______
Date: ______ 12/..

Test Purpose: DISARM STALL CHUTE & BLAST DEFLECTOR

Test Procedure:

1) CYPRESS DEVICE - DISCONNECT

2) DOOR:

DISCONNECT SEAL & ELECTRICAL

DOOR: ROTATE HANDLE
(COORDINATE WITH GRND CREW)

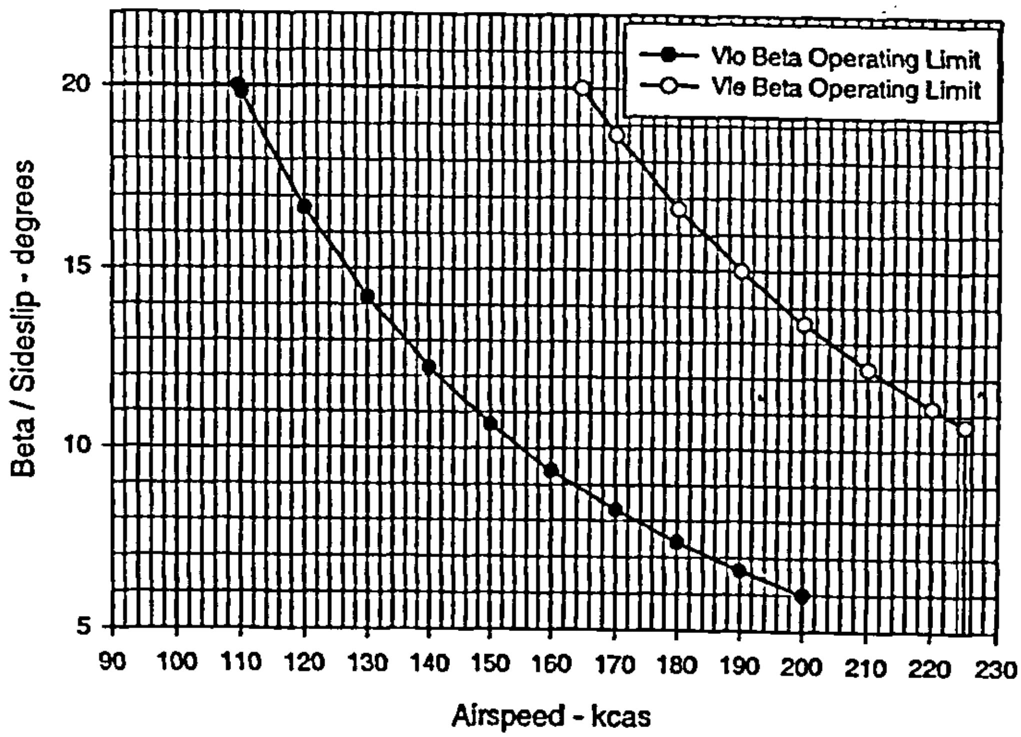
Run	A/S	Alt	Slats / Flaps	Gear	Power Set	Bleeds
--	< 160	> 5k ft	EXT/0	RETR	TFLF	OFF

Aircraft S/N 002
Temporary Test Aircraft Limitation Summary

					TTAL No.
Weight:		Maximum Takeoff	AFM Limits		
		Maximum Landing	AFM Limits		
Load Factor:		Clean	0.0g to 2.0g (trimmed), 0 to 2.0g (mistrimmed)		10,55,60
		Flaps 10, 20, 31	0.0g to 2.0 g		8,55
		Gear Operation	1g ± 0.25g		56
Altitude:		Maximum	AFM Limits		
Speeds:		Vmo/Mmo	320 knots / 0.83 Mach		7
		Vfe(10, 20)	180		8
		Vfe(31)	150		8
		Vlo / Vle	200 / 225		56
Yaw:		Gear Operating	Function of Airspeed (See Attached) 6° at 200 knots		56
		Gear Down / Locked	Function of Airspeed (See Attached) 10.7° at 225 knots		56
Operation:		VMC conditions ONLY, IMC Operation Prohibited			54, 63,
		Takeoff / Alternate airports and enroute must meet VFR requirements or as dictated by the PIC.			66
		Crosswind TO / Ldg	10 knots		58
Pilot Forces:		Elevator: 200 lbs	Monitor Forces where large sideslips, pilot control forces or g is expected.		55
		Aileron: 85 lbs			
		Rudder: 225 lbs			
Performance:	*Takeoff*		*Flaps 10*	*Flaps 20 Prohibited*	18, 68
		MTOW	AFM – 250 lbs	AFM – 600 lbs	18, 68
		TOFL	AFM + 550 ft	AFM + 600 ft	18, 68
		Speeds	AFM + 5	AFM + 5	18, 68
		1st Segment	AFM – 0.5%	AFM – 0.5%	18, 68
		3rd Segment Dist	AFM + 0.9 NM	AFM + 2.0 NM	18, 68
	Landing	MLW	AFM – 200 lbs		18
	Flaps 31	LFL	AFM + 275 ft		18
		Speeds	AFM + 5		18
		Brake Energy	(Hp<2kft) AFM +0.55 Million / ~~(2k<Hp<4kft) +1.6 Million~~		18
		Appr Grad (F10)	AFM – 0.5%		18
		Balked Ldg Climb	AFM – 2.0%		18
Systems:		Cabin Delta P	6 Psid 6 Psid Valves Installed		23, 59
		Wing Anti-Ice	Prohibited		1
		Engine Anti-Ice	Prohibited		2
		Autopilot Use	Prohibited		5,16
		Flight Director	Restricted (Uncoupled)		13
		Rudder Bias	Prohibited		16, 44
		Stick Pusher	Prohibited		6, 33
		Landing Light	Prohibited		57
Other:		No Flight into known heavy turbulence or forecasted greater than moderate			10
		No Flight into known Icing			4, 31
		No Full or Rapid Control Elevator Reversals (Exception Flutter)			10
		No Intentional engine manual reversions in flight above idle.			11
		Takeoffs / Landing Gear Retraction prohibited when Brake Temps > 500°F			39
		Repeated Accel-Stops require to allow the entire brake assembly to cool to less than 100°F as noted by instrumentation or handheld brake temp device			39
		Landing Gear Warning Tone is disabled for Flaps less than landing			40
		Aileron Trim restricted to 20% and 80% of DAU indications (~ 20% remaining)			62
		Standby Static Source Heat Disconnected, Standby Pitot-Static Instruments may be affected in icing conditions			66
		Single Glidesope use Localizer Only Minimums, Dual Glideslopes tuned and monitored can use normal published minimas			72

Note: These limitations supersede those contained with the Preliminary AFM until lifted as detailed in Engineering Procedures EP-008. For limitations not listed refer to the Preliminary AFM.

TTAL 56, Vle/Vlo Sideslip Limits



SINO-SWEARINGEN AIRCRAFT CO.

AIRPLANE LOADING MANIFEST

AIRCRAFT S/N: 002 S/N: N138BF
FLT No.: DATE: REV: D

Item Description	Weight lb	Fus. Sta. in	C.G. % Mac	Comments	Moment lb-in/1000
Basic Empty Weight	9111	350.92	34.99	BEW determined FTWO 02-5162	3197
Occupants					
Pilot	210	186.5		CB - 210, CW - 165, MS - 195, SH - 190, JB - 170, I	39
Test Conductor / Co-Pilot		186.5			
Flight Test Analysis		275.0			
Second Observer	0	222.1		Two Locations Possible FS 221.2 or FS 293	0
Cockpit					
Parachutes	16.5	198		Parachutes 16.5 lbs / ea	3
Seat Cushions	0	198		Each Cushion 1.5 lbs / ea	0
Main Cabin					
Repositionable Ballast Box	0	236.8		Location can vary from FS 205- 349 @ 95 lbs	0
Ballast	0	236.8		Add 6 lbs for Rack when total Ballast+Rack>450 lbs	0
Aft Baggage Compartment					
Ballast	280	427.2		Maximum Weight - 440 lbs / ea. rack	120
Ballast Rack (2)	118	426.0		Aft Racks - 59 lbs ea	
Other					
	0	0.0		Add 9,223 in-lbs / 1000 for Gear	0
	0	0.0		Retracted Moment Calculation	0
Unusable Fuel, lb					
Unusable Fuel, lb				Included in BEW Build Up	
ZERO FUEL WEIGHT (MAX 10,100 LB):	9735	350.2	33.85		3409
Fuel, lb					
Fuel Quantity	3500	344.7		Max = 458 gal, 3068 lb	1206.5
RAMP WEIGHT (MAX 13,600 LB):	13235	348.8	31.48		4616

Loading Summary

Total Occupant Load (LB): 210 lbs
Total Fuel Load (LB): 3500 lbs
Total Payload (LB): 398 lbs
Ramp C.G. (%MAC): 31.48

Wheel Loading Reactions

Nose	*Main*
951	*12285*

T.O. C.G. Limits: Fwd = 18.44, Aft = 34.85

Mark Fairchild
Prepared by
Flight Test Operations

Checked / Approved by
Flight Crew Member

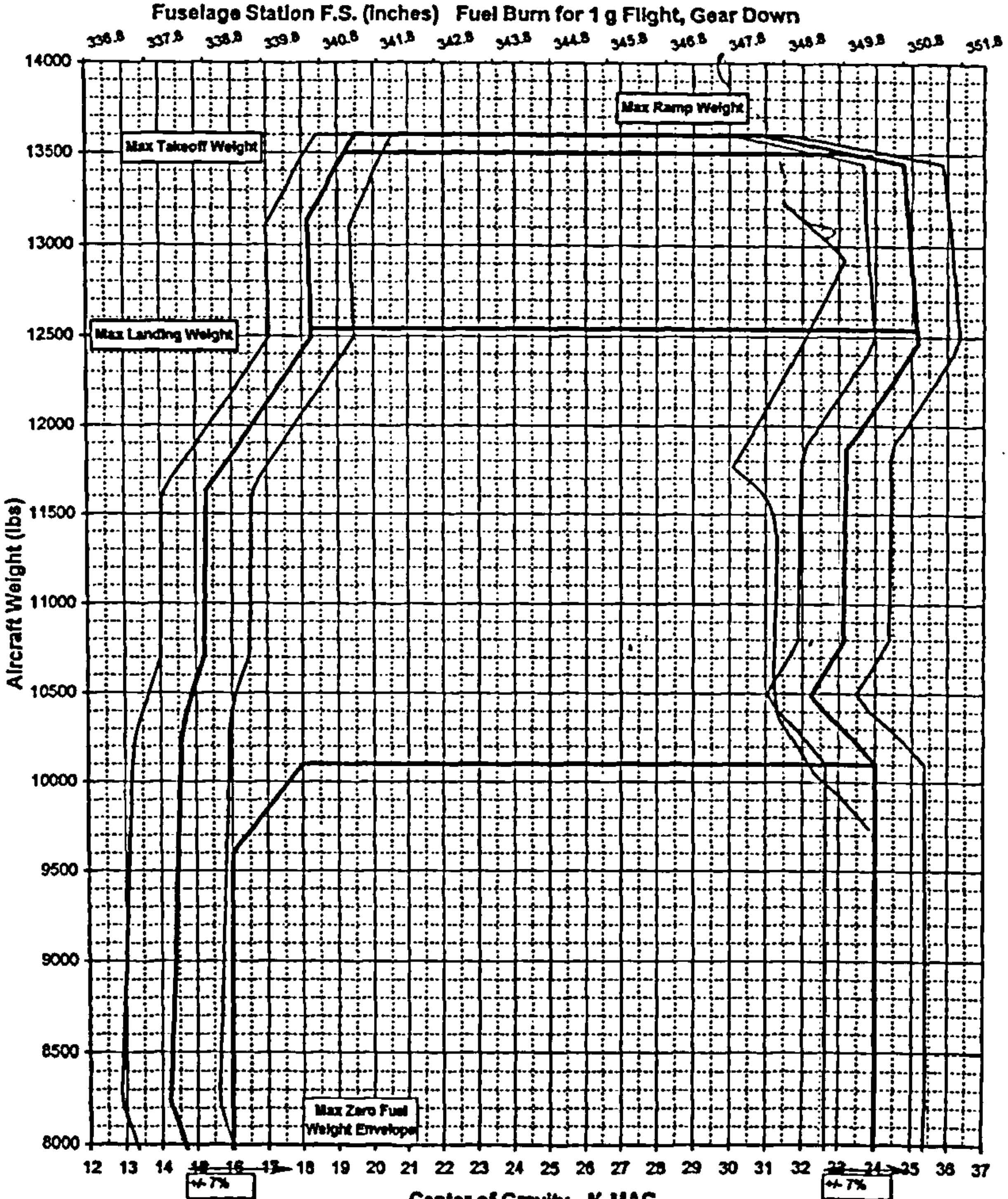
Approved by
Manager Test Operations

SINO-SWEARINGEN AIRCRAFT CO.

AIRPLANE LOADING MANIFEST

AIRCRAFT S/N: 002 S/N: N138BF

FLT No.: DATE: REV: D



SINO SWEARINGEN AIRCRAFT CORPORATION

AIRCRAFT RELEASE FORM

FLT. NO 231

DATE: APR 26, 2003

A/C TYPE: SWEARINGEN SJ30-2 | A/C S/N: 002 | REG. NO. N138BF

REFERENCE LASTEST SSAC APPROVED "AIRCRAFT INSPECTION / RELEASE AUTHORIZATION" DOCUMENT FOR LISTING OF AUTHORIZED PERSONNEL TO RELEASE THIS AIRCRAFT

1. AIRCRAFT PREFLIGHT:

THIS AIRCRAFT HAS BEEN INSPECTED IN ACCORDANCE WITH THE LATEST FAA APPROVED VERSION OF SSAC INSPECTION PROCEDURES "QA-INSPECTION-500". BASED ON THE FLIGHT PLAN FILED [VFR, VFR NIGHT, OR IFR], THE APPLICABLE INSTRUMENTS & EQUIPMENT SPECIFIED IN FAR §91.205 ARE OPERATIONAL.

THE AIRCRAFT IS READY FOR GROUND AND/OR FLIGHT TESTS!

AIRCRAFT CREW CHIEF

SSAC QUALITY ASSURANCE

2. CONFIGURATION/MAINTENANCE:

THIS AIRCRAFT WAS BALLASTED AND FUELED IN ACCORDANCE WITH *FTWO NO.* 2-5227

FTWOs ISSUED SINCE LAST GROUND/FLIGHT TEST HAVE BEEN CLOSED WITH THE EXCEPTION OF THE FOLLOWING:

DEFERRED FTWOs: REFERENCE ATTACHED FTWO STATUS REPORT

RELEASED & ACCOMPLISHED "SPECIAL INSPECTIONS" THAT WERE REQUIRED SINCE LAST FLIGHT

LEAD, FLT TEST GROUND OPS

SSAC QUALITY ASSURANCE

3. INSTRUMENTATION:

INSTRUMENTATION SYSTEM FUNCTIONAL/CALIBRATION CHECKS HAVE BEEN ACCOMPLISHED IN ACCORDANCE WITH APPROPRIATE FTWO[S] AND/OR SSAC REPORTS AND IS SATISFACTORY

ADDITIONAL REMARKS:

LEAD, INSTRUMENTATION

4. TEST CARD / LIMITATIONS:

AIRCRAFT AND INSTRUMENTATION ARE ACCEPTABLE FOR TEST(S) PRESCRIBED ON TEST CARD.

ADDITIONAL LIMITATIONS:

MANAGER, TEST OPERATIONS

5. AIRCRAFT ACCEPTANCE:

I HAVE REVIEWED THE CONFIGURATION CHANGES [FTWOs] THAT WERE MADE TO THIS AIRCRAFT SINCE THE LAST TEST AND ACCEPT THE AIRCRAFT FOR THE SPECIFIED GROUND AND/OR FLIGHT TEST.

PILOT-IN-COMMAND

SINO-SWEARINGEN AIRCRAFT CO.

AIRPLANE LOADING MANIFEST

AIRCRAFT S/N: 002 S/N: N138BF
FLT No.: DATE: REV: D

Item Description	Weight lb	Fus. Sta. in	C.G. % Mac	Comments	Moment lb-in/1000
Basic Empty Weight	9111	350.92	34.99	BEW determined FTWO 02-5162	3197
Occupants					
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Test Conductor / Co-Pilot		186.5			
Flight Test Analysis		275.0			
Second Observer	0	222.1		Two Locations Possible FS 221.2 or FS 293	0
Cockpit					
Parachutes	16.5	198		Parachutes 16.5 lbs / ea	3
Seat Cushions	0	198		Each Cushion 1.5 lbs / ea	0
Main Cabin					
Repositionable Ballast Box	0	236.8		Location can vary from FS 205- 349 @ 95 lbs	0
Ballast	0	236.8		Add 6 lbs for Rack when total Ballast+Rack>450 lbs	0
Aft Baggage Compartment					
Ballast	280	427.2		Maximum Weight - 440 lbs / ea. rack	120
Ballast Rack (2)	118	426.0		Aft Racks - 59 lbs ea	50
Other					
	0	0.0		Add 9,223 in-lbs / 1000 for Gear	0
	0	0.0		Retracted Moment Calculation	0
Unusable Fuel, lb					
Unusable Fuel, lb				Included in BEW Build Up	
ZERO FUEL WEIGHT (MAX 10,100 LB):	9735	350.2	33.85		3409
Fuel, lb					
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Ramp C.G. (%MAC): 31.48

Wheel Loading Reactions

Nose	Main
951	12285

T.O. C.G. Limits: Fwd = 18.44, Aft = 34.85

Prepared by
Flight Test Operations

Checked / Approved by
Flight Crew Member

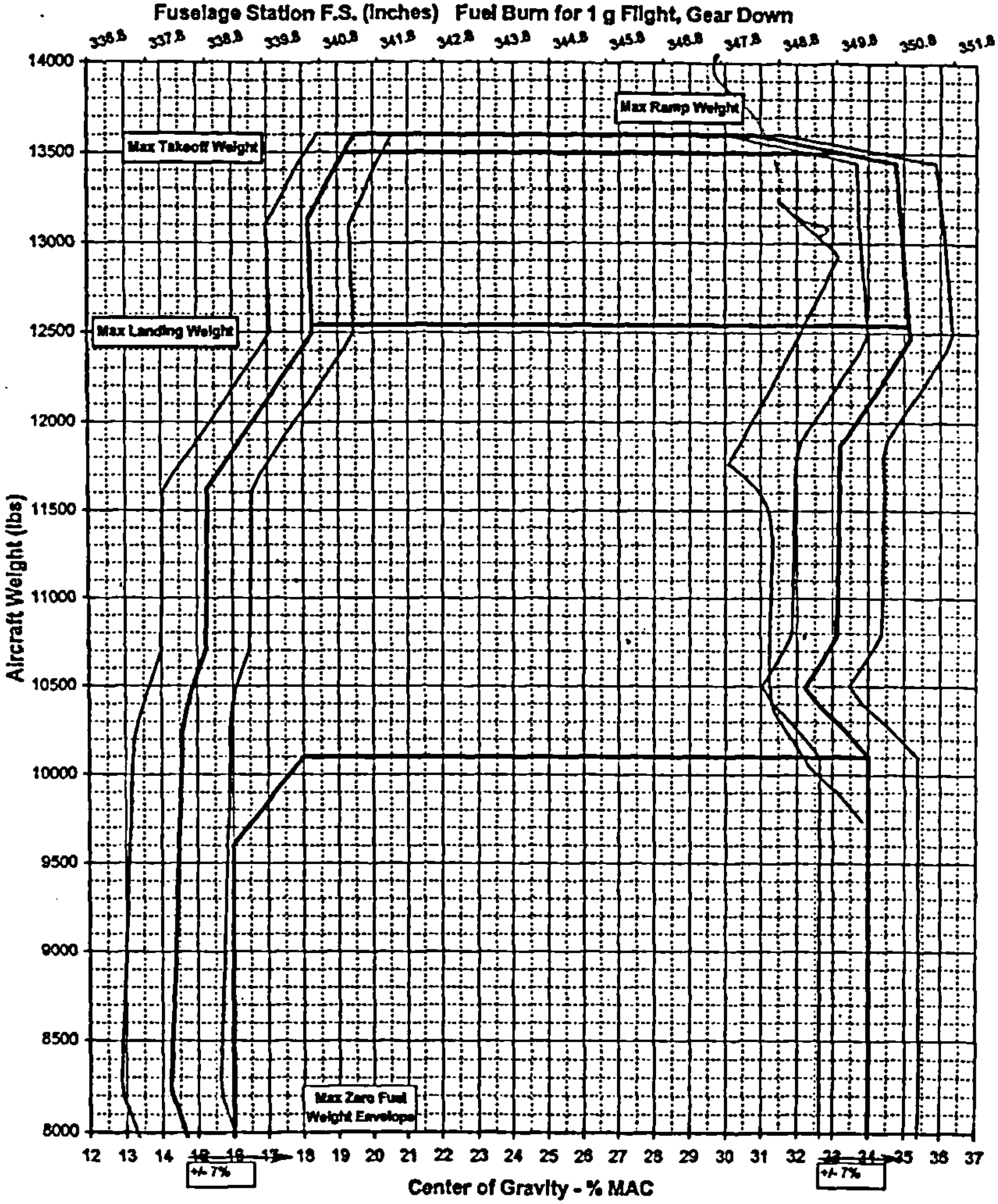
Approved by
Manager Test Operations

SINO-SWEARINGEN AIRCRAFT CO.

AIRPLANE LOADING MANIFEST

AIRCRAFT S/N: 002 S/N: N138BF

FLT No.: DATE: REV: D



SSAC SJ30-2 Flight 231: Post Flight Briefing April 26, 2003

Location: SSAC Flight Test Conference Room & SSAC TM Team in Rocksprings, TX

Time: 11:30 – 12:00 CST

Attendees:

Luca Ciccolari Micaldi, Johnny Doo, Ed Swearingen, Doug Gore, Michael Cavanaugh, Chuck Walls, Chuck Thornton, Tom Boardman, Victor Holmes, David Schweitzer (TM Team), Pat Carvel (TM Team), Peter Jennings (TM Team), Joe Zhao (TM Team).

The airplane was flying a mission to fulfill the requirements of SSAC Report 30-2222, "Flight Flutter Certification Test Plan for SSAC Aircraft Model SJ30-2".

Aircraft loading information, test limitations, test procedures, test conditions were per the test card for Flight 231, dated 4/26/03. The test aircraft was SN002 and the test pilot (and sole occupant) was Carroll Beeler. The following are the minutes of the post flight briefing conducted at the location and time indicated above.

1st test point (No. 14A, M_{IND}= .874)

TM Crew: test aircraft accelerated to target speed and, when on-condition, pilot input elevator, aileron and rudder in succession, as required;

test aircraft was cleared to the next test point;

Chase: crew noticed nothing unusual around the test airplane.

2nd test point (No. 1-14, M_{IND}= .884)

Test pilot: rumble at .865M_{IND};

TM Crew: test aircraft accelerated to target speed and, when on-condition, pilot input elevator, aileron and rudder in succession, as required;

wing showed Mach buffet; excitation decays looked OK;

test aircraft was cleared to the next test point;

pilot reported that full left aileron trim was required for this point;

no forces are available on the TM stream, but pilot had to hold additional aileron, on top of full aileron trim, to maintain wings level.

Chase: crew noticed nothing unusual around the test airplane, except that it was in a noticeable, yet controlled, right angle of bank before the event precipitated.

At the time of this debriefing, it was not clear what had happened after the airplane had been cleared to proceed to the next test point (M_{IND}= .894). Data from the TM will possibly reveal what happened then, i.e. whether the airplane accelerated towards the next test point or decelerated to re-enter the racetrack pattern in preparation for the next test point.

The test pilot then was heard on the radio saying, "The aircraft is rolling, I can't stop it" and the crew aboard the chase noticed that the airplane was in what appeared to be an uncontrollable, right-wing-down roll.

The chase crew followed the test aircraft until it impacted the terrain, exploded and caught on fire. In their assessment, the test pilot had not abandoned the aircraft prior to its impact with the ground. The estimated crash site was 29° 49' N and 101° W.

The TM crew informed that a total of 24 parameters were transmitted from the aircraft to the ground station, among which are all control surface positions (except aileron), airspeed, Mach, altitude and accelerometer data. The data transmitted to the ground station was subsequently copied to hard drive for post-processing.

5-17-2004

Subject: Activities incorporated since accident

Dear Paul Cox,

Hello Paul,

Thank you for your expedient support to finalize the NTSB report.

As per you request I have listed below a number of activities that have been implemented at SSAC after the loss of aircraft 002. Those activities followed by an "*" indicate they were underway before the accident.

If you have any questions please feel free to call myself or Bob Homan.

Regards,

Alfred Baumbusch
Senior Vice President Operations

Manpower

1. Hired additional test pilots and flight test engineers all having past business jet certification experience.*
2. All Pilots and FTE's have been given in-flight training in "recovery from unusual attitudes".
3. Retained the services of some industry recognized experts in the field of aerodynamics, stability and flutter to review the accident flight (Dr. William Rodden, Dr. Sam McIntosh and Ian Gilchrist)
4. Reviewed all flight test reports for safety and required duration by outside expert consultants. (Pete Reynolds and John Ligon)*
5. Continued to build a unified team of cross functional employees that make up the flight test department.*

Equipment

1. Purchased new telemetry van and telemetry equipment to replace the equipment lost. Enhancements of the new equipment have an antenna system that allows 360 degree tracking in any pattern. The dual transmitter system allows the data to be received at any attitude. In addition we have full data channel capacity to the ground with four stations. A hot audio mike from the aircraft is embedded in the data transmission. The new system transmits all measurements (1120 parameters) at full range that are being recorded on board the aircraft.
2. Critical flights such as the high speed flutter dive test are planned at Mojave that specializes in these types of tests and provides all the necessary air space and equipment.

Aircraft

1. Completed high speed wind tunnel testing.
2. Relocated the speed brakes outboard to reduce undesirable pitch effects.
3. Added wing Vortex Generators (VGs) to push back mach buffeting and improve lateral stability at high Mach.
4. Added flat-bottom/blunt trailing edge ailerons for roll authority enhancement – particularly at high Mach.
5. Added a deceleration parachute for the high speed flutter test.
6. A roll spoiler control system is under development for consideration to be fitted to the flight test aircraft for additional roll control enhancement.

Processes

1. Safety Review Board procedures were reviewed to ensure the chairman and members clearly understand their role and authority.
2. Hired additional experienced safety review board members to assure all flight test briefings are attended.*
3. High speed dive flutter flight test is reached by stepping up gradually with increased speed and altitude while comparing actual data received to the high speed wing tunnel data.
4. All flights considered critical will have two pilots on board.
5. All flight test plans requiring .83 mach or above must be approved by the aerodynamics group prior to the flight.

National Transportation Safety Board
Office of Research and Engineering
Washington, DC 20594

Vehicle Performance Group Factual

June 17, 2004

I. Accident

NTSB #:	IAD03MA049
Location:	North of Del Rio, Texas
Date:	April 26, 2003
Time:	Approximately 1005 Local Time (CDT)
Aircraft:	Sino Swearingen SJ30-2, N138BF
Operator:	Sino Swearingen Aircraft Company (SSAC)

II. Group

Chairman: Charles Pereira
Senior Aerospace Engineer
NTSB, RE-60
490 L'Enfant Plaza East, SW
Washington, DC 20594

Member: Kevin J. Renze, Ph.D.
Senior Aerospace Engineer
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Member: Gianricardo Frollo
Flight Test Engineer
FAA, ASW-170
2601 Meacham Boulevard, Room 448
Fort Worth, TX 76137

Member: David Wells
Lead Engineer, Flight Test Instrumentation
1770 Sky Place Boulevard
San Antonio, TX 78126-2879

Member: Johnny T. Doo
Deputy Vice President, Engineering
Senior Manager, Performance and Technology
1770 Sky Place Boulevard
San Antonio, TX 78126-2879

III. Summary

On April 26, 2003 at approximately 1005 CDT, a Sino Swearingen SJ30-2, N138BF, was destroyed when it impacted terrain north of Del Rio, Texas. The certificated airline transport pilot was fatally injured. Visual meteorological conditions prevailed and an instrument flight rules flight plan was filed. The experimental test flight was conducted under 14 CFR Part 91. The accident airplane and the accompanying T-38 chase plane (shown in Figure 1) departed San Antonio International Airport (SAT), San Antonio, Texas, at approximately 0911 to conduct high speed flight flutter testing north of Del Rio, Texas.

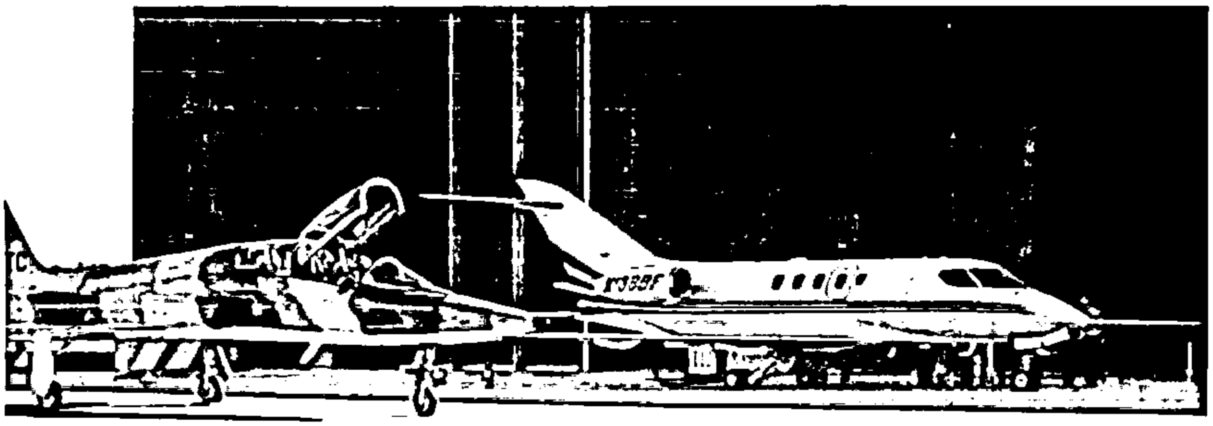

Figure 1: SJ30-2 (N138BF) and Northrop T-38 (N638TC) preparing for flight 231 on the morning of the accident.

IV. On Scene Documentation

The Airplane Performance Group (APG) initially convened at the Sino Swearingen Aircraft Company (SSAC) facility in San Antonio, Texas on April 27. The APG reviewed investigative policies and procedures, the SJ30-2 aircraft general arrangement and flight control systems, the SJ30-2 flight test program, and available accident information. The APG commuted to Del Rio, Texas on the night of April 27 and arrived at the accident site on April 28.

The APG assisted the Structures Group with the organization and conduct of the accident site survey (see Structures Group Chairman's Factual Report). The accident site was located on the top of a rocky hill at coordinates North 29° 52.335', West 100° 57.721', at an elevation of 1741 feet (per Garmin handheld GPS values). The airplane impacted a large, flat area of rock, and penetrated the rock about 2 to 3 feet deep at the center, with less penetration outboard of the center. The width of the crater was about 31 feet and appeared to resemble a wingtip to wingtip impression of the airplane, with nearly symmetrical tapering of the crater from the middle outboard to each end.

There were no tree strikes prior to the initial impact, nor was there sufficient penetration of the rock to establish flight path angle or airplane attitude at impact. Figure 2 documents locations of significant wreckage debris and Figures 3 and 4 present photographic evidence of the impact site.

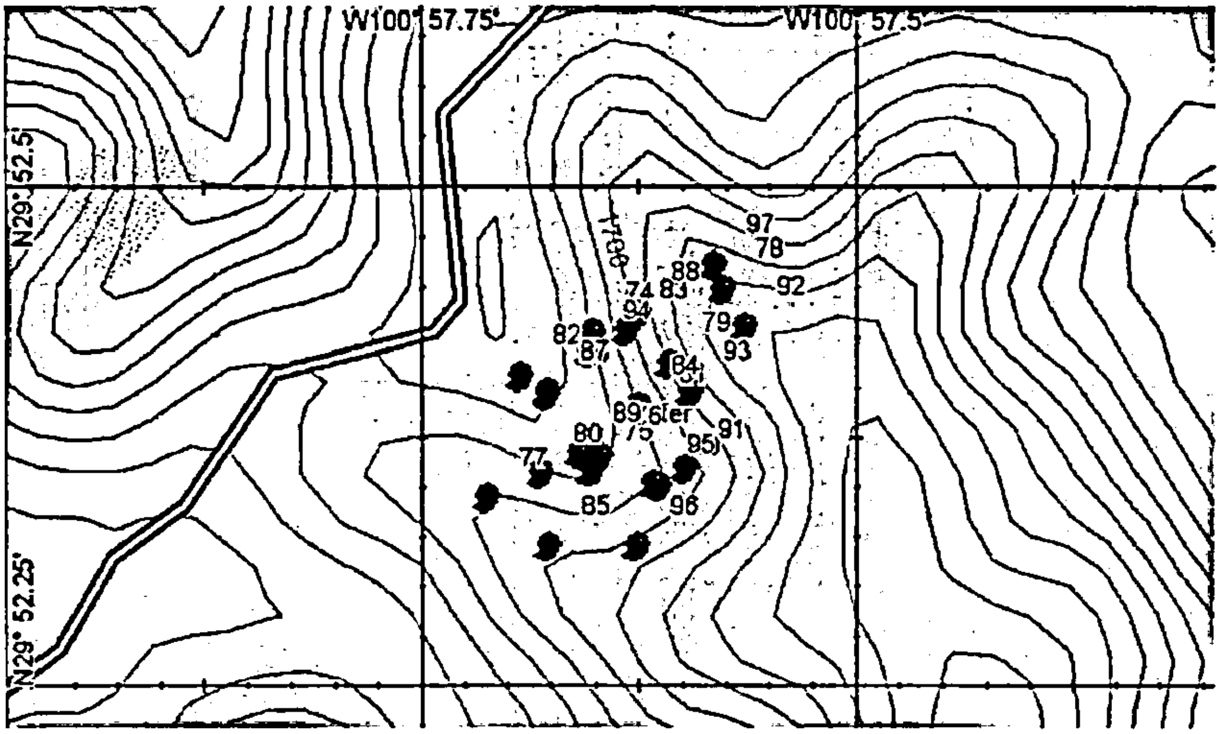

Figure 2: Location of main portions of wreckage distribution. See the Structures Group Chairman's Factual Report, Attachment A for identifier definitions.

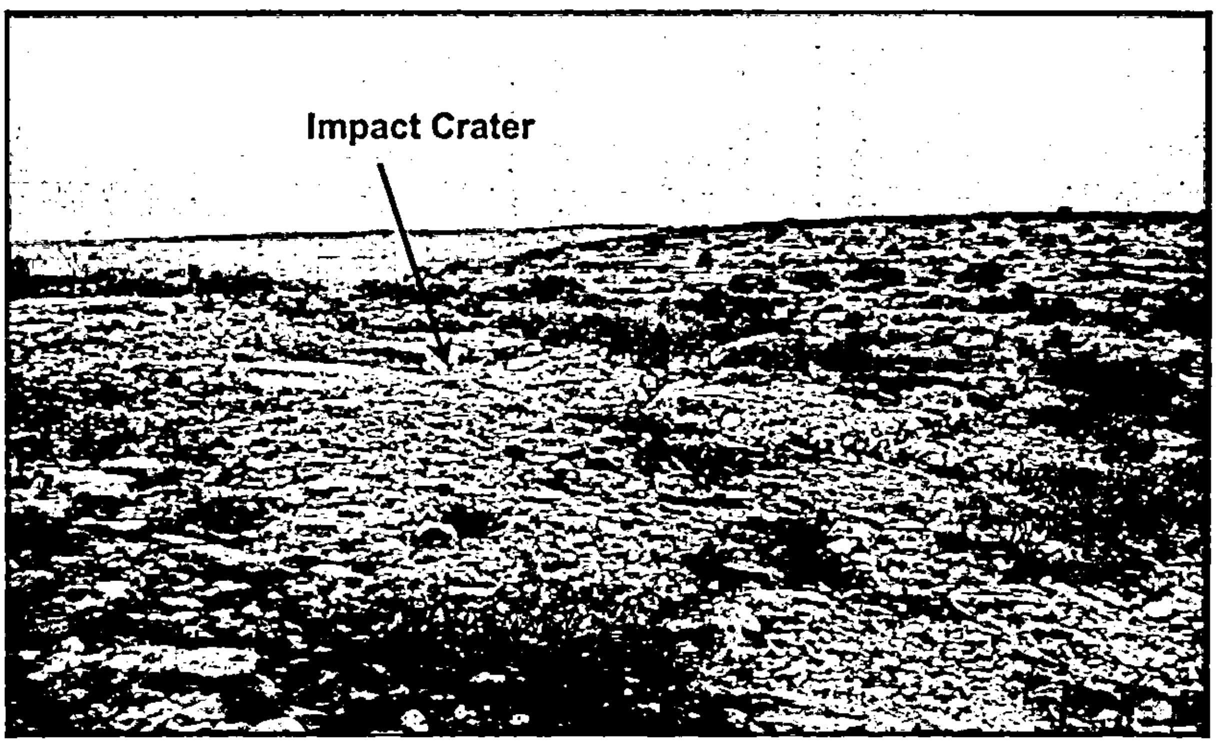

Figure 3: View of impact crater. Note light colored (white) crushed rock near center of picture.

Figure 4: View of center of impact crater.

Distribution of the wreckage around the crater did not show any obvious direction of travel or horizontal velocity, although there appeared to be considerably more wreckage east and north of the crater than south and west. Witnesses in the T-38 chase plane stated that the airplane maintained approximately the same ground track from initiation of the event to impact with terrain.

The airplane wreckage was severely fragmented. However, portions of all flight control surfaces, the Gurney flap, and most other significant systems and structures were located at the accident site, consistent with the airplane being intact at impact.

The airplane was equipped with a flight test instrumentation package that provided onboard recording of several hundred parameters at 100 and 300 Hz sample rates, and telemetry of 27 parameters at a 300 Hz sample rate. The onboard data were recorded on two Seagate Barracuda PC hard drives that were not designed to provide crashworthiness, nor were they required or recommended to be crashworthy by the FAA. Two additional PC hard drives were on the airplane at the time of the accident, the first a Seagate Barracuda and the second a laptop drive, neither of which were recording data.

Two of the three Seagate hard drives were recovered from the accident site. However, it was not known which of the three PC systems these hard drives were from because they were severely damaged and separated from their cases. The two recovered hard drives were returned to the NTSB Vehicle Recorder Lab (RE-40) for review. Upon consultation with RE-40 and industry hard drive recovery experts, it was determined that the data were not recoverable due to the extensive damage to the drives. Figures 5 and 6 document the general condition of the remnants of the hard drives and their cases:

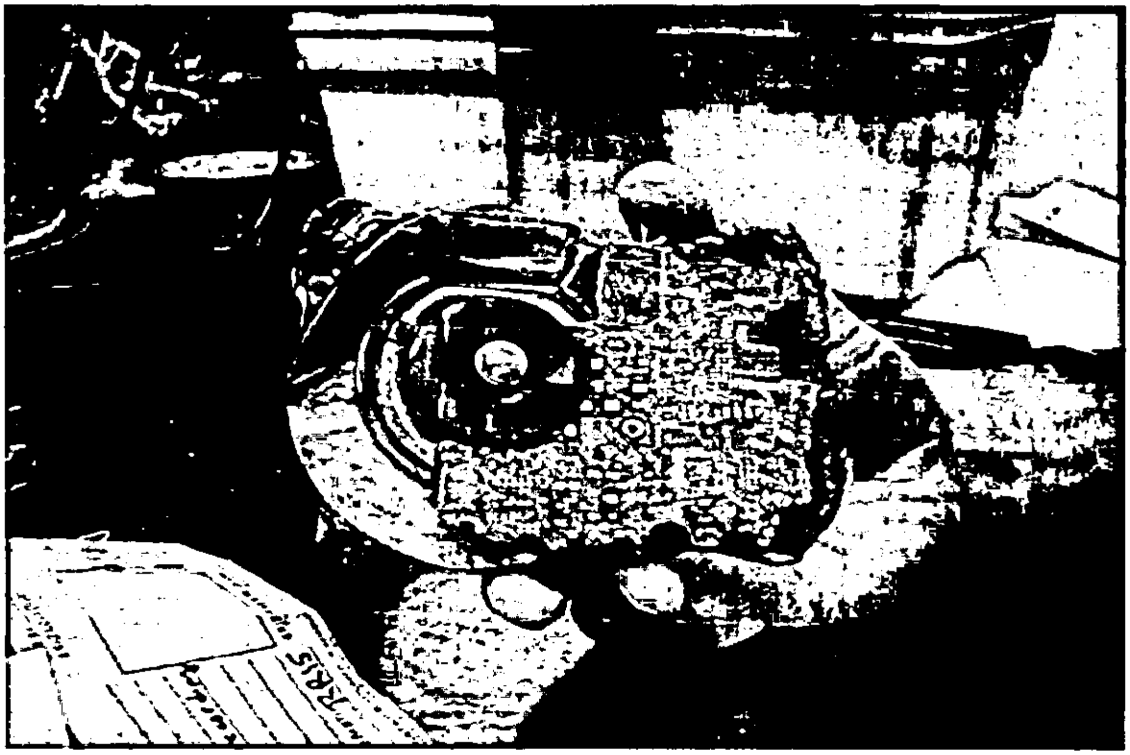

Figure 5: One of two hard drive remnants found. Note stamping impact damage and bends.

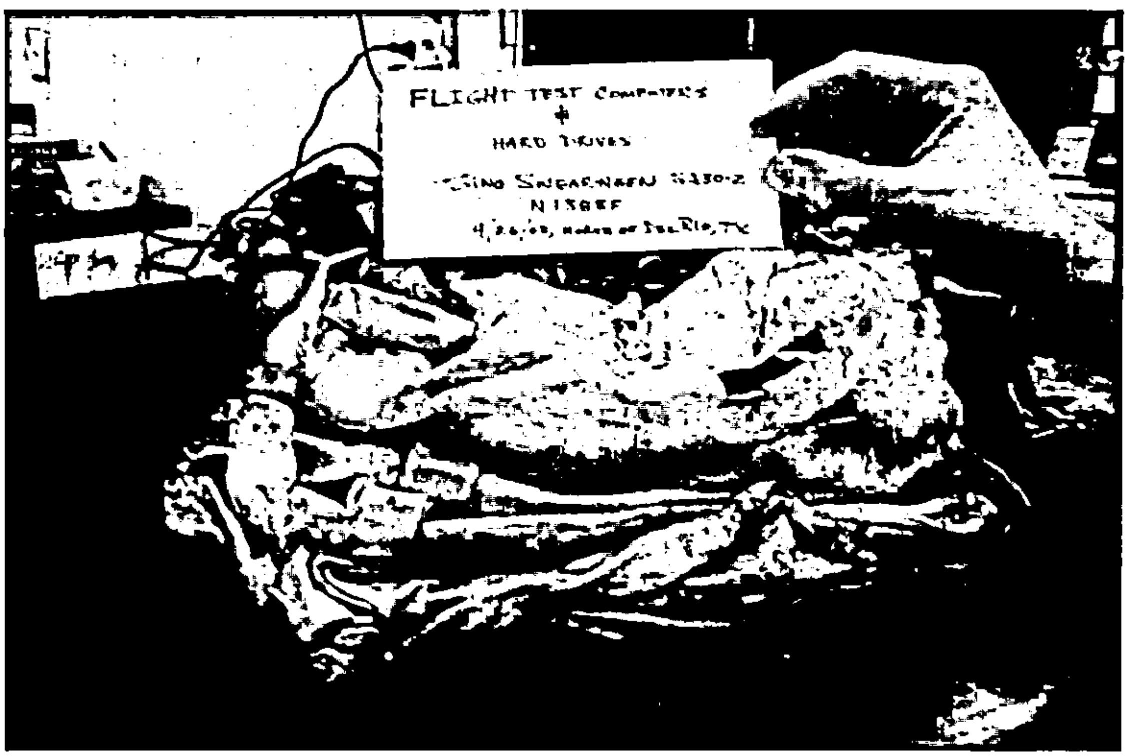

Figure 6: Computer case and hard drive remnants (one of several pieces).

V. Weather Data

Surface weather observations recorded near Del Rio, Texas at 0953 LST on the day of the accident indicated winds were 140° true at 13 knots, visibility was 10 statue miles with clear skies, the temperature was 25 °C, the dew point was 12 °C, and the altimeter was 29.88 inches of Hg. Upper air atmospheric characteristics measured via radiosonde observation (a balloon-borne instrument platform with radio transmitting capabilities) from the Del Rio (DRT) station are summarized in Table 1 below.

Table 1: Del Rio, Texas upper air sounding data (12Z on 26 April 2003).

PRES hPa	HGHT m	TEMP C	DWPT C	RELH %	MIXR g/kg	DRCT deg	SKNT knot	THTA K	THTE K	THTV K
1000.0	76									
973.0	313	16.8	9.8	63	7.87	170	4	292.2	315.0	293.6
925.0	751	20.2	7.2	43	6.93	174	6	300.0	320.8	301.2
917.0	826	20.4	7.4	43	7.09	175	7	300.9	322.2	302.2
900.0	987	19.2	7.2	46	7.13	177	8	301.3	322.8	302.6
889.0	1093	18.4	16.1	86	13.11	178	8	301.5	340.4	303.9
879.0	1191	18.4	10.4	60	9.08	179	9	302.5	329.8	304.1
850.0	1478	17.2	6.2	48	7.04	181	10	304.1	325.6	305.4
815.5	1829	15.7	1.2	37	5.13	185	12	306.2	322.2	307.1
786.6	2134	14.4	-3.2	29	3.85	205	11	308.0	320.2	308.7
765.0	2370	13.4	-6.6	24	3.06	228	13	309.3	319.3	309.9
758.7	2438	12.8	-7.2	24	2.95	235	13	309.4	319.1	310.0
731.4	2743	10.3	-9.7	23	2.51	260	12	309.9	318.1	310.4
705.0	3048	7.7	-12.3	23	2.12	295	12	310.3	317.4	310.7
700.0	3107	7.2	-12.8	23	2.05	295	12	310.4	317.2	310.8
618.0	4115	-1.1	-14.1	37	2.09	264	16	312.1	319.1	312.6
583.2	4572	-3.7	-20.7	25	1.27	250	18	314.4	318.8	314.6
561.1	4877	-5.4	-25.0	20	0.90	265	15	315.8	319.0	316.0
550.0	5034	-6.3	-27.3	17	0.75	291	13	316.6	319.2	316.7
539.6	5182	-7.5	-27.5	18	0.74	315	12	316.8	319.5	316.9
518.7	5486	-10.1	-28.0	22	0.74	330	12	317.3	320.0	317.4
500.0	5770	-12.5	-28.5	25	0.73	305	13	317.7	320.4	317.9
498.6	5791	-12.7	-28.6	25	0.73	300	13	317.8	320.4	317.9
478.6	6096	-15.2	-30.8	25	0.62	295	16	318.4	320.7	318.5
459.3	6401	-17.8	-33.0	25	0.52	310	17	319.0	320.9	319.1
423.2	7010	-22.8	-37.3	25	0.37	270	15	320.1	321.4	320.1
406.2	7315	-25.3	-39.5	25	0.31	290	14	320.6	321.7	320.6
400.0	7430	-26.3	-40.3	26	0.29	290	14	320.7	321.8	320.8
389.3	7620	-27.7	-41.6	25	0.26	275	17	321.4	322.4	321.4
372.8	7925	-29.9	-43.7	25	0.21	255	22	322.4	323.3	322.5
313.4	9144	-38.9	-52.0	24	0.10	280	19	326.4	326.8	326.4
300.0	9450	-41.1	-54.1	23	0.08	280	19	327.3	327.7	327.3
286.6	9754	-43.5	-55.8	25	0.07	285	21	328.2	328.5	328.2
250.0	10660	-50.7	-60.7	30	0.04	280	21	330.6	330.8	330.6
249.7	10668	-50.8	-60.8	29	0.04	280	21	330.6	330.8	330.6
239.0	10953	-52.9	-62.9	29	0.03	282	21	331.5	331.7	331.5
200.0	12090	-59.3	-68.3	30	0.02	290	22	338.7	338.8	338.7
196.7	12192	-60.0	-68.8	30	0.02	290	23	339.2	339.3	339.2
187.3	12497	-62.0	-70.5	31	0.02	275	22	340.8	340.9	340.8
175.0	12916	-64.7	-72.7	32	0.01	285	22	343.0	343.0	343.0
169.6	13106	-65.3	-73.3	32	0.01	290	22	345.1	345.1	345.1
161.3	13411	-66.3	-74.3	32	0.01	260	11	348.4	348.5	348.4
153.3	13716	-67.3	-75.3	31	0.01	285	17	351.8	351.8	351.8
150.0	13850	-67.7	-75.7	31	0.01	280	16	353.3	353.3	353.3
145.8	14021	-67.8	-75.8	31	0.01	265	15	355.9	355.9	355.9
139.0	14308	-68.1	-76.1	31	0.01	270	16	360.3	360.4	360.3

```
125.2  14935  -67.2  -75.2      31    0.01     280       18  372.8  372.8  372.8
120.0  15192  -66.9  -74.9      31    0.01                   378.0  378.1  378.0
```

Table 1 (Continued):

```
DRT station information and sounding indices
                         Station identifier: DRT
                             Station number: 72261
                           Observation time: 030426/1200
                           Station latitude: 29.36
                          Station longitude: -100.91
                          Station elevation: 313.0
                            Showalter index: 0.99
                               Lifted index: 4.97
    LIFT computed using virtual temperature: 4.78
                                SWEAT index: 107.76
                                    K index: 15.90
                        Cross totals index: 18.70
                      Vertical totals index: 29.70
                        Totals totals index: 48.40
      Convective Available Potential Energy: 0.00
             CAPE using virtual temperature: 0.00
                      Convective Inhibition: 0.00
             CINS using virtual temperature: 0.00
                     Bulk Richardson Number: 0.00
          Bulk Richardson Number using CAPV: 0.00
  Temp [K] of the Lifted Condensation Level: 279.23
Pres [hPa] of the Lifted Condensation Level: 809.96
     Mean mixed layer potential temperature: 296.61
              Mean mixed layer mixing ratio: 7.35
              1000 hPa to 500 hPa thickness: 5694.00
Precipitable water [mm] for entire sounding: 19.76
```

VI. Radar Data

Radar data for the accident flight were obtained in electronic format from the 5 independent sites documented in Table 2. The United States Air Force 84th Radar Evaluation Squadron provided the RADES data, which included latitude, longitude, time, range, azimuth, beacon code, primary altitude, and reinforced altitude information. Short range radar data were supplied by Laughlin radar approach control (RAPCON). The RAPCON data included time, range, azimuth, beacon code, and reinforced altitude parameters. The map in Figure 7 depicts the radar site locations, the N138BF ground track based on the RSG ARSR-4 data, and the accident site location.

Table 2: Radar data sources.

Identifier	Location	Type	Latitude	Longitude	Seconds/ Sweep	Source
KMN	King Mountain, TX	ARSR-4	N31 17' 06.700"	W102 16' 22.400"	12	RADES
RSG	Rocksprings, TX	ARSR-4	N30 02' 47.700"	W100 16' 04.300"	12	RADES
EGP	Eagle Pass, TX	ATS	N28 23' 06.924"	W100 17' 08.875"	12	RADES
OTL	Oilton, TX	ARSR-4	N27 29' 55.900"	W098 58' 08.500"	12	RADES
DLF	Laughlin AFB, TX	ASR	N29 21' 06.37"	W100 48' 19.82"	4.5	Laughlin RAPCON

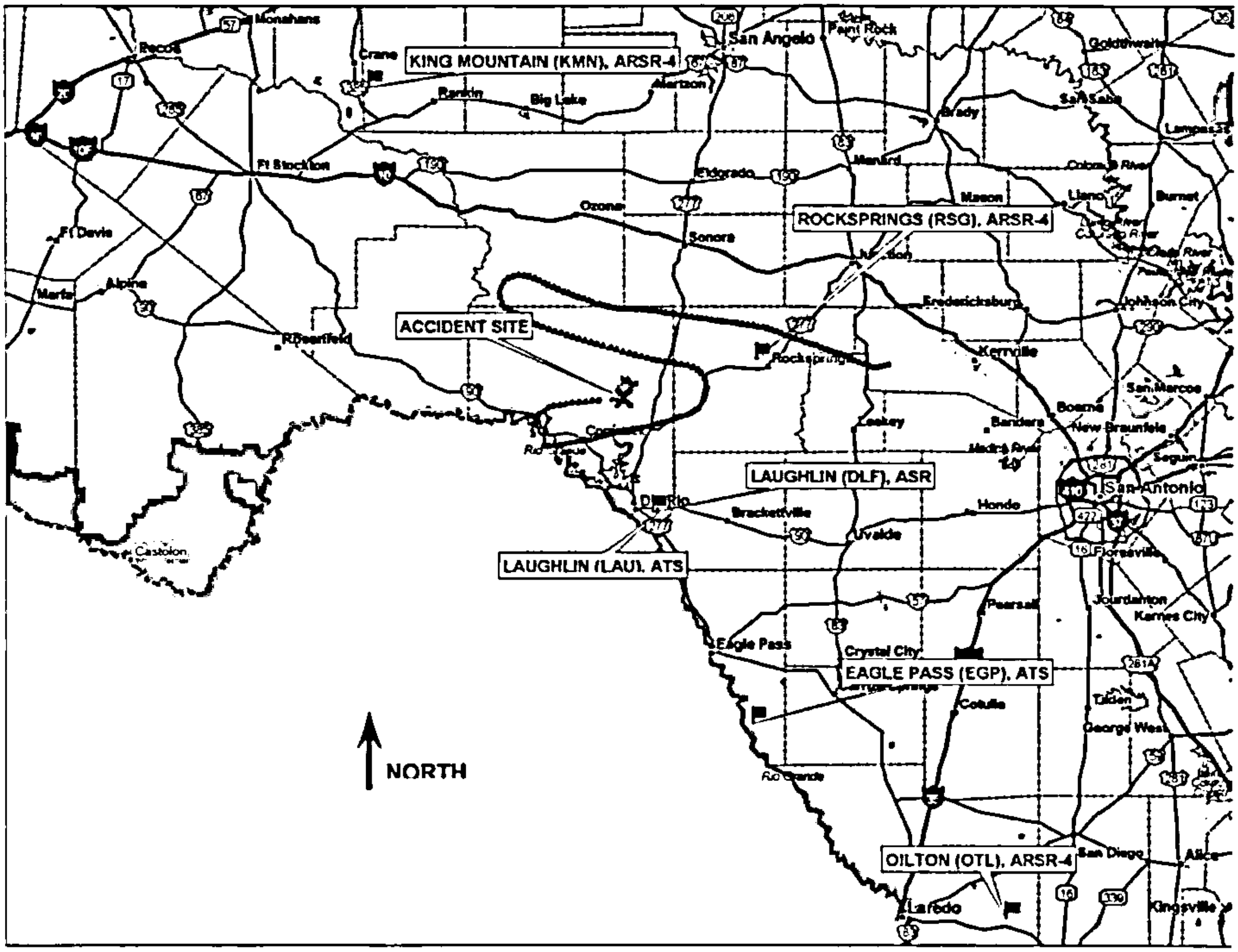

Figure 7: Radar site locations, N138BF ground track based on RSG ARSR-4 data, and the accident site location.

VII. Telemetry Data

N138BF was instrumented with and designed to communicate 27 critical flight flutter test parameters at 300 samples per second to a ground station via telemetry. Nineteen of the 27 channels were dedicated to accelerometer measurements with the remaining 8 parameters allocated to aircraft flight conditions, control surface positions, attitude, and fuel load. Table 3 identifies the telemetry parameters available from flight 231. Approximately 3 minutes of telemetry data were provided to the APG in electronic format.

Table 3: N138BF telemetry parameters.

#	Parameter	Description
1	CAS_CONE	CONE Calibrated Airspeed (200 to 400 KTS)
2	ALT_CONE	CONE Pressure Altitude (10,000 to 50,000 FT)
3	MACH	Indicated Mach (0.4 to 1.0)
4	TOTAL_FUEL	Total Fuel (0 to 5000 lb)
5	MAG_HDNG	Magnetic Heading (0° to 360°)
6	FWD_FUS_VRT_AC	Fwd Fuselage Vert Accel. (g's)
7	FWD_FUS_LAT_AC	Fwd Fuselage Lat Accel. (g's)
8	AFT_FUS_LAT_AC	Aft Fuselage Lat Accel. (g's)
9	AFT_FUS_VRT_AC	Aft Fuselage Vert Accel. (g's)
10	LWNG_RS_VRT_AC	LH Wing Tip, Aft Spar Vert Accel. (g's)
11	LWNG_LNG_AC	LH Wing Tip, Long Accel. (g's)
12	LWNG_FS_VRT_AC	LH Wing Tip, Fwd Spar Vert Accel. (g's)
13	RWNG_RS_VRT_AC	RH Wing Tip, Aft Spar Vert Accel. (g's)
14	RWNG_LNG_AC	RH Wing Tip, Long Accel. (g's)
15	RWNG_FS_VRT_AC	RH Wing Tip, Fwd Spar Vert Accel. (g's)
16	VSTB_FS_LAT_AC	Vert Tail Tip, Fwd Spar Lat Accel. (g's)
17	VSTB_RS_LAT_AC	Vert Tail Tip, Aft Spar Lat Accel. (g's)
18	HSTB_LH_LNG_AC	LH Horizontal Stab Tip, Long Accel. (g's)
19	HSTB_LH_VRT_AC	LH Horizontal Stab Tip, Vert Accel. (g's)
20	HSTB_RH_LNG_AC	RH Horizontal Stab Tip, Long Accel. (g's)
21	HSTB_RH_VRT_AC	RH Horizontal Stab Tip, Vert Accel. (g's)
22	AIL_RH_AC	RH Aileron Accel. (g's)
23	AIL_LH_AC	LH Aileron Accel. (g's)
24	RUD_TRIM_AC	Rudder Trim Tab Accel. (g's) [@ 0% trim]
25	ELEV_POS	Elevator Position (degrees)
26	RUD_POS	Rudder Position (degrees)
27	VRUD_POS	Ventral Rudder Position (degrees)

VIII. SJ30-2 Model

The Sino Swearingen SJ30-2 is a 7 seat (1 pilot, up to 6 passengers), twin engine, light business jet with a design range of 2500 NM at a long range cruise Mach number of 0.78. At the time of the N138BF flight test accident, the SJ30-2 had not completed Federal Aviation Administration (FAA) certification testing. Three view drawings of the SJ30-2 are presented in Figures 8 through 10.

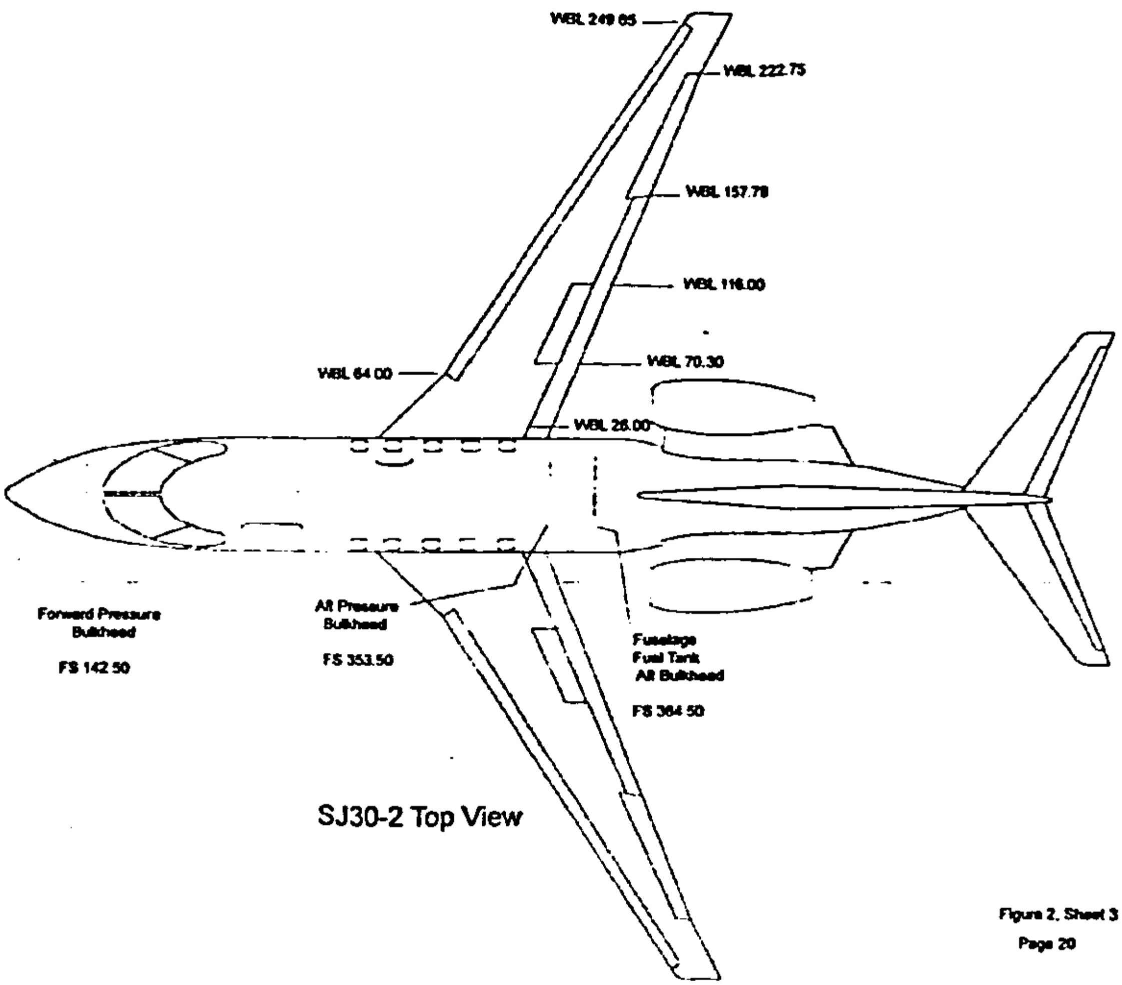

Figure 8: SJ30-2 top view.

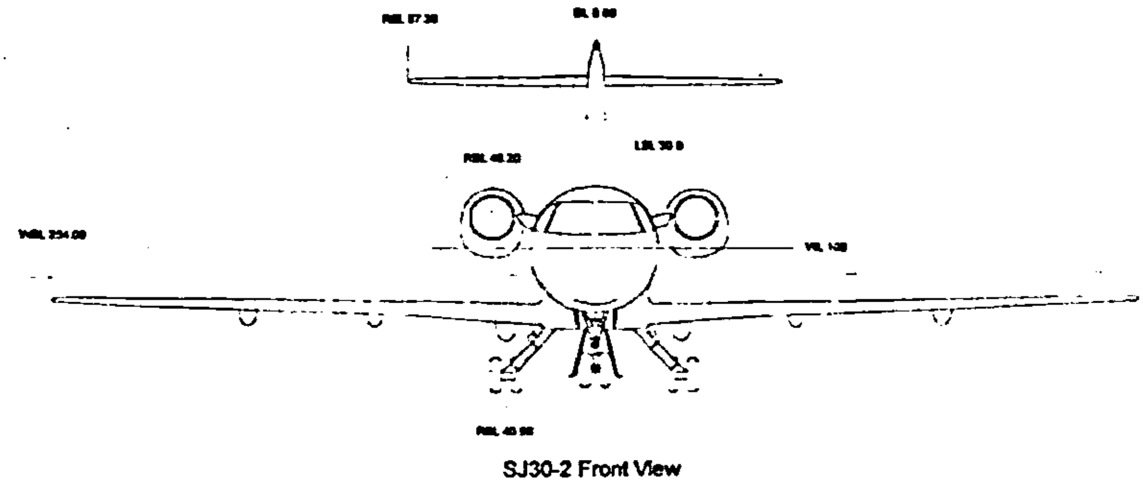

Figure 9: SJ30-2 front view.

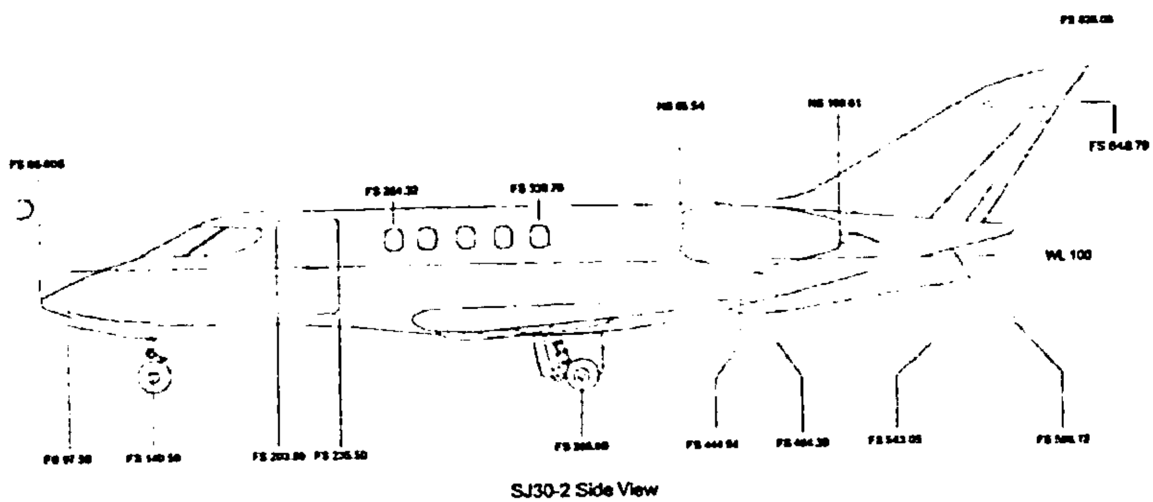

Figure 10: SJ30-2 side view.

National Transportation Safety Board
Office of Research and Engineering
Washington, DC 20594

Vehicle Performance Group Study

July 8, 2004

I. Accident

NTSB #:	IAD03MA049
Location:	North of Del Rio, Texas
Date:	April 26, 2003
Time:	Approximately 1005 Local Time (CDT)
Aircraft:	Sino Swearingen SJ30-2, N138BF
Operator:	Sino Swearingen Aircraft Company (SSAC)

II. Group

Chairman: Charles Pereira
Senior Aerospace Engineer
NTSB, RE-60
490 L'Enfant Plaza East, SW
Washington, DC 20594

Member: Kevin J. Renze, Ph.D.
Senior Aerospace Engineer
NTSB, RE-60
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Member: Gianricardo Frollo
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Member: David Wells
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San Antonio, TX 78126-2879

Member: Johnny T. Doo
Deputy Vice President, Engineering
Senior Manager, Performance and Technology
1770 Sky Place Boulevard
San Antonio, TX 78126-2879

III. Summary

On April 26, 2003 at approximately 1005 CDT, a Sino Swearingen SJ30-2, N138BF, was destroyed when it impacted terrain north of Del Rio, Texas. The certificated airline transport pilot was fatally injured. Visual meteorological conditions prevailed and an instrument flight rules flight plan was filed. The experimental test flight was conducted under 14 CFR Part 91. The accident airplane and the accompanying T-38 chase plane departed San Antonio International Airport (SAT), San Antonio, Texas, at approximately 0911 to conduct high speed flight flutter testing north of Del Rio, Texas.

The flight 231 radar and telemetry data, N138BF lateral control and lateral trim documentation, and limited SJ30-2 transonic wind tunnel test results were analyzed. The data indicated that N138BF exhibited symptoms of lateral asymmetry during the SJ30-2 flight test program and reduced lateral control at Mach numbers above 0.86. The airframe lateral asymmetry was addressed in part by the introduction of a Gurney flap. Although lateral control authority was available within the design flight envelope, N138BF consistently required left wing down trim at speeds above 250 KCAS in zero sideslip conditions.

The loss of lateral control during high speed flutter flight testing was manifest in the form of a continuous, right wing down, descending roll. Post-accident transonic wind tunnel test data indicated that, at the accident flight condition, N138BF had negative lateral stability and significantly reduced aileron effectiveness due to shock-induced separation. The airplane was not able to generate enough aileron roll authority to balance the residual rolling moment coupled with the adverse rolling moment due to a 2° to 3° sideslip. Recovery from the lateral control upset would most likely have been accomplished by reducing speed (e.g., throttles to idle, speedbrake deployment) below Mach 0.84.

IV. Abbreviations

AND	airplane nose down
ANU	airplane nose up
ARA	Aircraft Research Association Limited, Bedford, England
ARSR-4	air route surveillance radar, model 4
ASR	airport surveillance radar
CDT	central daylight time
CFD	computational fluid dynamics
CFR	*Code of Federal Regulations*
DATCOM	USAF stability and control data compendium
DER	designated engineering representative
DLF	Laughlin Air Force Base, ASR
ECU	Edwards County Airport
EGP	Eagle Pass
KCAS	calibrated airspeed, knots
KMN	King Mountain, ARSR-4
LH	left hand
LWD	left wing down
OTL	Oilton, ARSR-4

RH	right hand
RSG	Rocksprings, ARSR-4
RWD	right wing down
SAT	San Antonio International Airport
SRB	safety review board
SSAC	Sino Swearingen Aircraft Corporation
TED	trailing edge down
TEL	trailing edge left
TER	trailing edge right
TEU	trailing edge up
TTAL	temporary test aircraft limitation
USAF	United States Air Force
UWAL	University of Washington Aeronautical Laboratory, Seattle, Washington

V. Nomenclature

M	Mach number
M_{DF}	maximum demonstrated flight Mach number
M_{MO}	maximum operating Mach number
V_{DF}	maximum demonstrated flight airspeed
V_{MO}	maximum operating airspeed

VI. Radar Data

The long range and short range radar data identified in the Vehicle Performance Factual Report were processed to determine aircraft latitude, longitude, altitude, rate of climb, and groundspeed as a function of time. The radar sites, accident site, and the accident and chase aircraft ground track data were superimposed on the map presented in Figure 1. The long range N138BF radar data are depicted by small blue, green, yellow, or red circular symbols, according to radar site source. The short range radar data are illustrated by the large blue, green, and red circular symbols. The data indicate that N138BF was on a course from west to east about 35 miles north of Del Rio, Texas at an altitude of 30,500 feet when the accident occurred.

A close up view of the accident site and the short range radar data is presented in Figure 2. The accident aircraft ground track is depicted by the large blue symbols, whereas the large green and red symbols denote the chase plane ground track. According to SSAC, N138BF was squawking beacon code 4761 during the flight test and N638TC was flying chase. As such, N638TC was the second aircraft in a flight of 2 aircraft and was not squawking an independent transponder code.

Subsequent to the accident, N638TC assumed the flight test transponder code and began squawking beacon code 4761. This fact is confirmed by the radar data documented in Figure 2 as the ground track transitions from N138BF squawking 4761 (large blue symbols), to only primary returns near the time of the accident (large green symbols), to N638TC squawking 4761 (large red symbols).

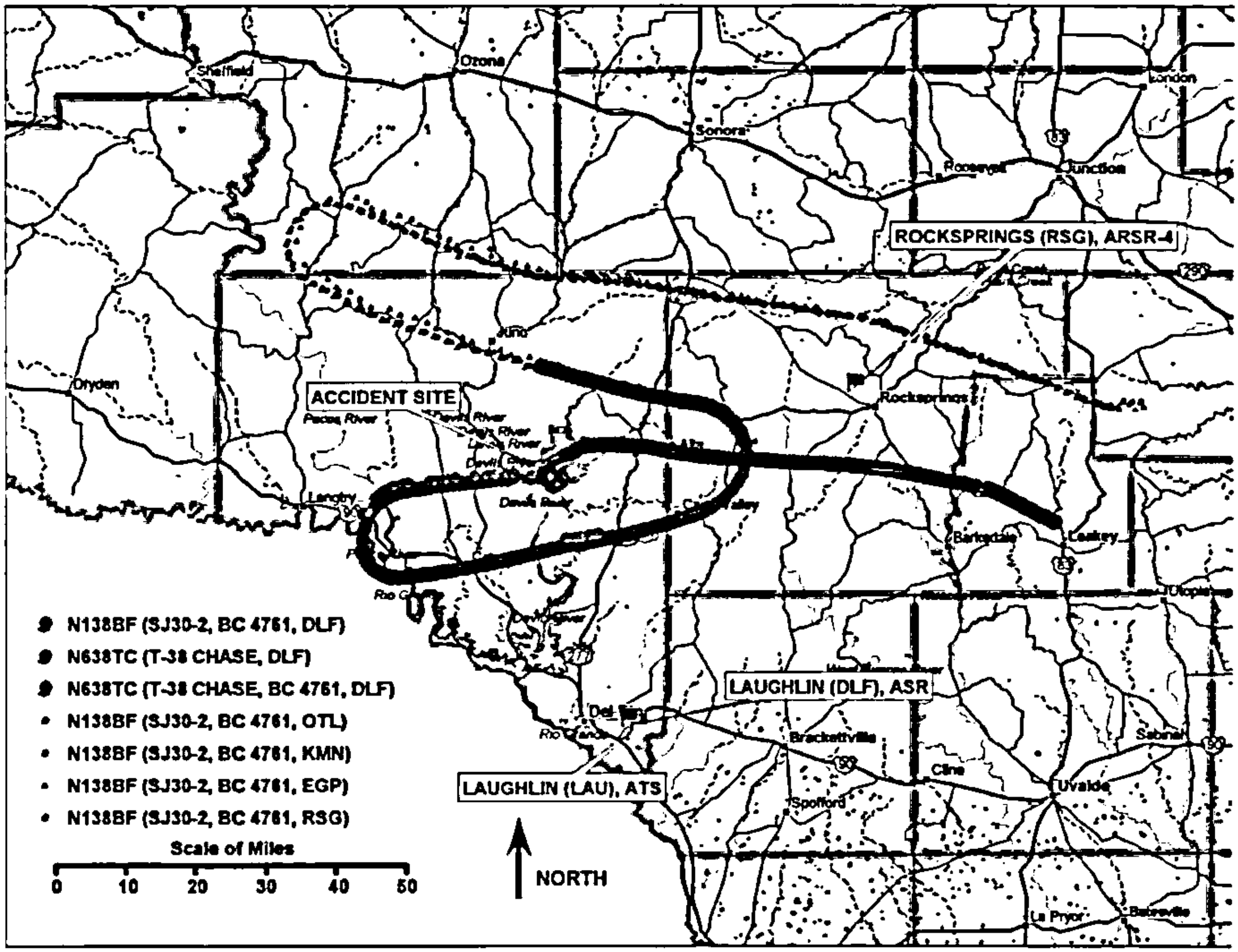

Figure 1: Partial accident flight ground track, accident site location, and partial chase plane ground track with key identifying aircraft by beacon code, if available, and radar data source.

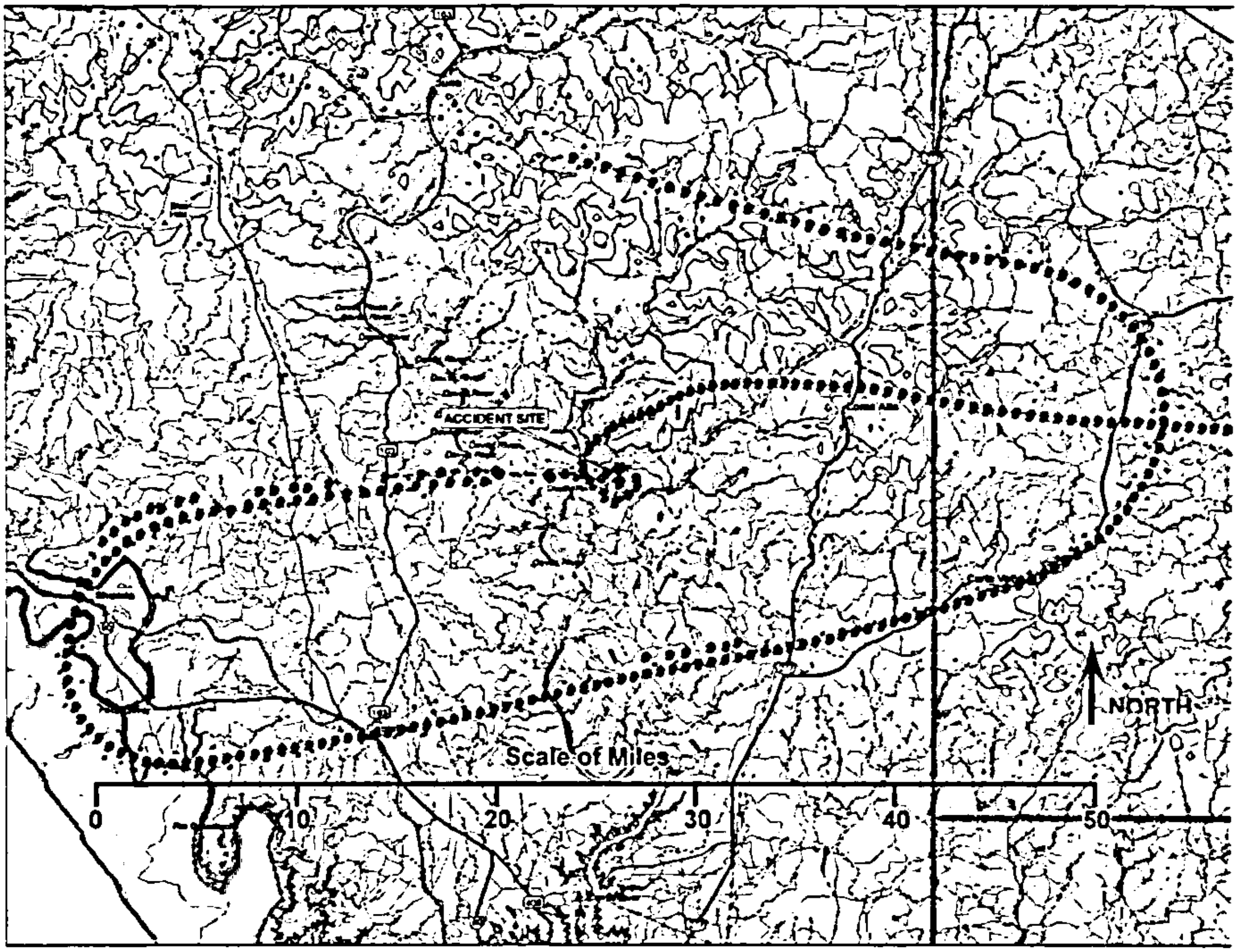

Figure 2: Close up view of DLF short range radar data used for aircraft performance calculations. The accident aircraft ground track is depicted by the large blue symbols. The large green and red symbols depict the chase plane ground track.

VII. Flight 231 Telemetry Data

The SSAC flutter test plan[1] required a Designated Engineering Representative (DER) to monitor the SJ30-2 airframe and control surface responses to control input excitations, or pulses[2], in real time. To meet this requirement, N138BF was instrumented with and designed to communicate 27 critical flight flutter test parameters at 300 samples per second to a ground station van via telemetry. The telemetry data[3] for the last 3 minutes of flight 231 were transcribed from binary to engineering units by SSAC and provided to the NTSB.

A. Overview

The telemetry data included the airplane flight condition (altitude, airspeed, Mach number); magnetic heading; control surface positions for the elevator, rudder, and ventral rudder; fuel weight; and 19 accelerometer parameters requested to support the flutter certification testing. Parameters of interest that were recorded but unrecoverable[4] included the accelerations near the airplane center of gravity; angle of attack and sideslip angle; roll and pitch attitude; aileron surface, speedbrake, slat, flap, and gear positions; engine parameters; control input positions; and column, wheel, and pedal forces.

A subset of the flight 231 telemetry data are attached in Appendices A through C. Each appendix contains 10 plots in which a series of parameters (individual vertical axes) were plotted as a function of time on a common horizontal axis. The first plot (e.g., Figure A.0) provides an overview of 3 minutes of data. The remaining 9 plots (e.g., Figures A.1 through A.9) present 20 second, sequential snapshots of the respective overview plot timeline. Telemetry flight condition, control surface, and attitude data are shown in Appendix A with calculated airspeed, ground speed, flight path angle, and sideslip angle data. The short range radar-based pressure altitude data were also compared to the telemetry data in Appendix A. Longitudinal and lateral axis accelerometer telemetry data from several aircraft locations were included in Appendix B with flight condition and attitude data. Similarly, vertical axis accelerometer telemetry data from several aircraft locations appear in Appendix C.

No significant telemetry data dropouts occurred prior to the lateral upset event. However, the recorded telemetry data contained a large number of data dropouts subsequent to the lateral upset event, which were attributed to the masking of the onboard antenna as the aircraft rolled, causing periods of telemetry sync loss between N138BF and the ground station van located at Edwards County Airport (ECU) near Rocksprings, Texas. The majority of these data dropouts[5] were removed in the plots presented in Appendices A through C. Timeline discontinuities or "gaps" in the telemetry data should be interpreted as data dropout regions. For example, a 3.8 second data dropout region exists from time 263.9 to 267.7.

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[1] Flight Flutter Certification Test Plan for SSAC Aircraft Model SJ30-2, Report 30-2222, Rev. A.

[2] A control surface pulse (e.g., elevator, aileron, or rudder pulse) refers to a pilot commanded, single step control input of short duration and small deflection, intended to provide excitation via control surface motion.

[3] Telemetry data parameter definitions are documented in the associated Vehicle Performance Factual Report.

[4] N138BF was also equipped with a flight test instrumentation package that provided onboard recording of several hundred parameters at 100 and 300 Hz sample rates. However, these onboard data were not recoverable due to extensive damage to the associated PC system hard drives.

[5] The algorithm used to remove data dropouts is not guaranteed to discard all potential dropouts.

The telemetry parameter scale limits were met or exceeded for three parameters defined in the Vehicle Performance Factual Report. As depicted in Figure A.8, the calibrated airspeed reached a plateau at its maximum threshold value (400 knots) by 268 seconds, about 27 seconds prior to the end of data. Similarly, the indicated Mach number maximum threshold value (Mach 1.0) was maintained between 272.9 and 278.3 seconds. As Figure A.9 illustrates, the telemetry pressure altitude bottomed at its minimum threshold value (10,000 feet) about 4 seconds prior to the end of data.

B. Accident Event Timeline

The events noted on the plots in Appendices A through C were based in part on the accident event timeline presented in the SSAC document, "S/N 002 Accident Investigation Final Report: Lateral Instability Theory," dated August 1, 2003. The events listed in Table 1 consist of N138BF flight conditions, control inputs, airplane responses, pilot communication, or witness statements of interest.

Table 1: Flight 231 Telemetry Data Events

Time (Seconds)	**Event Description**
193	Aircraft reaches Mach 0.86.
194	Accelerometers begin to record noticeably higher amplitude oscillations.
202	Aircraft sets up for test point 1-14. [32,000 ft to 28,000 ft; 0.884 Mach indicated]
214	Aircraft stabilizes at Mach 0.88; rudder position begins to transition from 0° to 2.0° TEL.
218.5	Elevator pulse complete.
228.5	Rudder pulse complete.
228.5+	ESTIMATED TIME [Pilot reports that he cannot free the controls.]
239	Aileron pulse complete. [335 KCAS; 30,500 ft; 0.881 Mach indicated]
239+	ESTIMATED TIME [Chase notes N138BF was in a right bank at the completion of the test point.]
239-244	Pilot commands increasing TEL rudder deflection. [2.8° to 4.6° TEL.] Aircraft heading begins to deviate nose right.
244.6	Pilot initiates a TEU elevator pull.
245	Rate of TEL rudder input increases significantly.
246	Rudder reaches peak deflection of 6.5° TEL.
246.2	Elevator reaches peak deflection of 3.5° TEU. [Elevator is held at this position.]
246.4	Rate of heading deviation increases significantly.
246.4+	ESTIMATED TIME [Chase reports N138BF is slowly rolling to the right.]
254	Aircraft completes one roll. 3° TEU elevator continues to be held in. 7° TEL rudder commanded. [352 KCAS; 28,000 ft; 0.885 Mach indicated]
254+	ESTIMATED TIME [Pilot reports that he cannot stop the roll.]
254-295	Aircraft rolls approximately 6 more times.
295.1	Telemetry data ends with indicated altitude of 10,000 ft for the last 4 seconds.

The telemetry data began at 130 seconds (10:02:10) with N138BF at about 38,000 feet, Mach 0.805 passing through a magnetic heading of 36° as it executed a right hand, shallow descending turn toward a magnetic heading of approximately 73°. The airplane accelerated to about Mach 0.83 by the time it completed the turn and continued its shallow descent, accelerating to about Mach 0.85 by time 180 seconds. The airplane stabilized at about Mach 0.85 for nearly 8 seconds as it passed through 36,000 feet, continuing to accelerate to about Mach 0.87 at 202 seconds. The airplane passed an indicated Mach number of about 0.86 at 193 seconds and 1 second later the accelerometers recorded noticeably higher amplitude oscillations indicative of high speed buffet. The lift coefficient at 194 seconds was calculated to be 0.25, which correlated well with the SJ30-2 buffet boundary curve.

The airplane maintained Mach 0.87 for about 9 seconds as it passed through 33,500 feet before accelerating to Mach 0.88 at about 214 seconds. As the airplane stabilized at Mach 0.88, the rudder position transitioned from about 0° to about 1.5° to 2° trailing edge left (TEL). The elevator pulse was completed at 218.5 seconds (see Figure A.5) with the airplane passing through 33,000 feet on a heading of 74° magnetic. The rudder pulse[6] was completed at 228.5 seconds (see Figure A.6) with the airplane passing through 31,500 feet. At about this time according to witness statements, the pilot reported he could not free the controls.

The aileron pulse (see Figure A.6) was initiated at about 237.8 seconds and completed by about 239 seconds as the airplane passed through 30,500 feet. The rudder position began to move before the aileron pulse damped out, from about 2° TEL to about 3.5° TEL in 2 seconds. At about 240 seconds, airplane heading began to deviate airplane nose right from about 74 to 76.5° magnetic over 3.2 seconds. The ventral rudder position moved about 0.75° TEL, the same direction as the rudder, between 237.8 and 243.2 seconds. The chase aircraft reported N138BF in a slow right bank at this point.

At 243.2 seconds, the rudder moved about 1° TEL over 1.8 seconds to 4.5° TEL and the airplane nose right heading rate was briefly checked at 244.4 seconds. Until 243.2 seconds, the elevator remained relatively constant at its initial test condition position near 1° trailing edge down (TED). At 244.6 seconds, the elevator moved about 4° airplane nose up (ANU) to 3.5° TEU in 1.8 seconds. The elevator maintained a position of 2° to 5° TEU for the next 34 seconds.

As the elevator moved TEU at about 244.6 seconds, the airplane heading once again deviated airplane nose right. At 245 seconds, rudder rate increased significantly as the rudder moved 2° TEL over 1 second to 6.5° TEL. After time 243.2, the ventral rudder position appeared to represent a scaled, offset reflection of the rudder position time history[7].

[6] Based on the telemetry data from the flight 231 Mach 0.884 flutter test, SSAC concluded that the pilot command input sequence was elevator pulse, rudder pulse, aileron pulse. The test plan called for an elevator, aileron, rudder pulse sequence. It is not known why the aileron and rudder pulse sequences were transposed for this test condition. The SJ30-2 Flight Test Point Report found in Appendix A of Report 30-2222, Rev. A and flight 231 test card (page 5/12) called for an elevator, aileron, rudder, speedbrake sequence. SSAC noted that the speedbrake deployment command excitation was removed for flight 231 and other high speed buffet flight conditions.

[7] SSAC provided steady heading sideslip flight test data in an attempt to use ventral rudder data to derive sideslip angle. The ventral rudder tended to float into the relative wind when the yaw damper was inactive. Review of these data concluded that the direction indicated by the ventral rudder position was more reliable than the magnitude for use as a sideslip angle indicator.

The combination of increased ANU elevator and increased airplane nose left rudder coincided with a marked increase in airplane nose right heading rate. From about 246.2 seconds to the end of telemetry data, magnetic heading established a periodic oscillation between 65° and 95° magnetic with a period that varied between 6 and 9 seconds per cycle. Elevator ANU deflection and rudder TEL deflection were maintained, with some variation in magnitude, to nearly the end of the data. Calibrated airspeed and Mach number increased well beyond the SJ30-2 V_{MO}/M_{MO} and V_{DF}/M_{DF} design goals during the accident descent.

The approximately 7 second period observed in the first heading oscillation following the aileron pulse was consistent with the T-38 witness report that N138BF entered and maintained a slow right roll after the aileron pulse. The magnetic heading oscillations, rate of altitude descent, and increasing Mach number were consistent with T-38 witness reports that N138BF entered a continuous, descending roll and accelerated away from the T-38 (N638TC) despite its attempts to follow.

C. Performance Calculations

The flight 231 pressure altitude, Mach number, and rudder position telemetry data were used to calculate the airspeed, ground speed, flight path angle, and sideslip angle shown in Appendix A. Radiosonde data documented in the Vehicle Performance Factual Report were used to calculate the speed of sound. As N138BF accelerated toward the test condition Mach number, the airplane transitioned from level flight to a flight path angle about 7° below the horizon. The flight path angle was about 10° below the horizon at the completion of the aileron pulse. At 243.2 seconds, as rudder deflection TEL opposed the airplane nose right heading deviation, the airplane descent became increasingly steep. The flight path angle continued to decrease toward a final estimated value of 77° below the horizon.

Sideslip angle was estimated as a function of rudder position based on SJ30-2 steady heading sideslip data. Results of this calculation were considered valid only for periods when 1) N138BF was maintaining a relatively steady heading, and 2) rudder position was constant or slowly transitioning[8]. Sideslip angle results were plotted between 210 and 247.5 seconds. Sideslip angle was calculated to vary between at most ±1° until the aileron pulse, when it increased to about 2° between 238 and 243.2 seconds. The sideslip angle increased toward 2.7° with increasing rudder TEL deflection between 243.2 and 244.4 seconds, at which point the airplane established a nearly constant roll rate[9] during the high speed descent.

D. Other Telemetry Data Features

The forward fuselage lateral and vertical acceleration parameters contained distinct features or "spikes" at 10 instances[10]. The features appeared only in the 2 forward fuselage accelerometer

[8] Sideslip angle estimates resulting from dynamic rudder events near 218.5 and 228.5 seconds were not considered valid.

[9] SSAC provided bank to bank roll flight test data which illustrated magnetic heading deviation as a function of bank angle for bank angles between ±30°.

[10] The features occurred at approximate times of 137.7, 141.5, 146, 196, 198.5, 214.5, 231.5, 236.5, 271, and 290 seconds on Figures B.1-B.2, B.4-B.6, B.8-B.9 and C.1-C.2, C.4-C.6, C.8-C.9.

channels. The duration and relative frequency of the spikes were consistent with short communication transmissions the pilot might use to identify control input pulses. After review, SSAC concluded that these spikes were induced by coupled interference from radio transmission during pilot communication.

The character of the left and right aileron accelerometer data clearly changed between 220 and 230 seconds, as illustrated in Figure A.6 near the bottom of the page. The left hand (LH) aileron data indicated a cycle (+6 g's at 222.5 seconds; -3 g's at 228 seconds) not present in the right hand (RH) aileron data. The LH aileron cycle occurred at approximately 0.1 Hz. SSAC concluded that this frequency was too low for a piezo-electric accelerometer measurement to be valid[11] and that the LH aileron accelerometer data feature did not likely reflect an actual flight event.

VIII. N138BF Lateral Control History

The SJ30-2 lateral trim system used an adjustable trim spring to apply a constant force to the control wheel. The spring rate of the installed lateral trim system was equivalent to about 10 lb pilot wheel force or about 15 percent total roll authority. The constant force design dictated that the amount of trim required to balance an aerodynamic force asymmetry must be speed dependent. Given telemetry and eyewitness evidence that a lateral upset occurred, the airplane performance group documented the N138BF lateral control history. N138BF lateral control issues and pertinent events are summarized in Table 2, based on SSAC documents and communication provided during the course of the investigation.

Table 2: N138BF lateral control history

1997	• SSAC purchased a drag chute and developed flight test installation plans.
Prior to 2002	• SSAC made decision not to implement the high speed drag chute installation originally planned for N138BF flutter testing, due to pilot group concern about the possibility of an inadvertent chute deployment.
Prior to June 1, 2002 (Prior to flight 114)	• A speed restriction of 250 KCAS was in place. • N138BF required a significant amount of roll trim adjustment. • The roll trim requirement switched between left wing down (LWD) and right wing down (RWD). • The roll trim requirement was speed dependent. • The N138BF ailerons were removed, measured, and replaced to correct the discovered twist deviations from the aileron design surface loft.
Post June 1, 2002 (Post flight 114)	• A speed restriction of 250 KCAS remained in place. • N138BF required much less roll trim adjustment. • The roll trim requirement was consistently LWD and increased with airspeed. • N138BF could be trimmed in the lateral direction within the 250 KCAS speed restriction. • SSAC concluded that the N138BF tendency to roll RWD could be attributed to measured wing twist and aileron twist deviations from the respective design surface lofts.
Post October 2002	• The speed restriction of 250 KCAS was opened up to 320 KCAS or Mach 0.83 following completion of Phase 1 flutter testing.

[11] The accelerometer specification sheets indicated that the output deviation trailed off logarithmically as the excitation frequency approached 1 Hz.

	• The consistent LWD roll trim requirement was a known N138BF characteristic. • N138BF required nearly full LWD lateral trim at 320 KCAS. • A Temporary Test Aircraft Limitation (TTAL) instructed pilots to limit use of aileron trim to the 20 to 80 percent range of a 0 to 100 percent scale, where 50 percent was neutral.
December 16-17, 2002 (flight 199 and flight 200, respectively)	• N138BF was instrumented with tufts on the left and right wing upper surfaces. Two video cameras (one camera per wing) were installed to record the real time tuft positions on each wing upper surface throughout the test flight. • N138BF conducted 2 high speed tuft tests[12]. • Tuft testing confirmed the presence of large regions of shock-induced separation above Mach 0.81. (The SJ30-2 design cruise Mach number is 0.80 and the maximum operating Mach number is 0.83.)
April 14, 2003	• N138BF speedbrake travel was limited to 17.5° of nominal 35° design travel to reduce undesirable speedbrake deployment pitch characteristics (i.e., speedbrake deployment could cause a large airplane nose down pitching moment).
April 15, 2003	• SSAC held a Safety Review Board (SRB) meeting to discuss flight flutter test issues. • Given the open N138BF lateral trim issue and flutter test plan airspeeds exceeding 320 KCAS, full LWD trim and pilot hand pressure on the wheel would be required if no corrective action was taken. • The use of a Gurney flap on the right wing tip was approved. (The Gurney flap was an aerodynamic device intended to balance N138BF in the lateral axis, independent of airspeed, and restore lateral trim margin.)
April 24, 2003 (flight 229)	• N138BF conducted flight 229 to quantify the Gurney flap effectiveness, flight test the flutter instrumentation, and perform a telemetry range check. • The Gurney flap improved the N138BF lateral trim margin. For airspeeds up to 305 KCAS, approximately 40 percent lateral trim was required on a scale from 0 to 100 percent, where 50 percent was neutral. One Gurney flap design/installation/flight test iteration did not eliminate all unbalanced rolling moments. • SSAC considered the fact that N138BF would likely require additional LWD control input to trim laterally as airspeed increased beyond V_{MO} (320 KCAS). • The flutter test consultant indicated that the flutter data analysis would be valid if roll control pulses were superimposed on a basic wheel force required to hold N138BF wings level. • As part of the pre-test review, SSAC decided to continue with the Phase 2 flutter testing if the pilot needed to apply a small wheel force to trim laterally as airspeed increased beyond V_{MO} (320 KCAS).
April 25, 2003 (flight 230)	• N138BF completed flight flutter test point 1-12[13]. • All available aileron trim was required at Mach 0.84 for point 1-12 at altitudes

[12] Tuft tests are useful for evaluating the quality of flow over aerodynamic surfaces as a function of the aircraft flight condition, configuration, angle of attack, and sideslip angle. Wind tunnel or flight test tuft testing can readily identify regions of attached flow, regions of separated flow, and shock wave locations, depending in part on the density of the tufts. Use of tufts during flight test has the advantage of readily achieving the actual flight Reynolds number.

[13] Although the test cards for flights 230 and 231 referred to flight flutter test points 4.1.1-12, 4.1.1-13, and 4.1.1-14, the actual N138BF aircraft configuration and flight condition were consistent with test points 4.1.1-7, 4.1.1-8, and 4.1.1-9, respectively, per Flight Flutter Certification Test Plan for SSAC Aircraft Model SJ30-2, Report 30-2222, Rev. A. The test point identification discrepancy differed in whether or not the aircraft carried a full wing fuel load.

	between 31,000 and 30,000 feet. Rudder pedal was used to augment aileron trim (set at approximately 25 percent) as the airplane descended from 33,000 to 31,000 feet. • Data showed that all of the earlier TTAL lateral trim margin (20 percent to 80 percent) was required to trim N138BF between Mach 0.84 and 0.86[14]. • N138BF experienced an **uncommanded LWD roll** during test point 1-13. • The roll event was corrected by pilot wheel input over a period of about 20 seconds as the airplane decelerated below Mach 0.85. Rudder pedal was used in an attempt to augment the aileron roll control during the recovery period. • SSAC discovered that the pilot had not been using the designated calibrated Mach indication. As a result, the true Mach number was higher than planned and SSAC terminated testing prior to completion of test point 1-13 to conduct data analysis. • SSAC concluded that the LWD roll resembled a wing drop, likely caused by the presence of shock-induced separation. The pilot was briefed to expect increased vibration, buffeting, and possible wing drops as the aircraft passed the 1g buffet boundary at Mach 0.86.
April 26, 2003 (flight 231)	• N138BF attempted to complete point 1-14[15] of Flight Flutter Certification Test Plan for SSAC Aircraft Model SJ30-2, Report 30-2222, Rev. A. • N638TC reported N138BF ended the test point in a slight right bank. • N138BF began a slow **uncommanded RWD roll**. • After 2 revolutions, pilot reported he could not stop the roll. • N138BF rolled approximately 5 more times during a steep descent terminated by ground impact.
August 2003	• SJ30-2 transonic wind tunnel model build contract awarded.
December 2003	• SJ30-2 transonic wind tunnel model delivered.
January 2004	• SJ30-2 transonic wind tunnel test conducted at ARA facility in England.
May 2004	• SSAC presented results of the SJ30-2 transonic test at ARA to the airplane performance group.

The lateral control history data indicated that N138BF exhibited symptoms of lateral asymmetry during the SJ30-2 flight test program. Lateral control authority was available within the design flight envelope (i.e., to V_{MO}/M_{MO}), but requirements for LWD lateral trim increased with airspeed. Incremental lateral trim improvements were made when the ailerons were replaced and the Gurney flap was added. However, N138BF consistently required LWD trim at speeds above 250 KCAS in zero sideslip conditions.

[14] Lateral trim requirements presented as a function of Mach number can be misleading, depending on how airspeed and altitude were varied. Figure 3.0-6 of SSAC document, "S/N 002 Accident Investigation Final Report: Lateral Instability Theory," dated August 1, 2003 indicated that nearly all of the TTAL lateral trim margin was required to trim N138BF between Mach 0.70 and 0.86. However, the SJ30-2 lateral trim requirement is primarily a function of dynamic pressure, as opposed to Mach number. Increasing dynamic pressure (e.g., increasing airspeed and/or decreasing altitude) generally required more lateral trim.

[15] Although the flight 231 test card and flight flutter test plan Report 30-2222, Rev. A, Appendix A called for excitation pulses to be conducted once in each direction, the actual pulses were commanded in a single direction, consistent with the exception documented on page 6 of Report 30-2222, Rev. A, for flight conditions above the maximum level speed of the aircraft. Speedbrakes were not extended for this test point, and were not planned to be extended.

IX. SJ30-2 Stability and Control Characteristics

Prior to the N138BF accident, SSAC estimated the SJ30-2 high speed stability and control characteristics by extrapolating from low speed wind tunnel data, using methods in the USAF Stability and Control Data Compendium (DATCOM), conducting numerical simulation with Computational Fluid Dynamics (CFD) tools, and extrapolating from flight test data[16].

A. Wind Tunnel Testing

SSAC conducted 8 low speed wind tunnel tests at the University of Washington Aeronautical Laboratory (UWAL) in Seattle, Washington between 1996 and 2002. The baseline SJ30-2 configuration was developed during 3 tests completed between February 1996 and February 1997. Aerodynamic stability and control data for the production SJ30-2 configuration were collected during tests in October 1997 and May 1998. Secondary flight control surface asymmetry deployment effects were evaluated in September 2001. Speedbrake pitching moment characteristics, stall chute stinger/emergency egress deflector effects, and alternative speedbrake configurations were analyzed in August and October 2002. The low speed wind tunnel data showed that the presence of separation due to either speedbrake deployment or high (post-stall) angles of attack tended to reduce wing lateral stability.

Following the accident, SSAC developed a test plan and authorized a transonic test to define the high speed stability and control characteristics of the SJ30-2. A 1/9th scale model was built to SJ30-2 design loft specifications by Tri Models, Inc. of Huntington Beach, California between August and December 2003. The model design enabled hinge moments generated by specific hinge-wise deflections of the horizontal stabilizer, aileron, elevator, rudder, and outboard spoiler/speedbrake flight control surfaces to be measured. In addition, vortex generator, thick trailing edge flap and aileron, Gurney flap, winglet, strake, and wing blade components were built and tested. The transonic test took place in the Aircraft Research Association Limited (ARA) 9 by 8 foot transonic tunnel in Bedford, England during January 2004.

Results of the transonic test were presented to the airplane performance group by SSAC in May 2004. The transonic wind tunnel test data indicated that lateral stability on the SJ30-2 deteriorated with increasing Mach number and angle of attack. Lateral stability measured in terms of rolling moment due to sideslip became negative (unstable) above Mach 0.83. Given this lateral stability sign change, a rudder input intended to augment the lateral trim (or roll capability) and raise a low wing could, beyond a certain Mach number, aggravate the need for lateral trim (or roll capability). Similarly, an elevator TEU input would tend to increase the angle of attack resulting in deteriorated lateral stability.

The transonic wind tunnel test data also provided evidence that roll authority deteriorated above Mach 0.86. Flow visualization results showed that the flow on the upper wing surface separated between Mach 0.84 and 0.88 and flow on the lower wing surface separated between Mach 0.86 and 0.88 at 2° angle of attack and 0° sideslip angle. A 1° angle of attack is representative of the accident flight condition lift coefficient. By Mach 0.88, the aileron upper and lower surfaces were both in separated (low energy) flow regions.

[16] Flight test data were available from a smaller scale, pre S/N 001 "prototype SJ30-2" designated the SA30 and from N138BF.

B. Computational Fluid Dynamics

SSAC used Computational Fluid Dynamics (CFD) methods for wing design and to supplement the SJ30-2 high speed stability and control database. However, prior to the accident, primarily vortex lattice and Euler methods were used. Euler methods tend to predict shock locations farther aft than the actual shock position for transonic flight conditions. More advanced CFD methods, including Navier-Stokes codes, tend to improve shock strength and location calculations, but remain challenged to accurately predict hinge moment coefficients, skin friction drag, and wave drag. SSAC has only recently applied CFD methods for the prediction of stability and control derivatives.

Wing designs for the SA30 (a pre SJ30-2 prototype) and SJ30-2 were performed using WIBCO, a NASA/Grumman transonic small disturbance code. A coupled integral boundary layer method was available, but WIBCO lacked an asymmetric analysis capability. The WIBCO code was used primarily for cruise analysis, although runs were also made at Mach 0.88 (the dive Mach number at the time) to check for separation onset.

Prior to the accident, the three-dimensional MGAERO[17] Euler code (inviscid mode) was used to design the pylon for cruise, analyze the flap track fairings, and benchmark the Euler code used at SSAC as well as the VLAT code used for loads. MGAERO predicted a reduction in lateral stability above Mach 0.815, but positive lateral stability up to Mach 0.90. Two-dimensional CFD aileron power studies showed aileron power decreasing with increasing Mach number.

Following the accident, SSAC made inviscid calculations up to Mach 0.9, including sideslip, in an attempt to understand three-dimensional, transonic, asymmetric characteristics. The fully viscous NSAERO Navier-Stokes code has been recently applied to gain additional insight.

C. N138BF Flight Testing

SSAC steady heading sideslip flight tests conducted with N138BF demonstrated that the SJ30-2 had positive lateral stability from 1.2 V_S up to Mach 0.817. Sideslip angles up to 6° were tested at Mach 0.817. Bank to bank roll testing demonstrated adequate aileron authority out to Mach 0.819. Flight 230 data demonstrated N138BF response to aileron and rudder inputs above M_{MO}. Flight 199 and flight 200 high speed tuft test data confirmed the presence of large regions of shock-induced separation above Mach 0.81.

X. SJ30-2 Aircraft and Flight Test Program Improvements

SSAC made aerodynamic improvements to the SJ30-2 following the accident as a result of post-accident design and development efforts. First, vortex generators were added to the wings to delay the onset of shock-induced separation. Second, thicker trailing edge ailerons were installed to improve aileron effectiveness at high Mach numbers. In addition, a high Mach number roll

[17] The MGAERO code is used to analyze complex geometry configurations by solving the Euler equations for compressible inviscid flow. Cartesian embedded grids are used to discretize the domain and multi-grid and other methods are used to accelerate the solution calculation. A correction which partially accounts for viscous effects is available via an integral boundary layer calculation along surface streamlines.

spoiler system was prepared for implementation to augment roll control above Mach 0.835. As a result of design work prior to the accident, the single speedbrake panel on each wing was relocated farther outboard to minimize the large pitch down effects caused by tail lift interference.

The SJ30-2 flight flutter test aircraft was equipped with a high speed drag chute before Phase 2 flutter testing resumed. Moreover, the speedbrakes were operational at all airspeeds to the design deployment range with improved pitch characteristics. SSAC pilots received unusual attitude training and corrective actions for overspeed and upset conditions were formally defined. SSAC successfully completed the SJ30-2 Phase 2 flight flutter testing in August 2004 and demonstrated that the high Mach number roll spoiler schedule was not needed.

XI. Post-Accident Flight Test Data (S/N 004)

Recent flight test results on S/N 004, which incorporated the configuration modifications outlined above, demonstrated improved SJ30-2 high speed stability and control characteristics. The S/N 004 airplane flew multiple flutter test points to V_D/M_D (372 KCAS/0.90 Mach). The point of neutral lateral stability was shown to be approximately 0.015 Mach higher at the critical altitude (28,000 ft) than that predicted by the transonic wind tunnel data. The modified SJ30-2 configuration maintained positive lateral stability at M_{MO} (0.83 Mach) and demonstrated neutral lateral stability at about 0.85 Mach.

High-speed dive recovery (deceleration from Mach 0.885 to Mach 0.85) accomplished by simply reducing thrust to idle resulted in a return to the laterally stable flight regime within about 9 seconds. Releasing rudder input from a nominally stabilized sideslip condition caused the airplane to return to wings level flight at all Mach numbers tested up to 0.9 Mach, even when $C_{l\beta}$ was positive. Finally, the modified configuration repeatedly demonstrated controlled flight into the "unstable" regime with positive roll control at all times and rapid recovery to M_{MO} when required.

XII. Conclusions

The N138BF lateral control upset occurred during flight in high speed buffet at approximately Mach 0.88. The loss of lateral control was manifest in the form of a continuous, right wing down, descending roll. Although no roll authority problems were previously documented, the airplane had an established history of limited lateral trim capability that deteriorated with increasing airspeed, above 250 KCAS.

Flight test data indicated that rudder pedal was used in an attempt to augment roll control during two high speed flight flutter test conditions prior to the accident. Telemetry rudder position and sideslip angle estimates indicated that N138BF was in a 2° to 3° sideslip condition at the time of the upset. Post-accident SJ30-2 transonic wind tunnel test data showed that aileron effectiveness was markedly reduced above Mach 0.86 and that the lateral stability became negative (unstable) above Mach 0.83. Rudder deflection intended to raise a low wing in flight conditions where lateral stability was positive would have aggravated the low wing situation in flight conditions where the lateral stability was negative.

At the accident flight condition, N138BF was not able to generate enough aileron roll authority to balance the residual rolling moment coupled with the adverse rolling moment due to a 2° to 3° sideslip. Shock-induced separation effects tend to decrease with lower Mach number and reduced angle of attack. Adverse rolling moment effects due to negative lateral stability tend to decrease with lower Mach number and reduced sideslip angle. Based on the available N138BF flight test data and the ARA transonic wind tunnel data, recovery from the lateral control upset would most likely have been accomplished by reducing speed (e.g., throttles to idle, speedbrake deployment) below Mach 0.84.

Appendix A

N138BF Flight 231 Control Surface Telemetry Data and Calculated Parameters

(Figures A.0—A.9)

FIGURE A.0: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

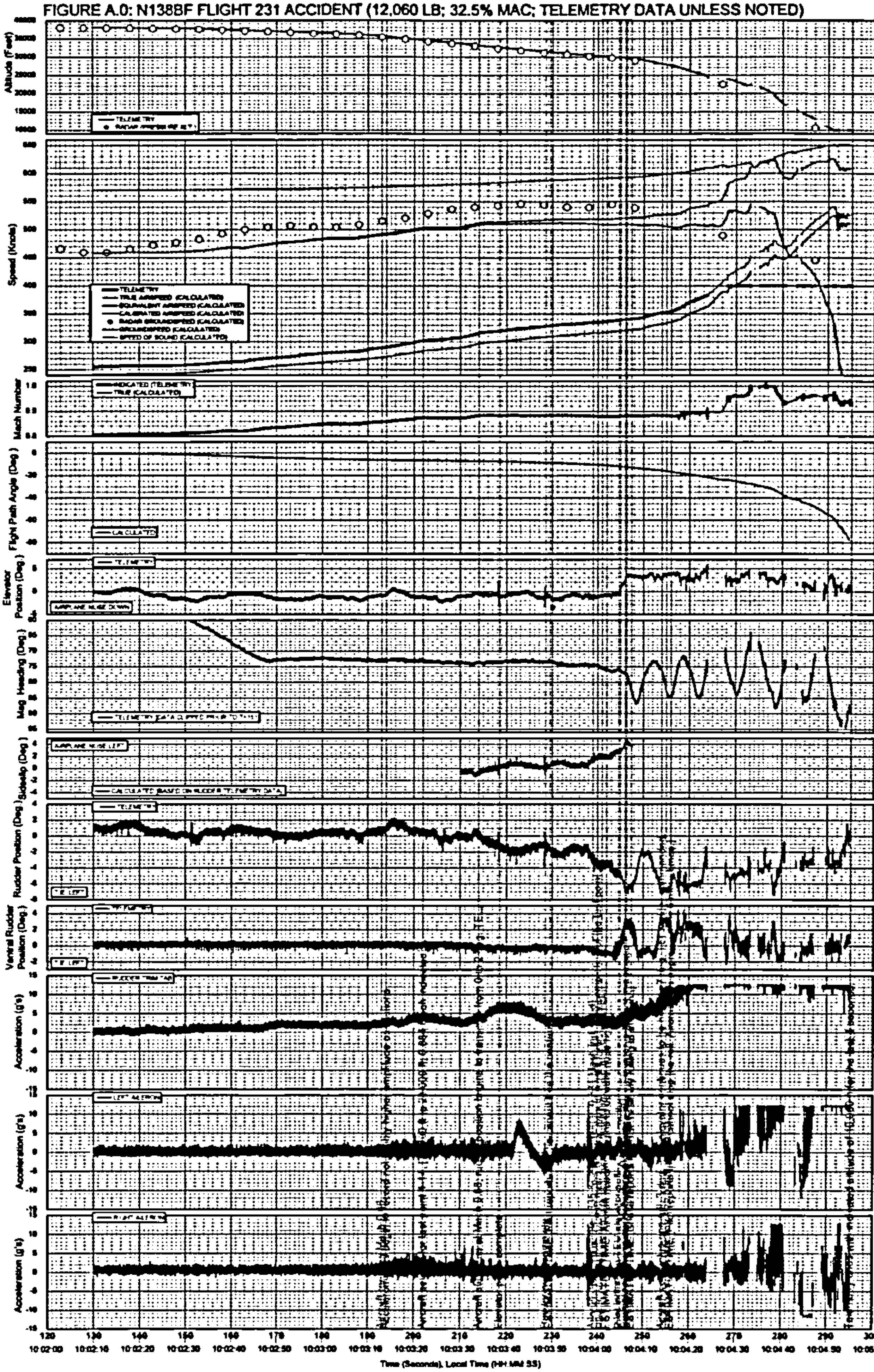


FIGURE A.1: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

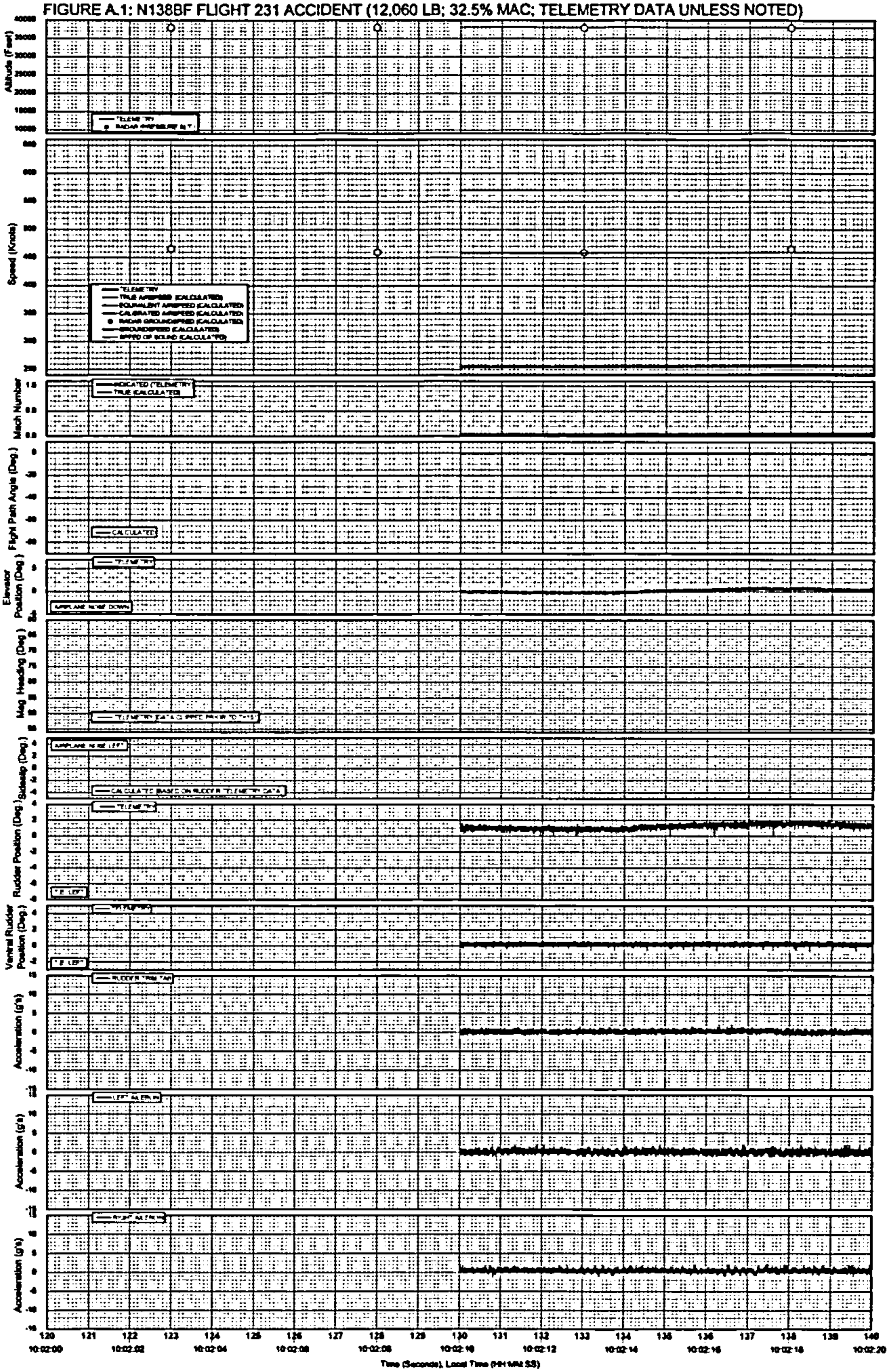


FIGURE A.2: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

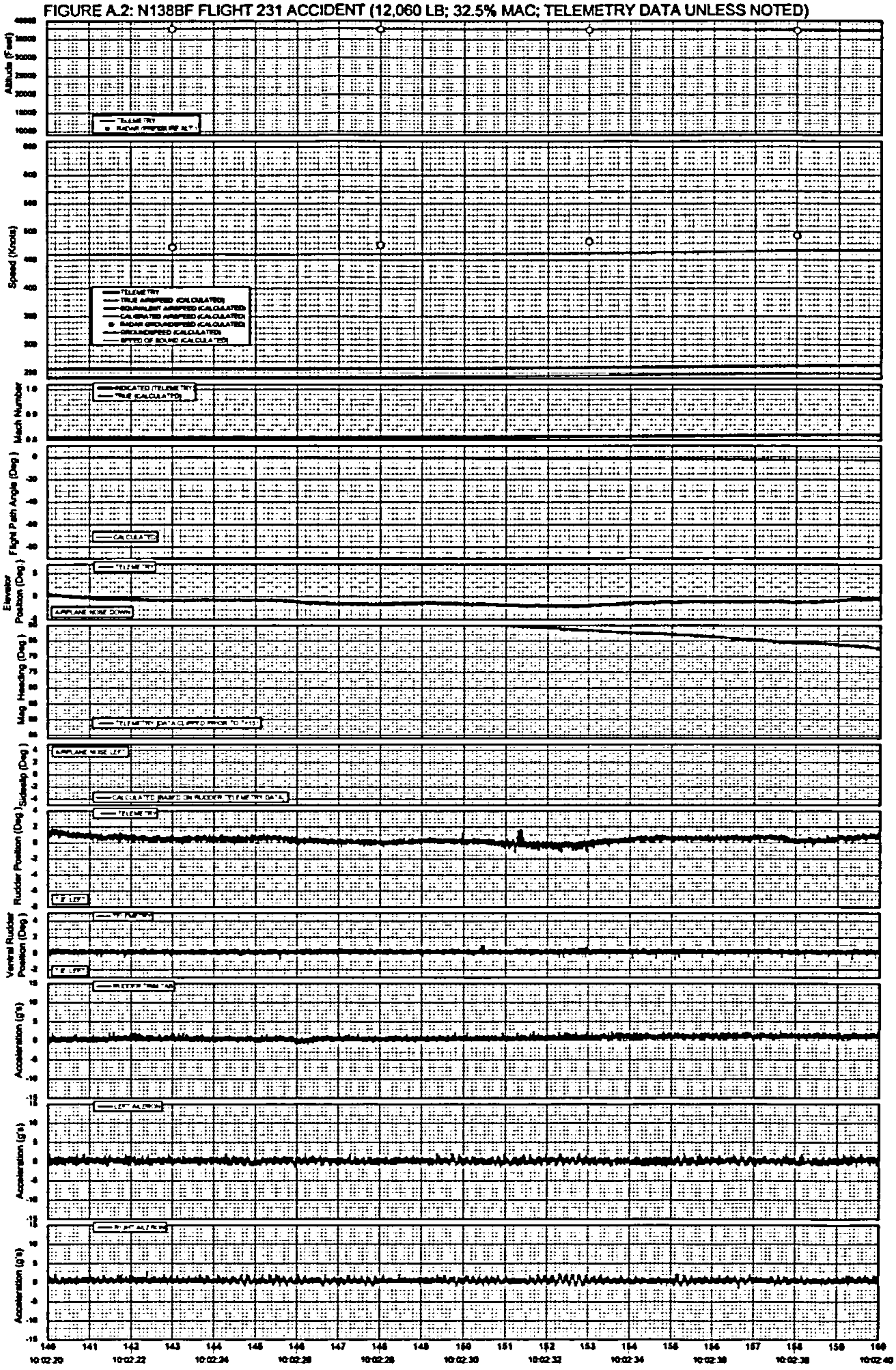


FIGURE A.3: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

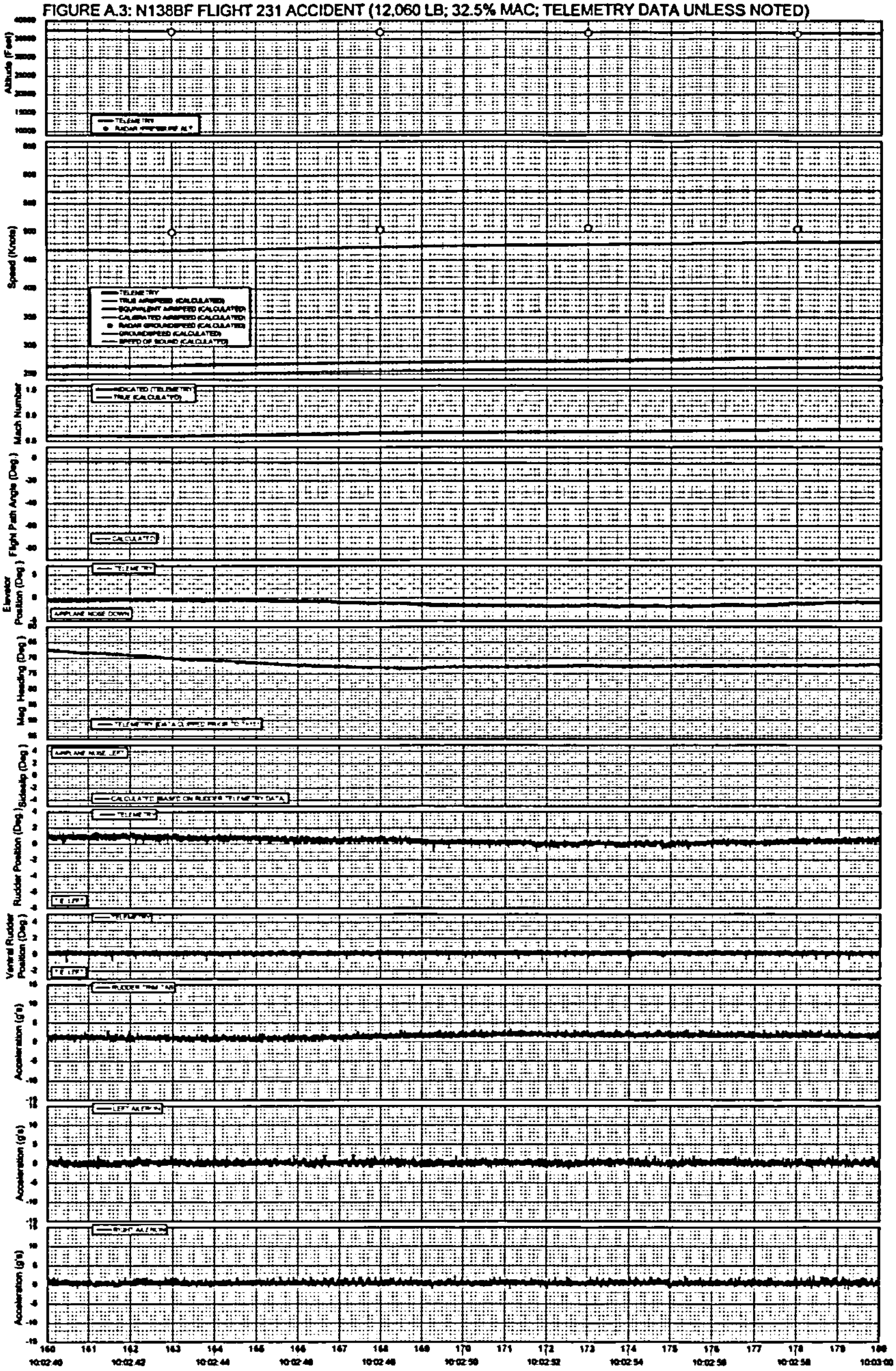


FIGURE A.4: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

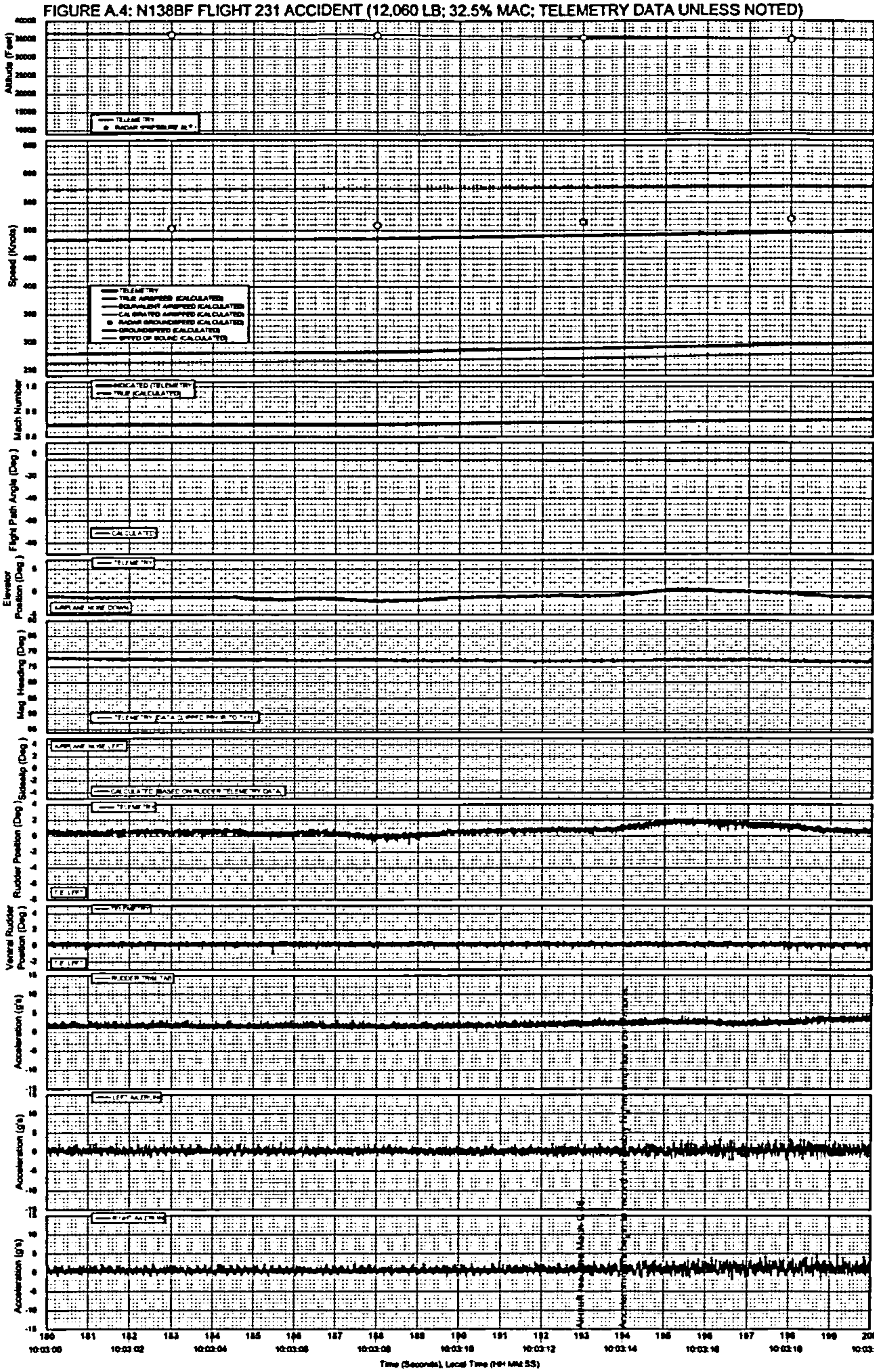


FIGURE A.5: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

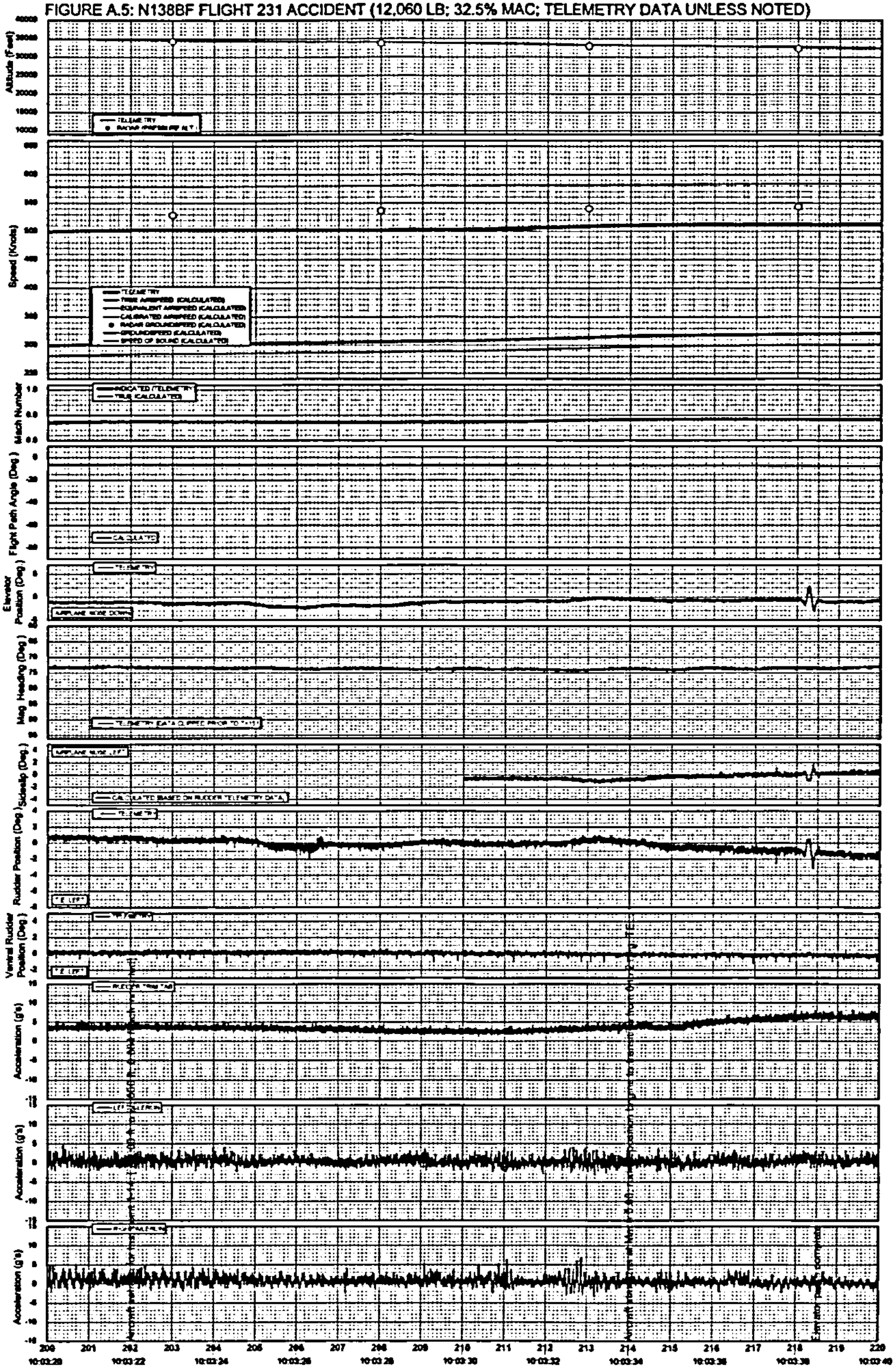


FIGURE A.6: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

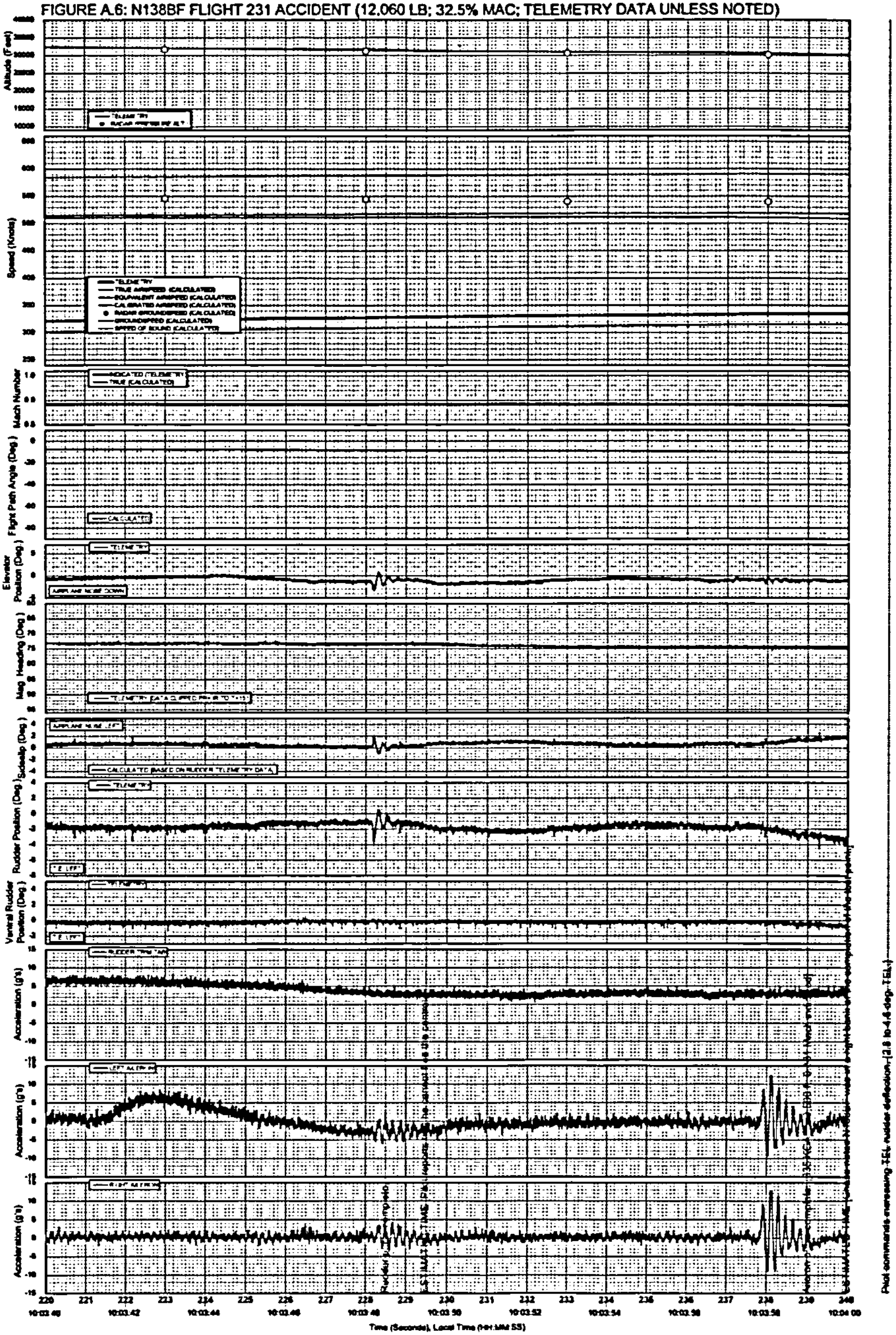


FIGURE A.7: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

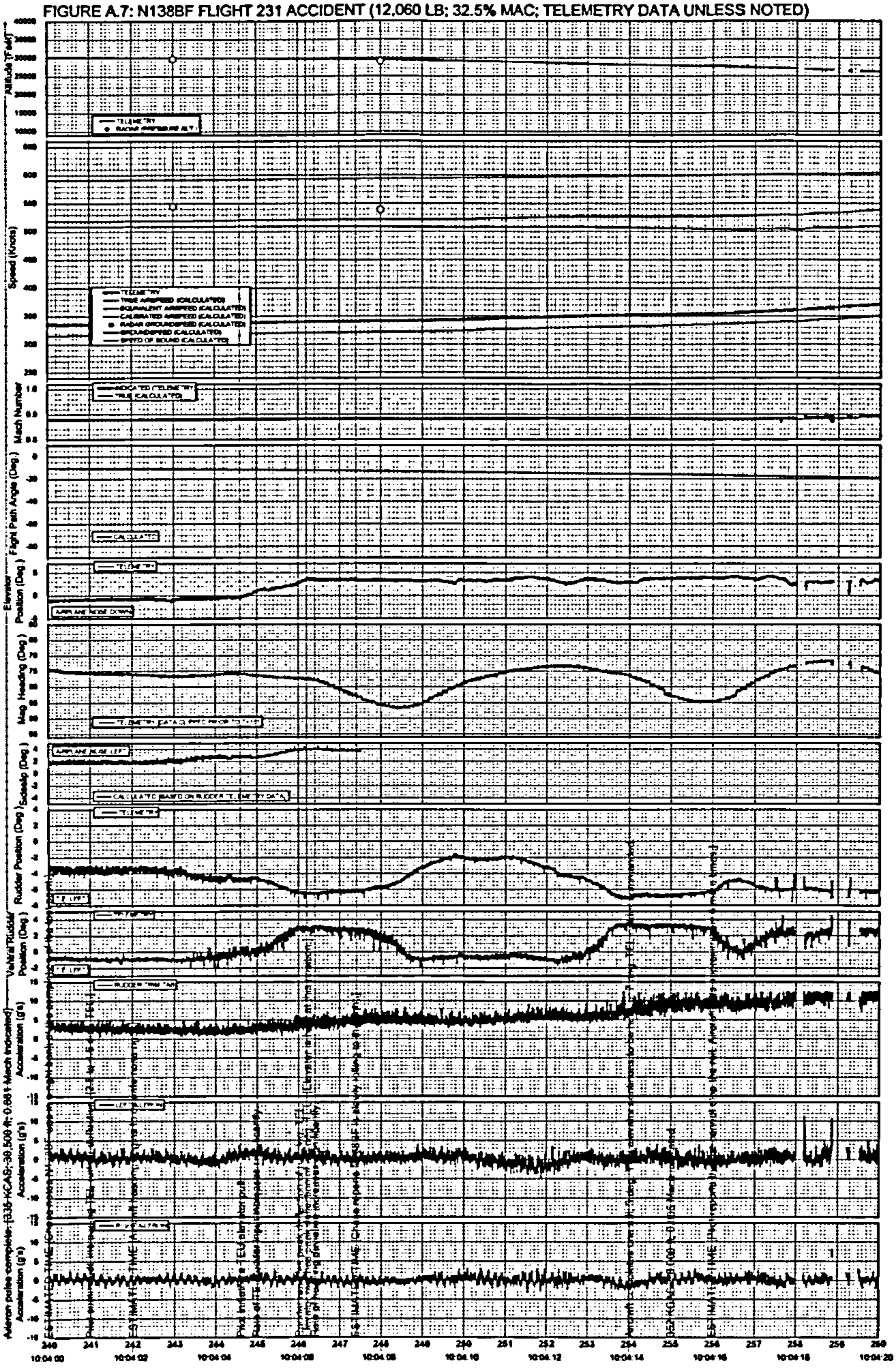


FIGURE A.8: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

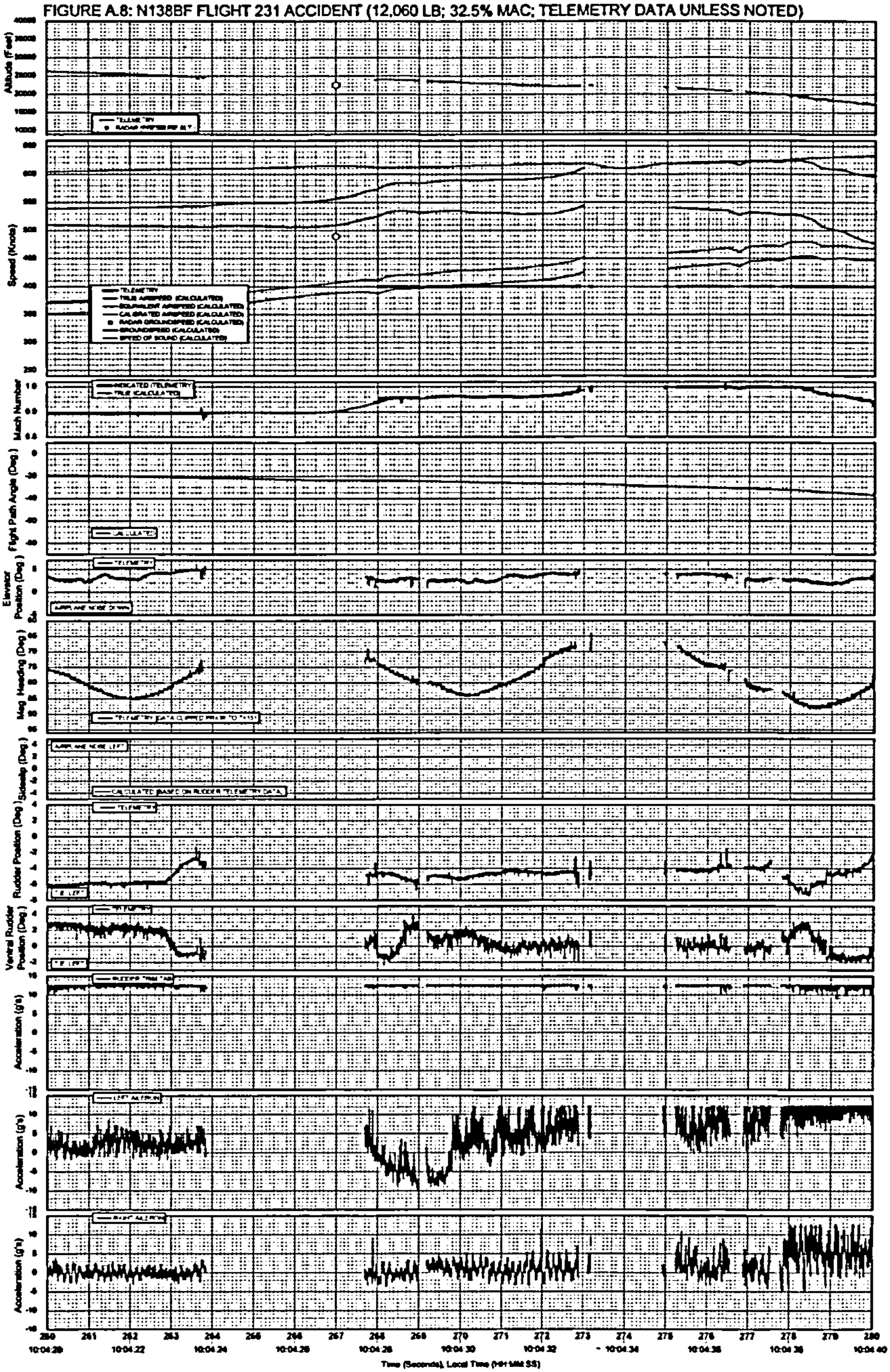
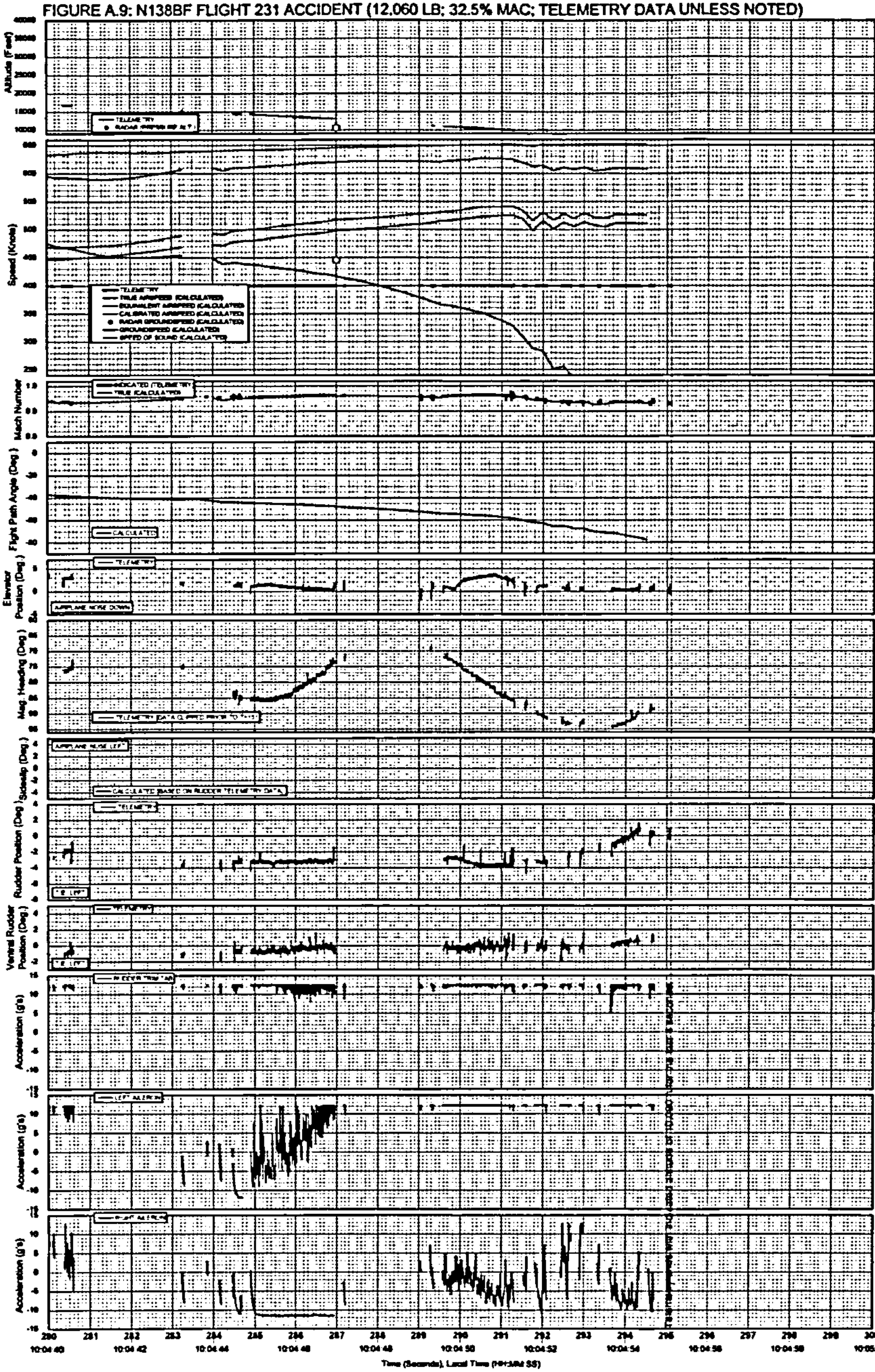


FIGURE A.9: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)



Appendix B

N138BF Flight 231 Longitudinal and Lateral Accelerometer Telemetry Data

(Figures B.0—B.9)

FIGURE B.0: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

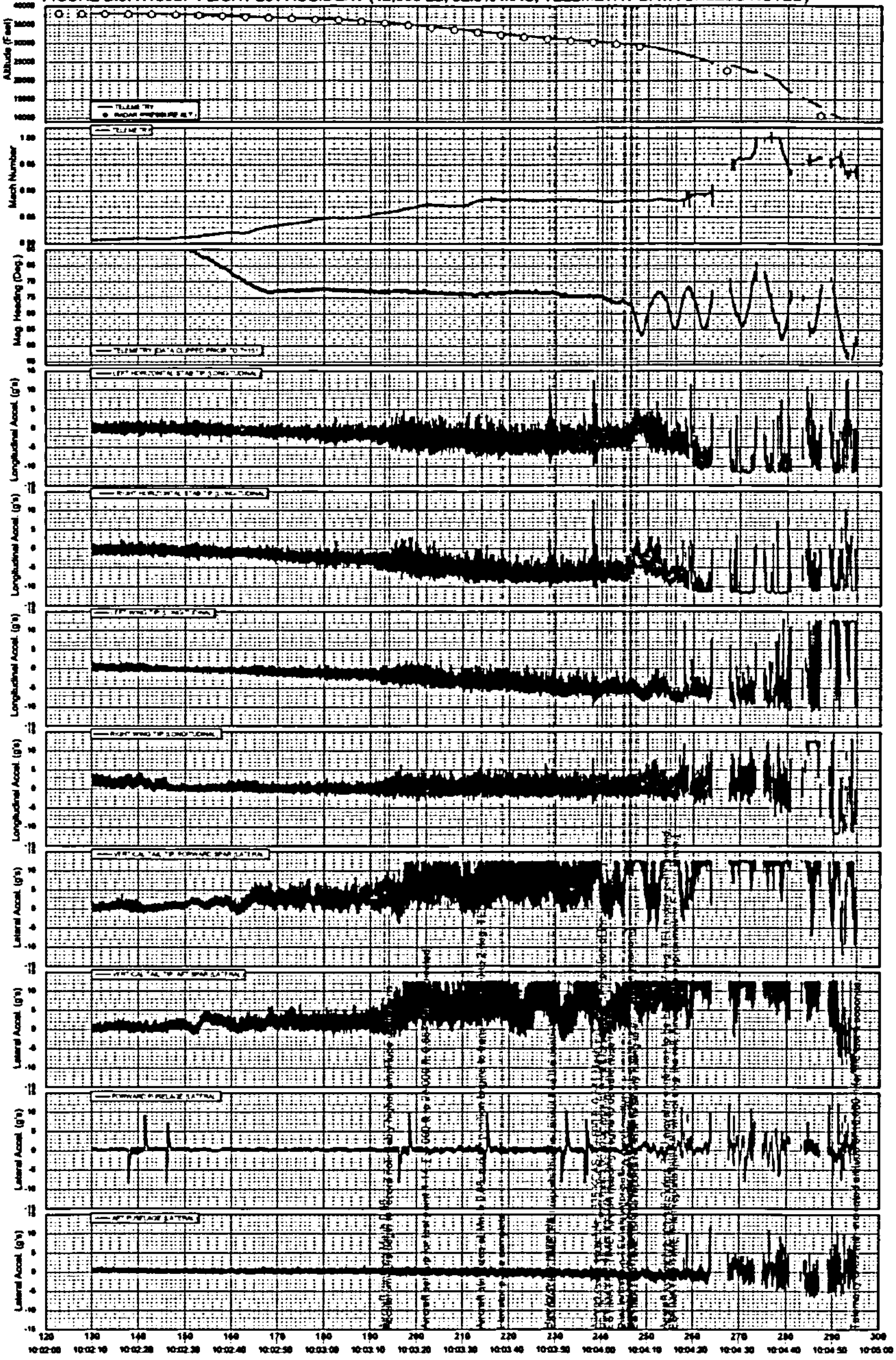


FIGURE B.1: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

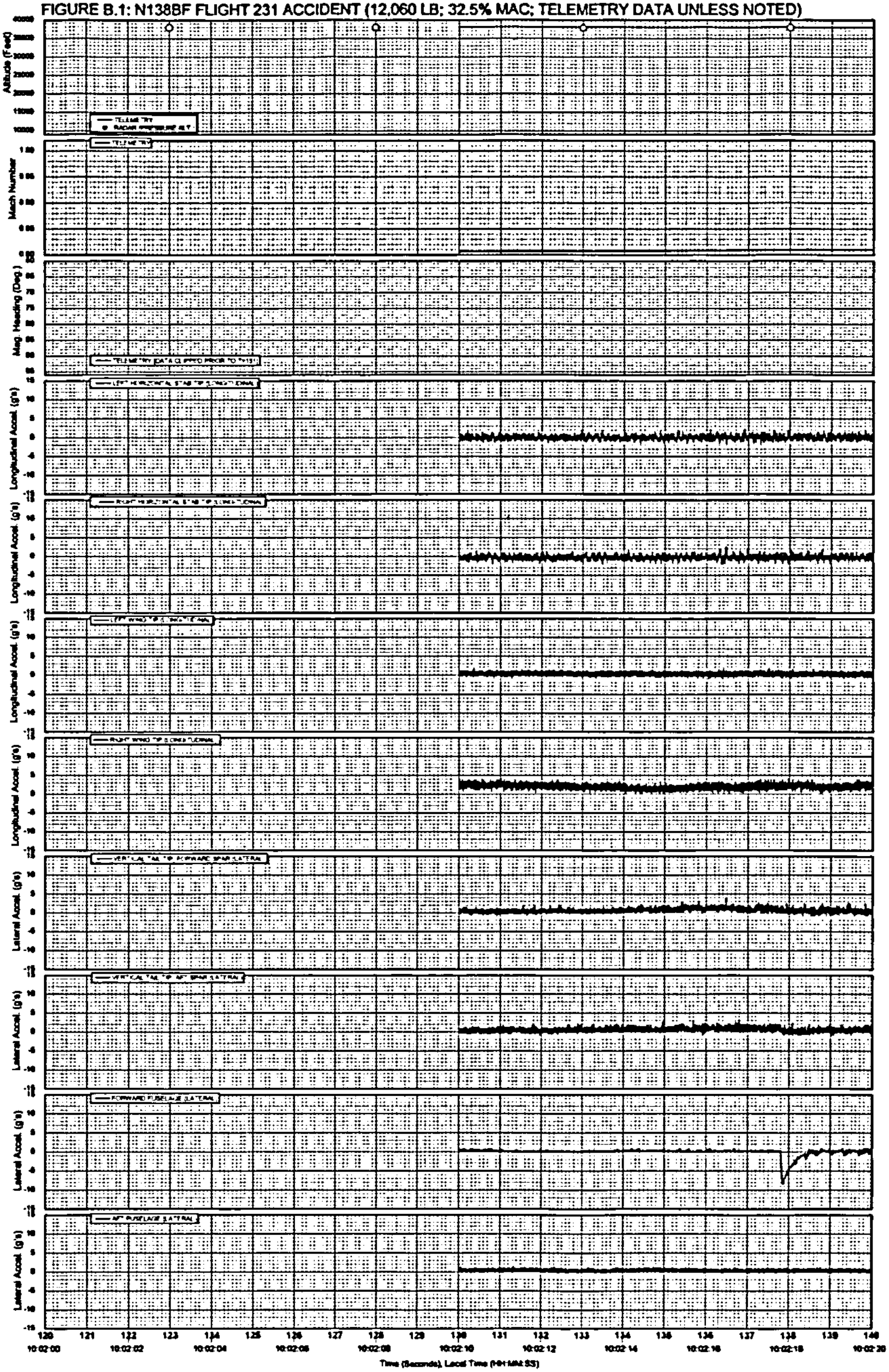


FIGURE B.2: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

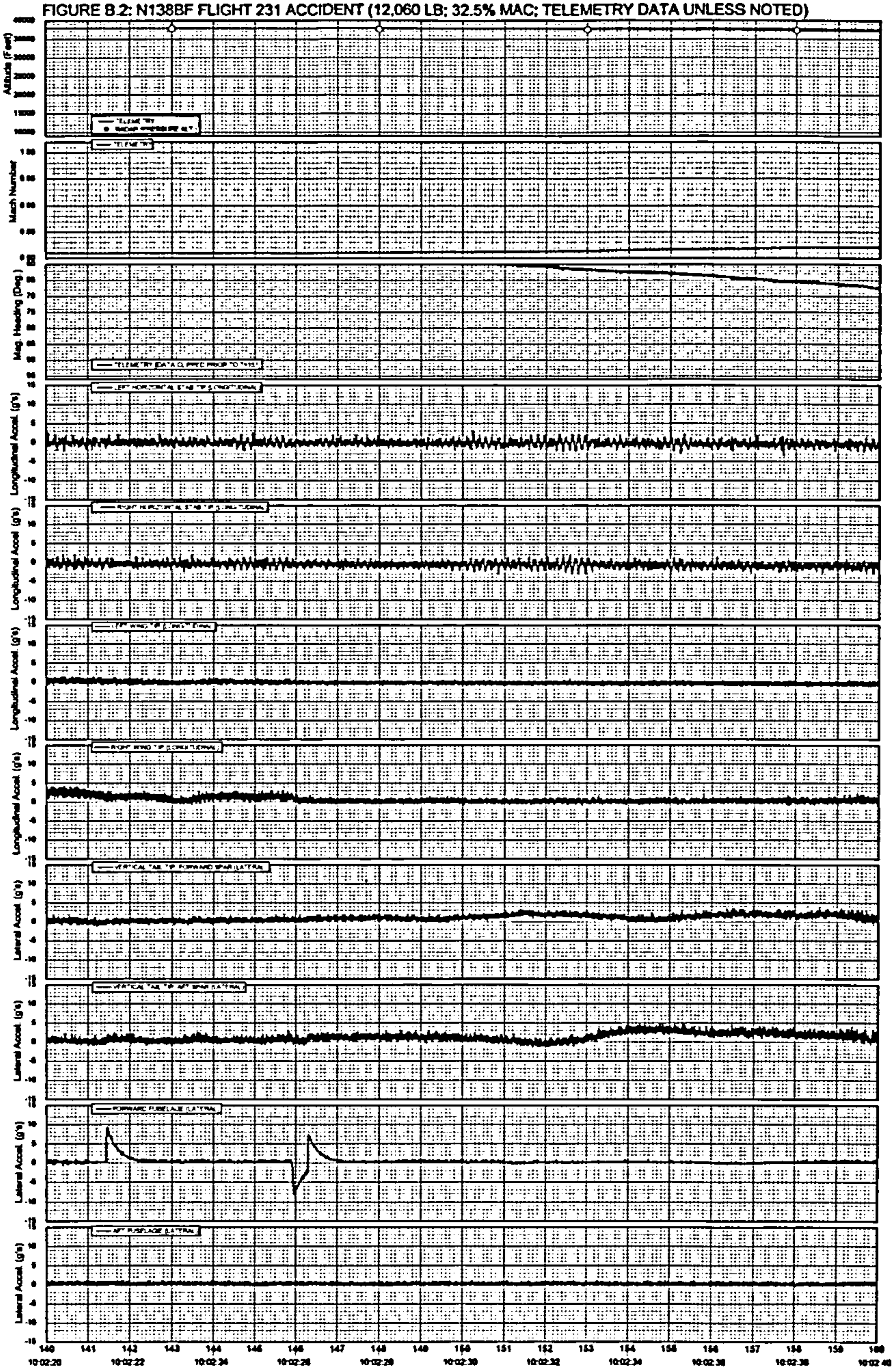


FIGURE B.3: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

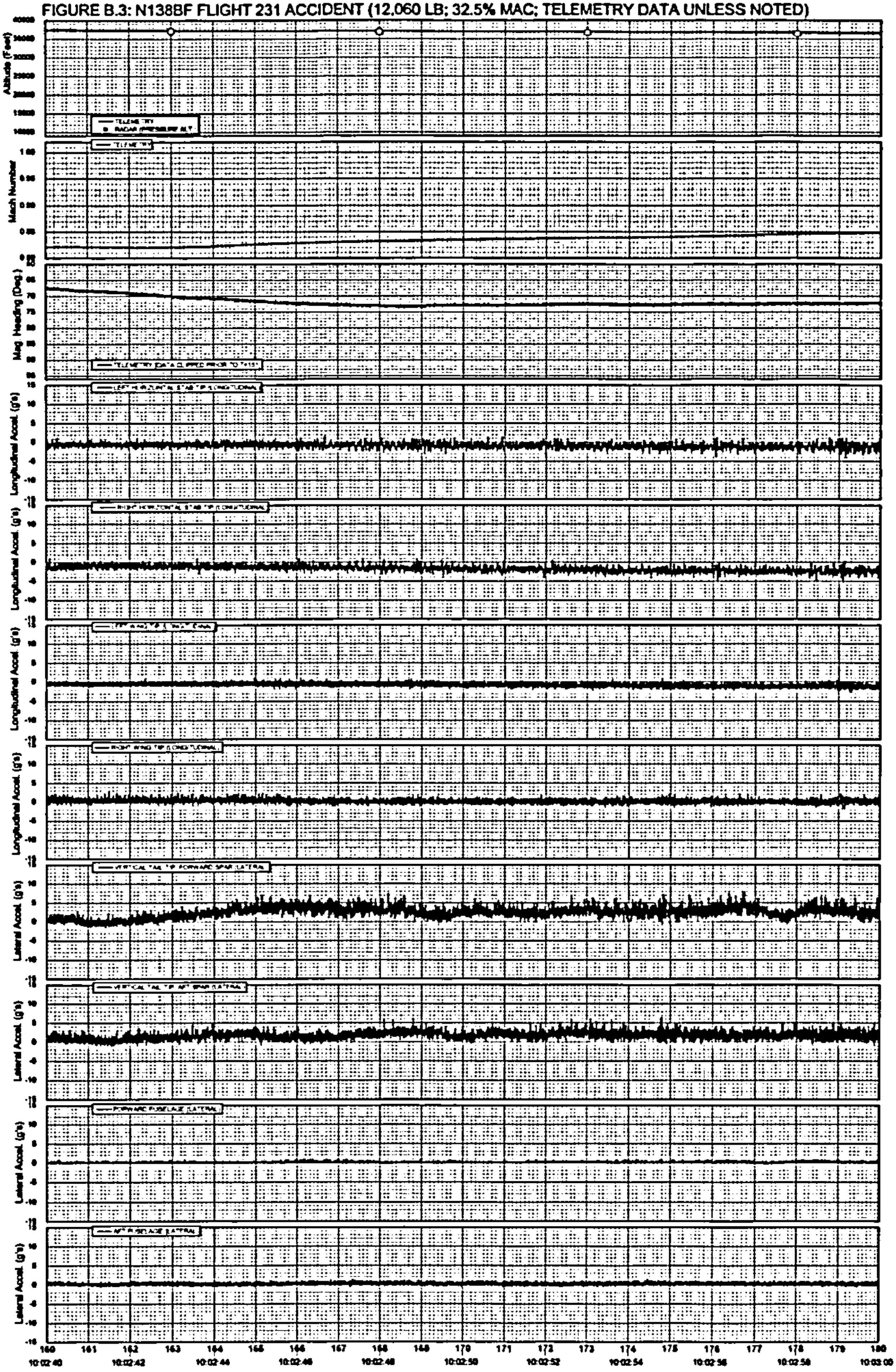
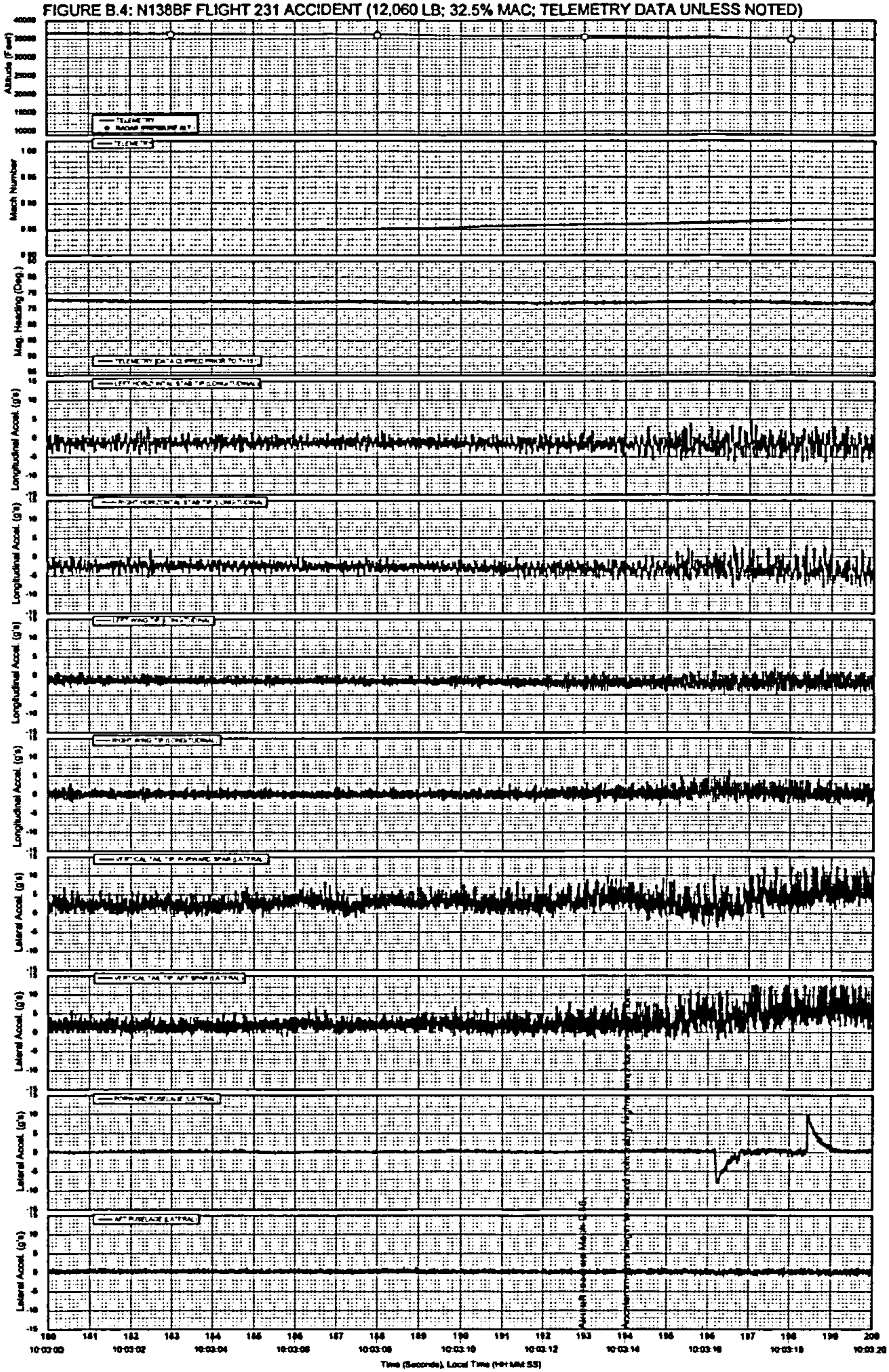


FIGURE B.4: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)



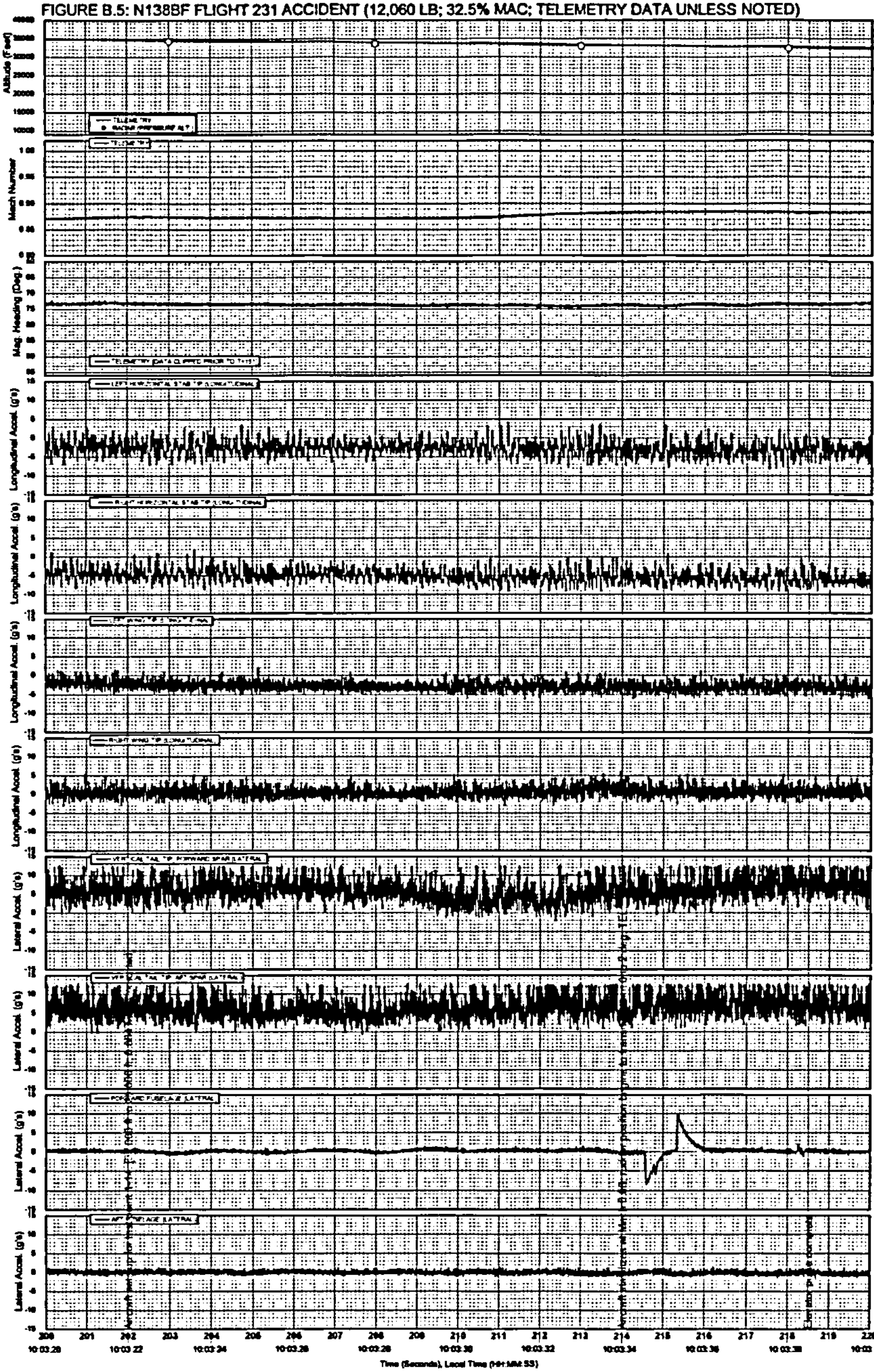


FIGURE B.5: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

FIGURE B.6: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

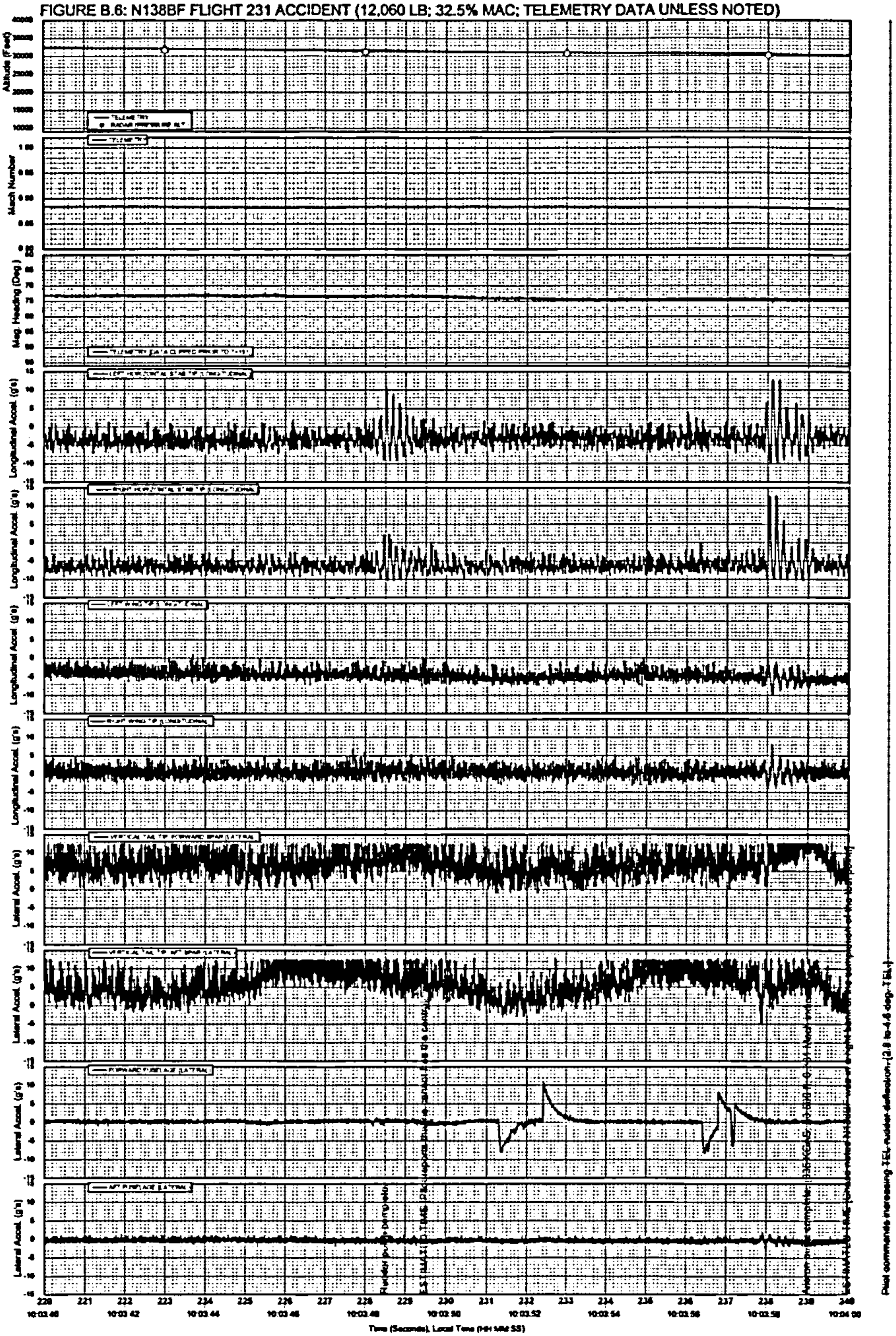


FIGURE B.7: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

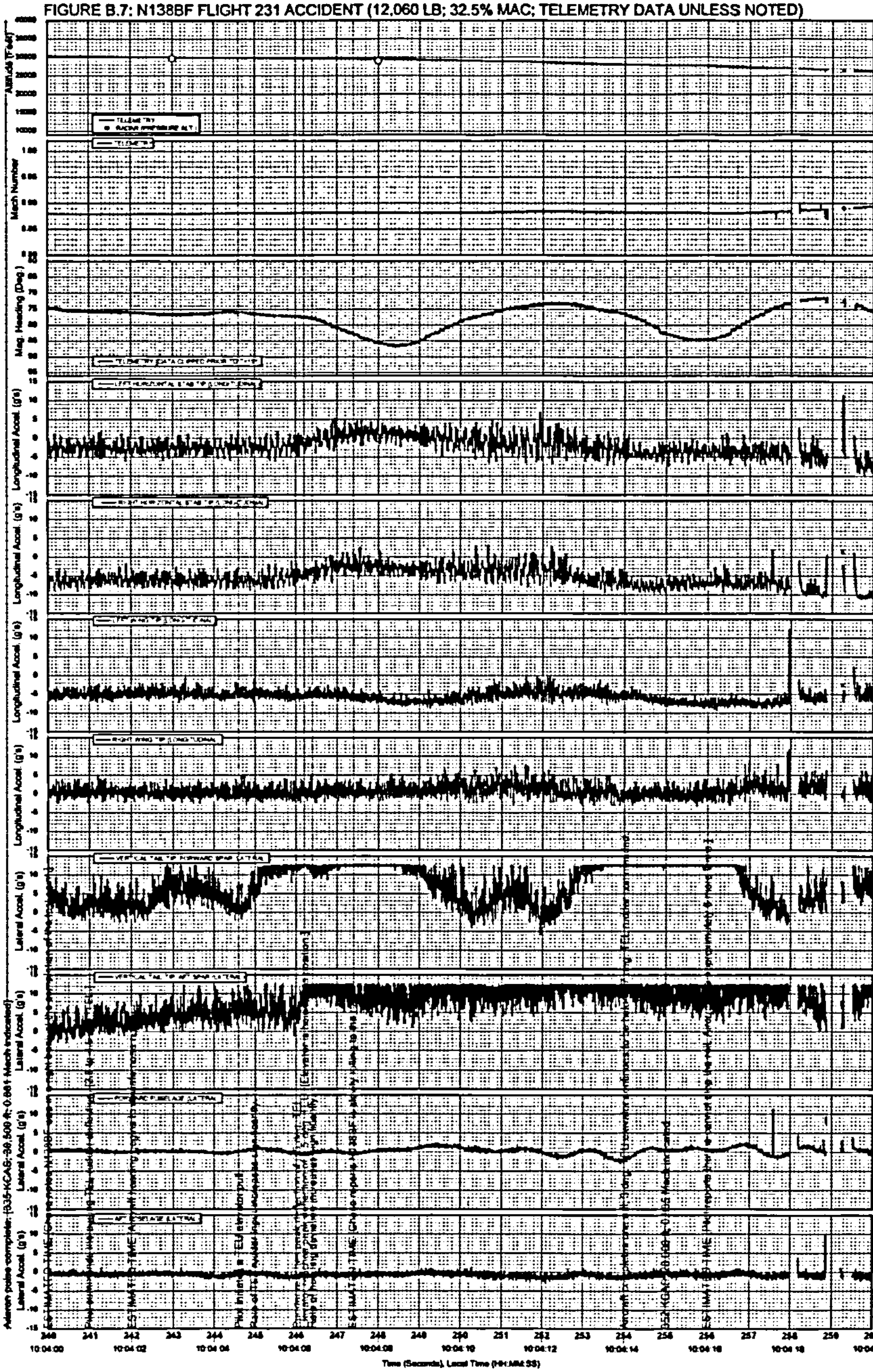


FIGURE B.8: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

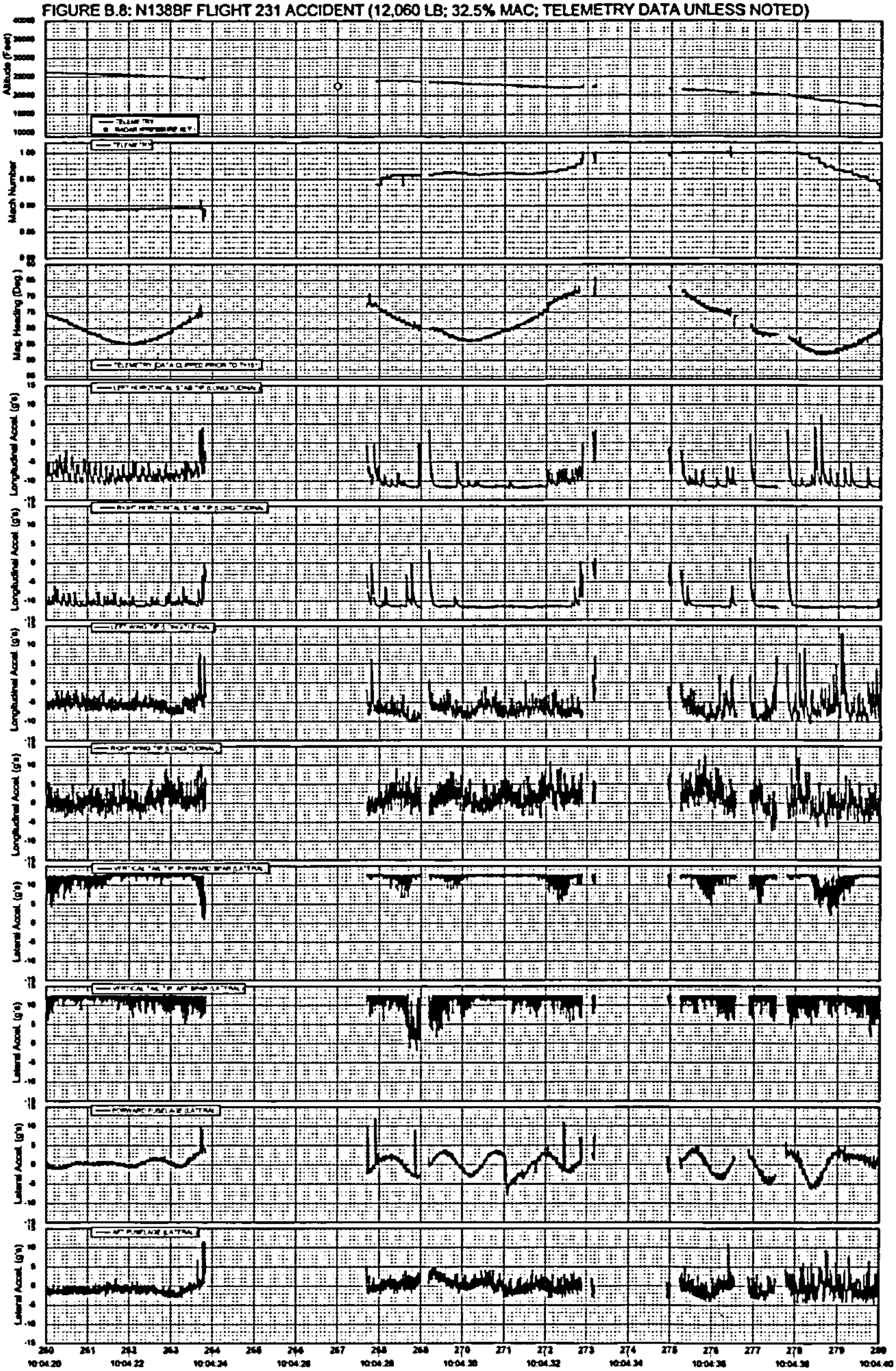
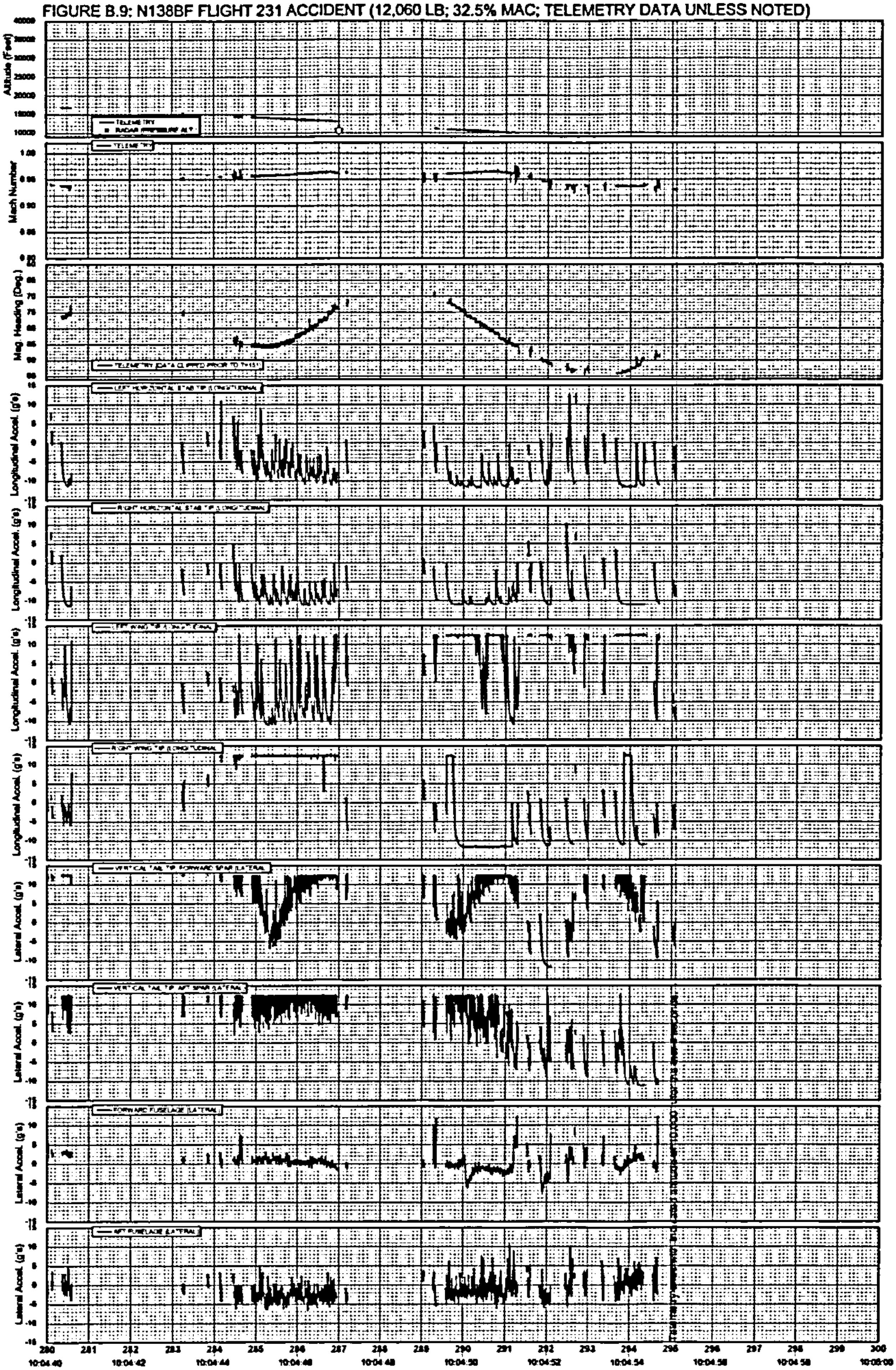


FIGURE B.9: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)



Appendix C

N138BF Flight 231 Vertical Accelerometer Telemetry Data

(Figures C.0—C.9)

FIGURE C.0: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

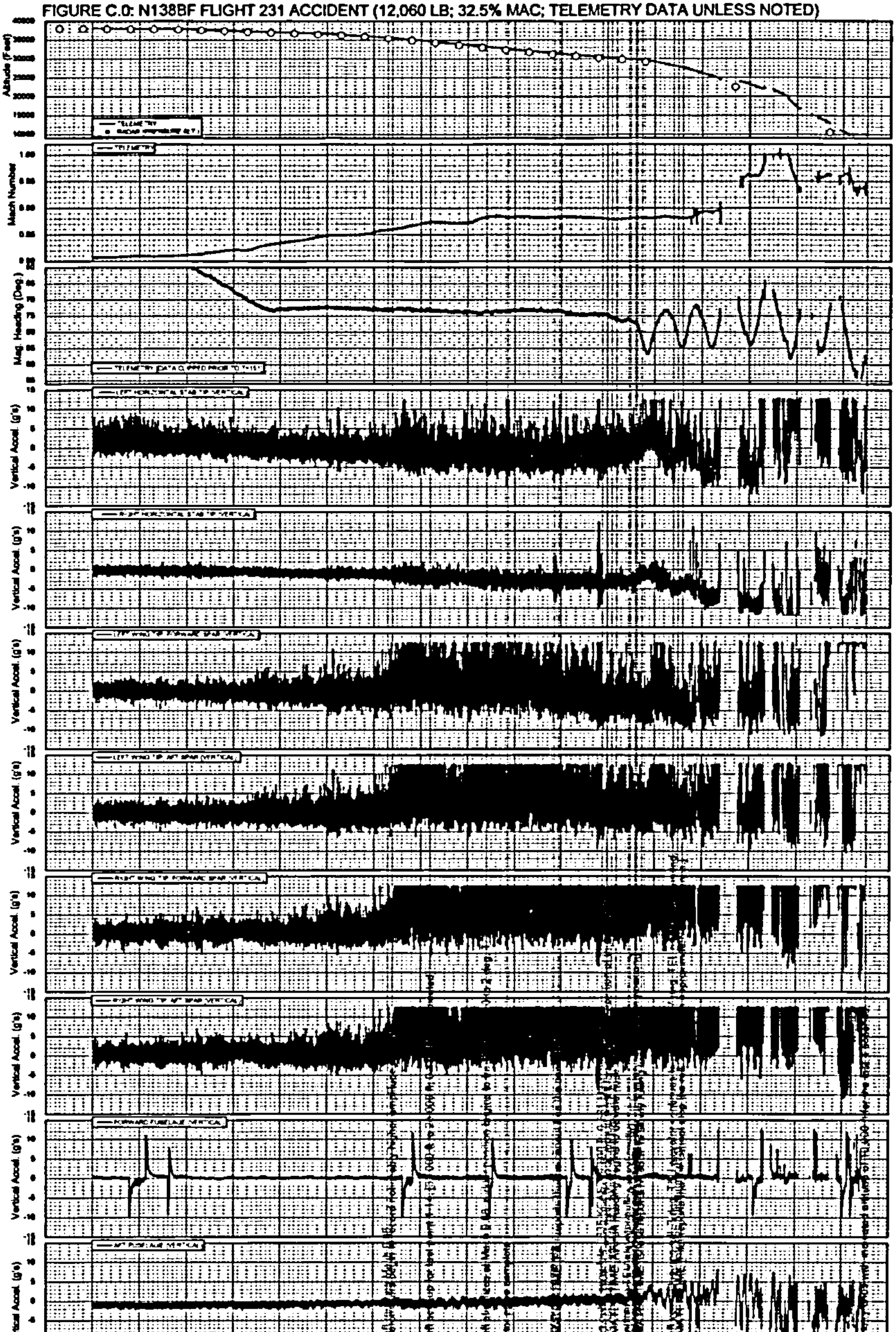


FIGURE C.1: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

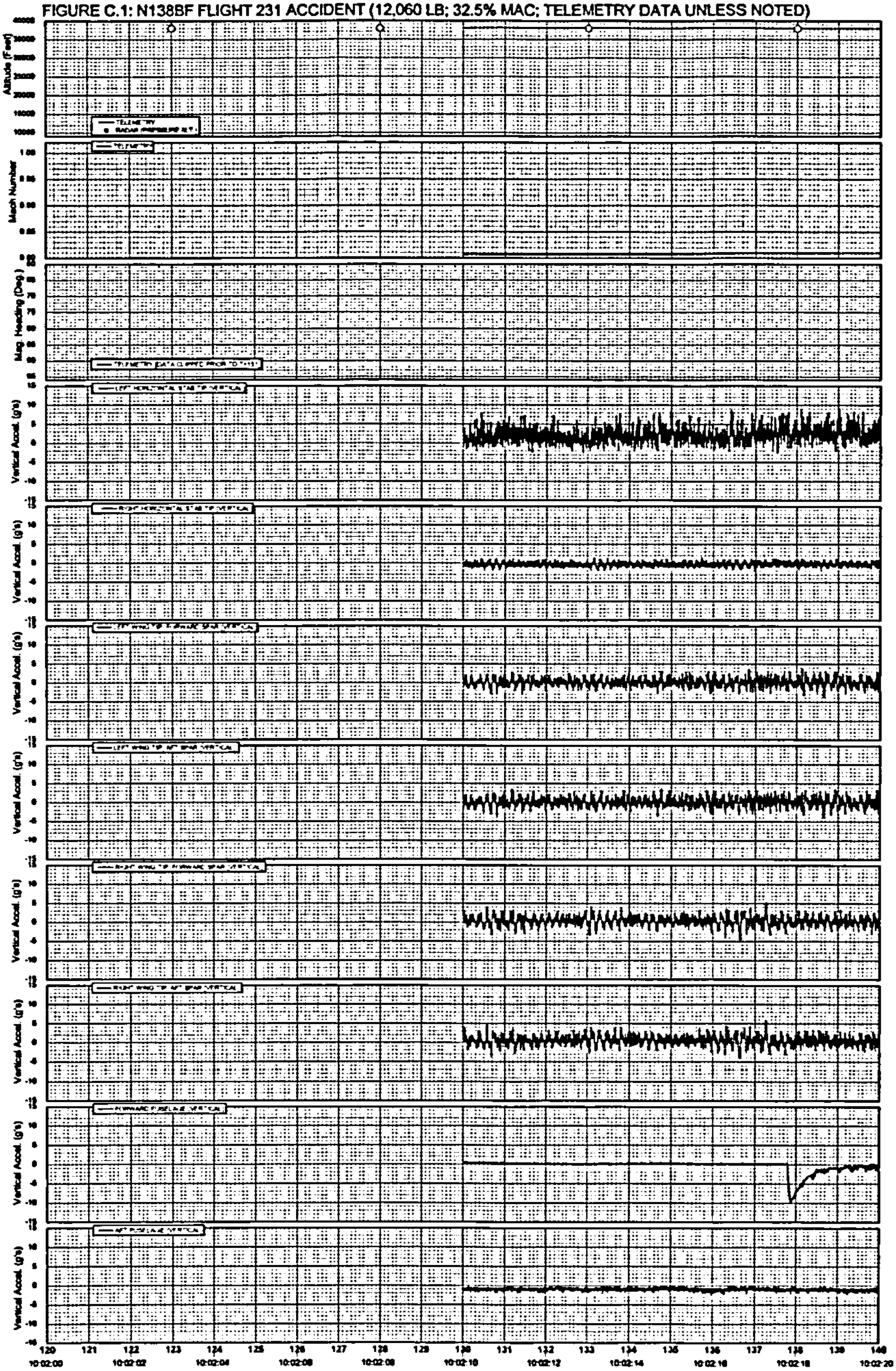


FIGURE C.2: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

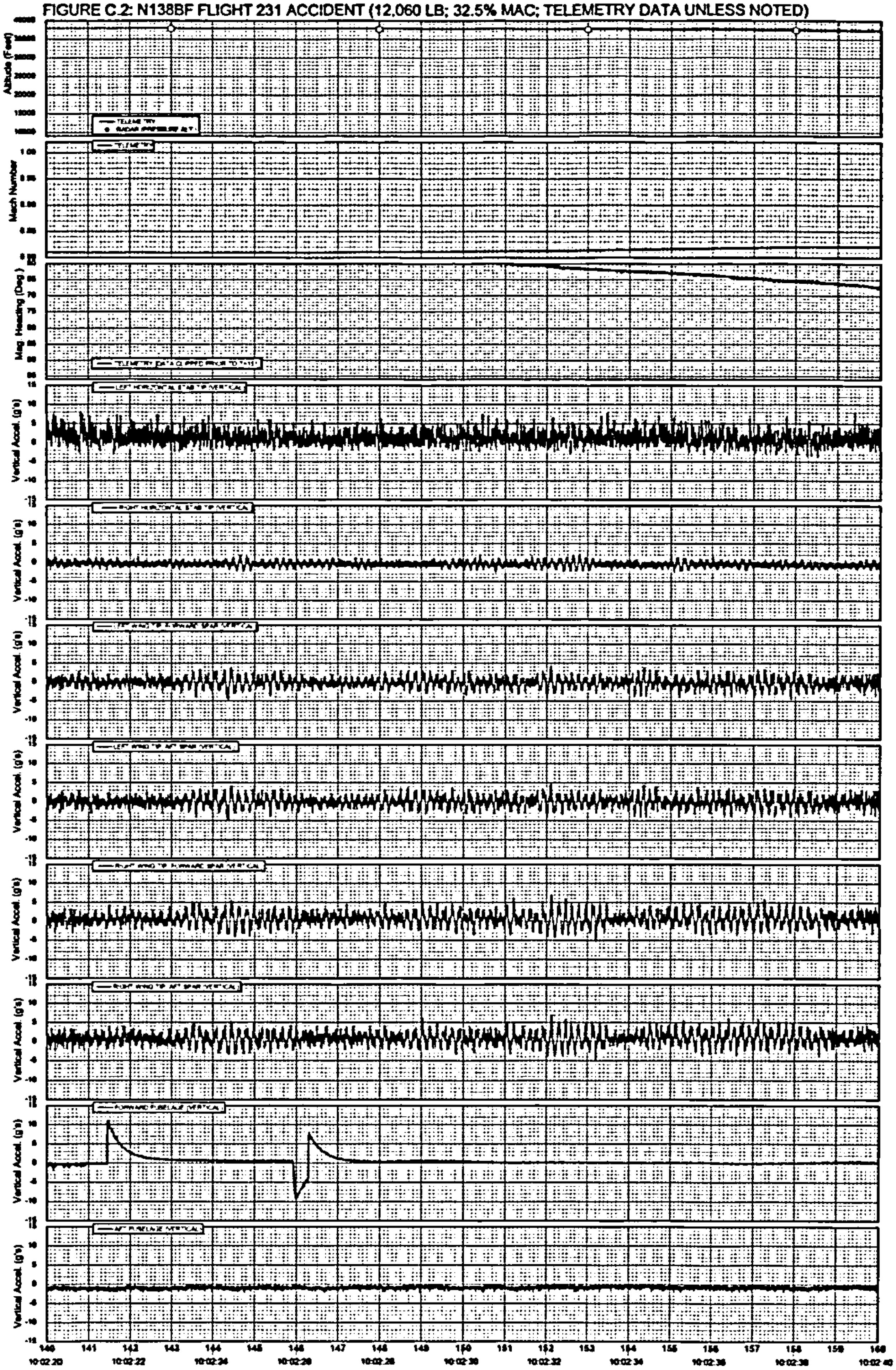


FIGURE C.3: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

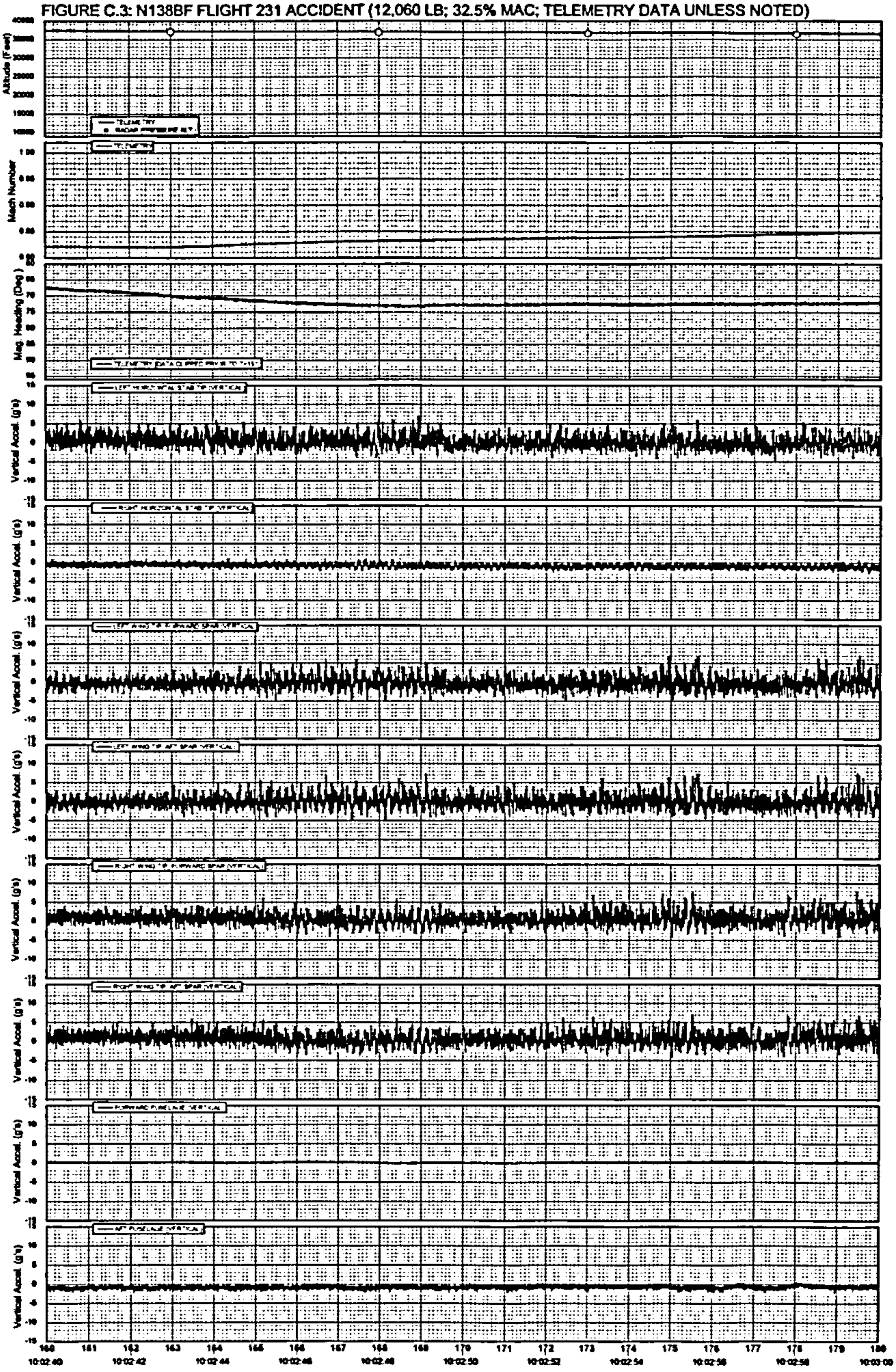


FIGURE C.4: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

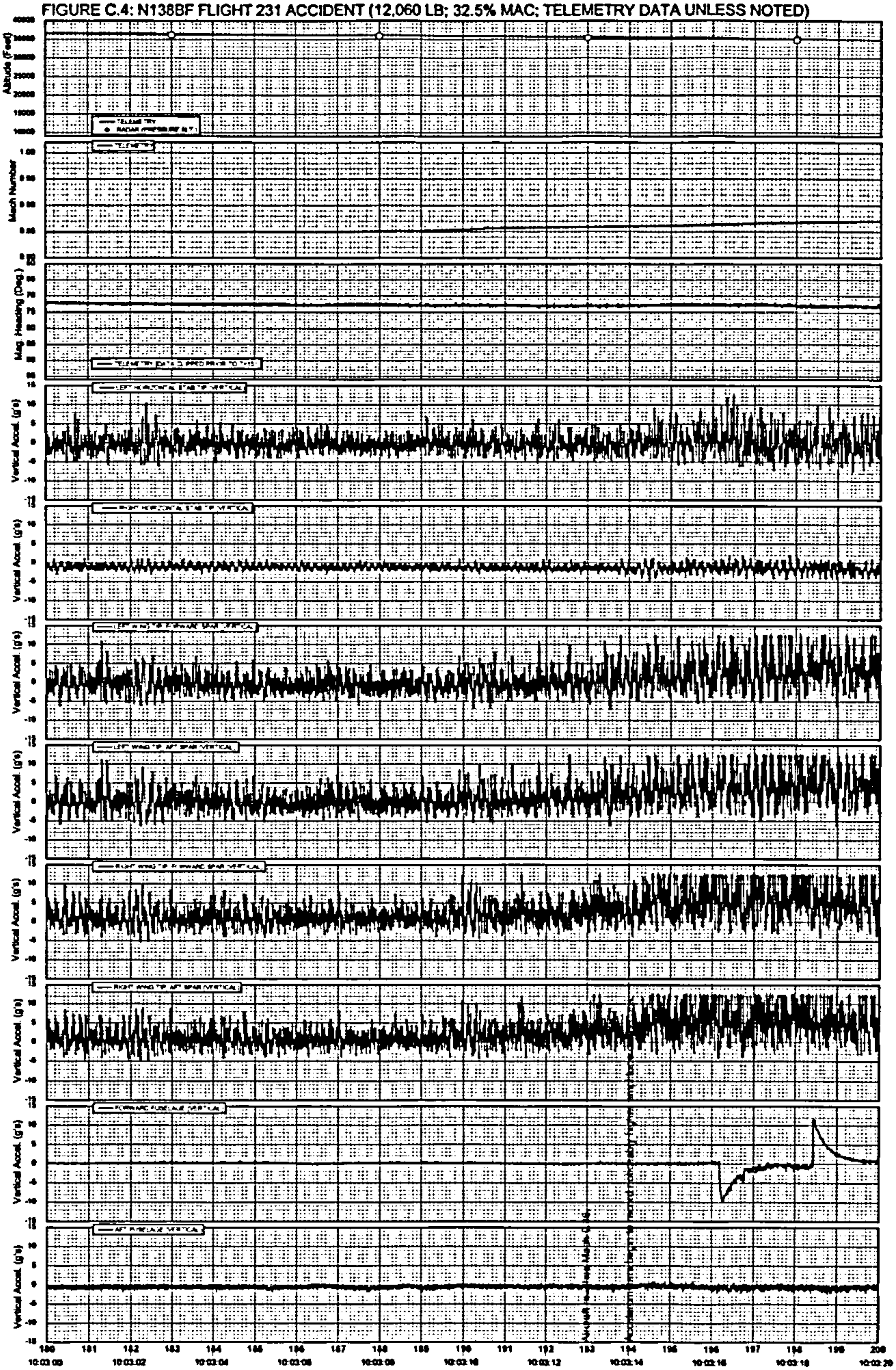


FIGURE C.5: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

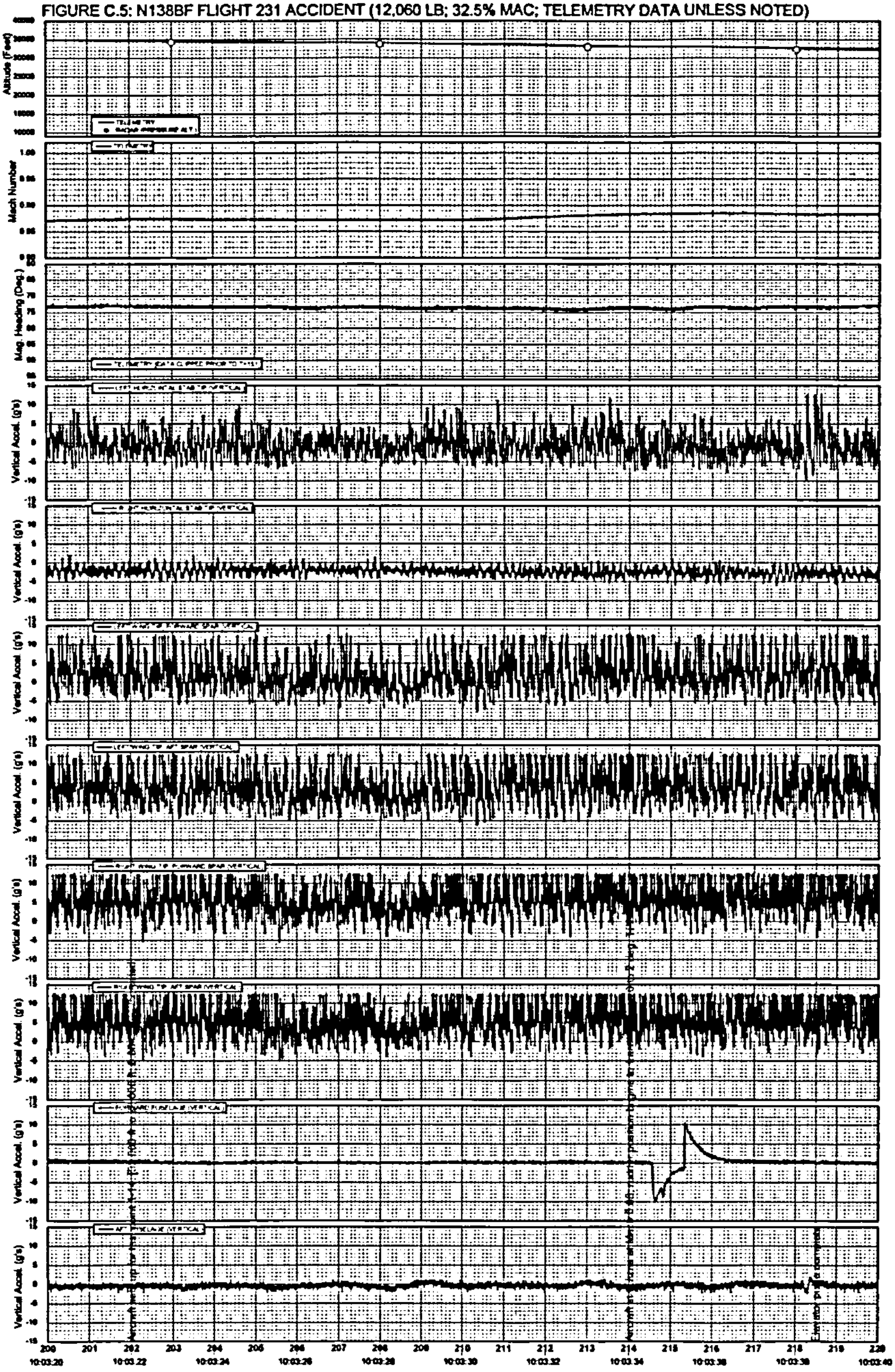


FIGURE C.6: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

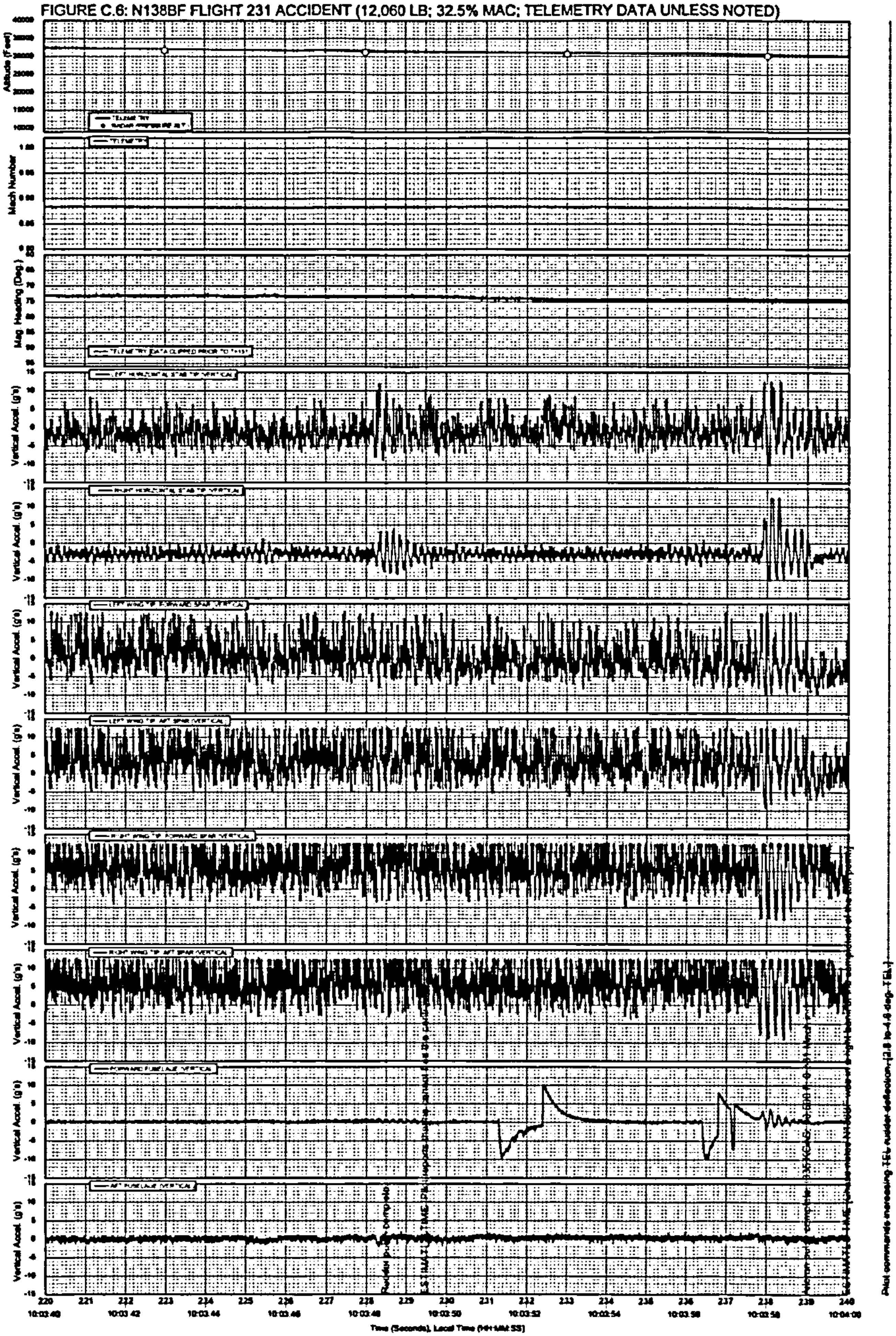


FIGURE C.7: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

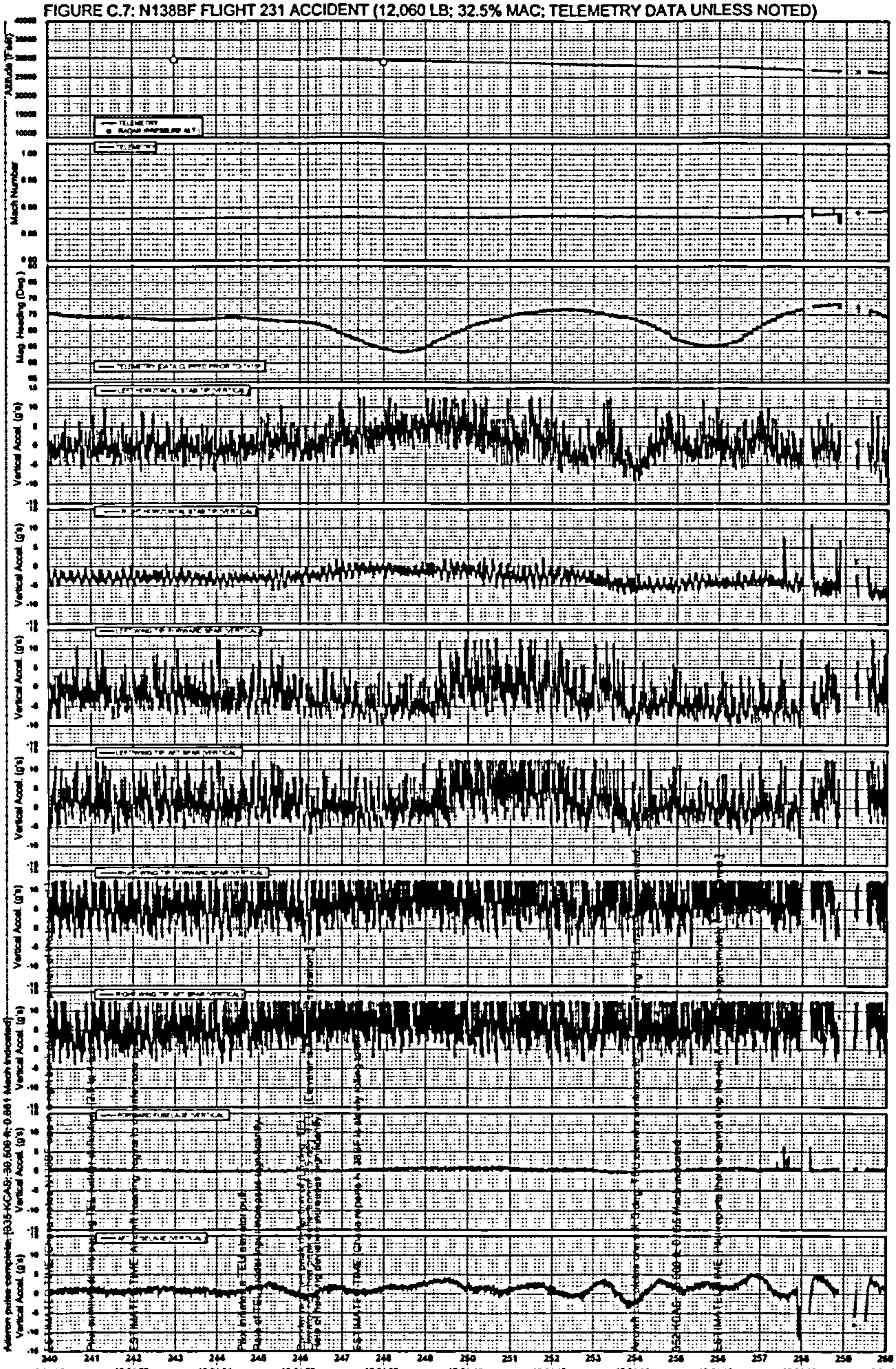


FIGURE C.8: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)

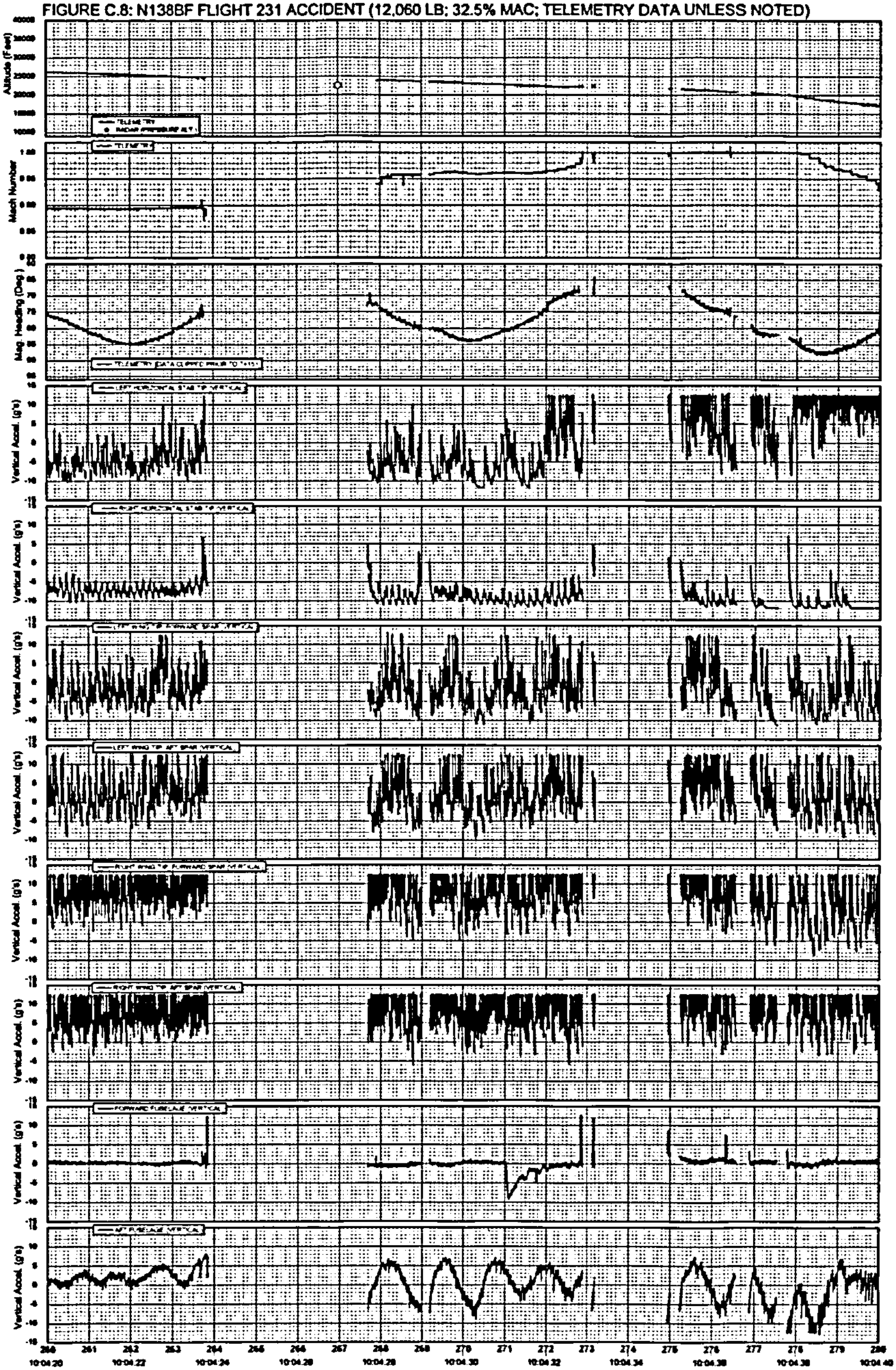


FIGURE C.9: N138BF FLIGHT 231 ACCIDENT (12,060 LB; 32.5% MAC; TELEMETRY DATA UNLESS NOTED)