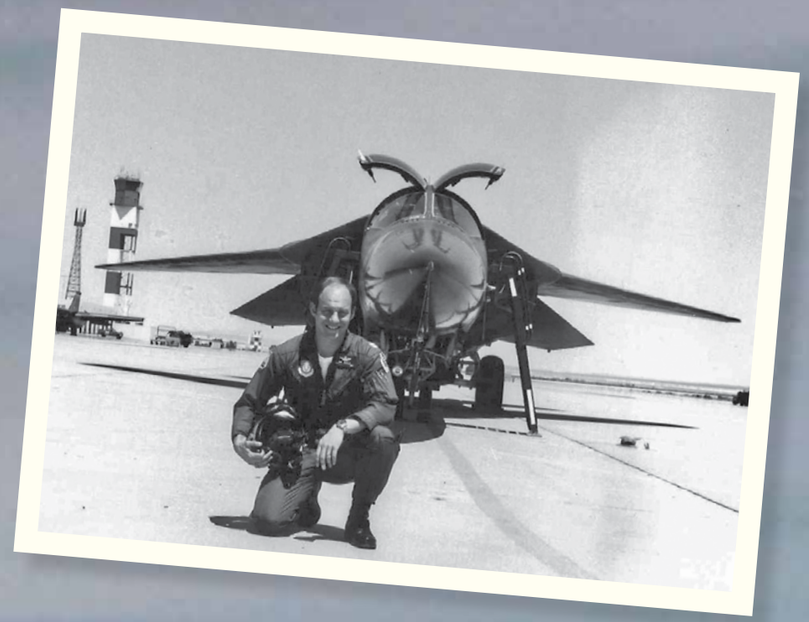
Forgiveness

Lt. Gen. Richard Reynolds on crashing a $379 million B-1 prototype

BY JAN TEGLER

By the time Lieutenant General Richard Reynolds retired from the USAF in 2005, he'd had a distinguished 34-year career as a B-52 pilot, an Air Force test pilot with experience flying 72 different aircraft types, a B-2 system program office director, a commander of Air Force Flight Test Center at Edwards AFB, and more.



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If you walk into his home office you'll find a letter opener made from a piece of molten aluminum. Etched on its handle is the word "Forgiveness." The long-ago-cooled metal is a fragment of what was once the second B-1 bomber prototype. Known as "Ship-2," it was one of the four original A-model B-1s from Rockwell International that preceded the 100 B-1B Lancers built between 1983 and 1988, just 45 of which remain in service.

The letter opener is a tangible reminder of the August, 29, 1984 accident that instantly made national news on TV and in newspapers. It's also emblematic of compassion Reynolds didn't expect in the wake of the tragic incident.

"I thought it was game over"

"I thought we had ejected too low," Reynolds remembers. "I was at peace with it. The ground was coming up fast!"

It was a beautiful Wednesday morning. Then Maj. Dick Reynolds was pilot-in-command in Ship-2's left seat with Rockwell International's senior engineering test pilot Doug Benefield in the copilot's seat and flight engineer Captain Otto Waniczek seated at one of the two aircrew stations amid flight test instruments behind them.

Just to the north of Edwards AFB along an east-west corridor that follows the contour of Cords Road, the aircrew was setting up to execute the fifth test point sequence of the day's test flight, performing air minimum control speed, or Vmca, tests.

The B-1's ability to sweep its wings from 67.5 degrees aft to 15 degrees forward can significantly alter its center of gravity depending on sweep. Consequently, the bomber has a wide range of CG points at which it is in balanced flight—and even more where it is out of balance—depending on aerodynamic configuration, weight, airspeed, and other factors.

To retain the proper center of gravity as its wings sweep, the B-1 automatically transfers fuel between its forward and aft fuselage tanks. This automatic mode, known as "optimum cruise mode," calculates where the center of gravity should be as a percentage of the airplane's mean aerodynamic chord, or MAC, the midpoint on a swept tapered wing where the CG is in balance. With wing position changing as the B-1 flies, optimum cruise mode continually calculates the midpoint CG for the bomber's center of gravity and automatically transfers fuel to keep the airplane in balance.

The Vmca tests were aimed at collecting data on how the B-1 flew at low speed and at the extreme limits of its forward and aft center of gravity in various configurations. The aircrew had just completed the first Vmca test point, flying at 6,000 feet and 250 knots with the wings swept to 55 degrees in a clean configuration—flaps up, gear up, slats retracted—and began to set the airplane up for the second Vmca test point.

"We transitioned to the next test point, wings at 15 degrees full forward with flaps, slats and gear down," Reynolds explains. "That required a huge transition of the center of gravity."

The test point was meant to simulate "a go-around from a pattern approach where maybe you sucked birds into the engines on the right side."

The point called for Reynolds and Benefield to fly the B-1A at the extreme aft limit of its CG envelope with the wings swept all the way forward in a "dirty" configuration, well below 10,000 feet.

The pilots slowed the "Bone," stabilizing "on condition" for the test point at 137 knots just 4,400 feet above the desert, when the unexpected happened.

10:23 am, 70 degrees, nose up

The $379 million "one-of-a-kind test asset" had flown "just fine" on the previous test point, Reynolds says, and continued flying normally with its high-authority stability control augmentation system "very slowly trimming the full trailing edge down, trying to keep our nose down" as the aircrew transitioned to the next test configuration.

ALL HELL BROKE LOOSE ... THE COCKPIT FILLED WITH SMOKE AND EVERY ALARM CAME ON. THE AIRPLANE SHUDDERED AND ROLLED. IT WAS A SICKENING FEELING.

A little after 10:20 am, "the nose pitched up a little," Reynolds recalls. "Doug and I had done a lot of angle of attack testing together in my short time flying with him in the B-1. But we both recognized that that was an indication of stall."

Reynolds was flying but immediately both pilots made control inputs, pushing their sticks forward and sliding the bomber's four throttles to full power.

"Two or three seconds later, all hell broke loose," Reynolds says. "The nose pitched up to 70 degrees. It was pointed at the North Star as opposed to some reasonable deck angle. The cockpit filled with smoke and every alarm came on. The airplane shuddered and rolled. It was a sickening feeling. I can remember it like it was yesterday."

Warning lights filled the instrument panel, including the airplane's master caution lights and the "CG Limit Light"—which had already

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LEFT: Need caption (FCGMS panel). RIGHT: Need caption (Doug Benefield)
BELOW: Need caption (instrument configuration)

"THE GOLDEN RULE IS IF YOU'RE BELOW 10,000 FEET AND YOU'RE NOT IN CONTROL OF THE AIRPLANE, YOU EJECT. WE DIDN'T COMPLY WITH THAT."

been flashing—but, as Reynolds explains, the aircrew had what was later termed "warning fatigue."

To perform the Vmca testing, the pilots turned off the automatic system that continually adjusted the bomber's CG, instead using a knob to manually set the airplane's percentage of MAC. That allowed them to set the CG at forward, mid-point, or aft limits to evaluate how the aircraft flew at those limits.

The warning lights routinely flashed when the pilots manually selected a setting, going out after enough fuel had been transferred to achieve the desired center of gravity. During testing, the lights "would activate all the time, dozens of times per flight," Reynolds affirms. "We got so anesthetized to those warnings that we stopped paying attention to them. We set a trap for ourselves."

For the first Vmca test point, the pilots manually set the MAC control knob at 45 percent, balanced in the middle of airplane's 25-percent forward CG limit and its 60-percent aft limit at 250 knots clean with 55 degrees of wing sweep.

The second test point's combination of 15 degrees full forward sweep with gear, flaps, and slats down drastically diminished the CG window in which the aircraft could maintain flight without control difficulty. The center of gravity limits dropped to between 10- and 21-percent MAC.

But no one remembered to manually reset the MAC to the new target CG, 21 percent.

"We had a minus 24-percent negative static margin outside the aft limit for gear, flaps, and slats down with wings at 15 degrees sweep. The airplane was grossly unstable in the longitudinal axis."

"We may have to punch it ..."

Those were among the last words Doug Benefield was ever to utter. Fifty-five-year-old Benefield was "the high time B-1 pilot on the planet," Reynolds says. He adds that Benefield was "a test pilot from the Golden Age of flight testing."

Reynolds, 34, was the newest B-1 pilot, one of just six men who had flown the headline-making bomber to that point. Serving his second stint as a project test pilot on the B-1 combined test force in 1983, he'd accumulated only 13 hours on a "handful of flights" by the time of the accident.

Benefield had flown combat missions in Korea and Vietnam, flight-tested large aircraft from the C-133 and KC-135 to the Concorde, and attained the top speed for a B-1 at Mach 2.2 on October 5, 1978.

"We had a good relationship professionally and personally," Reynolds reflects. "I had qualified Doug in the F-111 in his re-currency check because I was a flight examiner in the F-111. He had checked me out in the B-1."

Reynolds says Ship-2's sudden pitch up wasn't accompanied by a heavy G-load, not that he noticed at least. "Any sensation of G was overcome by the visual, by the horizon suddenly disappearing and seeing blue sky plus the warning lights, aural signals. It was more the ugly feeling of being on your back in a large airplane. That's not a natural position to be in at all.

"The airplane wallowed left and right and then sliced off to the right [180 degrees], swapping ends. It was basically starting a flat spin. Even then, I had no idea we were as low as we were.

"We were both on the controls. They were completely unresponsive."

An F-111 piloted by Rockwell International test pilot Mervyn Evenson, who would go on to make the first flight in the B-1B just 50 days after Ship-2 crashed, and Capt. Steve Fraley were in the chase aircraft for the August 29 flight. As the B-1's nose pitched up, Evenson radioed Benefield.

"Hey Doug, have you got it?"

Benefield replied, "'No, we are trying to come out of it now, maybe.'"

"I got off the controls," Reynolds remembers. "Doug continued to fight it. I sensed ground rush. I didn't look at the altimeter. I've got over 30 parachute jumps so I knew what ground rush looks like. I sensed it, saw it out the window and basically told Doug to give it up."

As Ship-2 swapped ends and started to descend rapidly, Evenson radioed Benefield again.

"How you doing, Doug?" Benefield responded, "I don't know yet. We may have to punch it. We have to punch."

Reynolds had already realized that time had almost run out for the crew to eject. "I took my right arm and smacked him in the chest to get him in the position for ejection, then reached down with my left hand and pulled the ejection handle," he says.

The pilots had tried to regain control for an amazing 29 seconds from the instant the prototype pitched, but "there was no way that airplane was going to fly," Reynolds notes, adding that he's often asked himself why they continued to try save Ship-2.

"We shouldn't have bothered. I think in part it was the realization that this was a $379 million, one-of-a-kind test asset, and punching out was unthinkable at least for a heartbeat or two. The golden rule is if you're below 10,000 feet and you're not in control of the airplane, you eject. We didn't comply with that."

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40 G's on impact

Reynolds pulled the ejection handle to his left just in time. "We punched out at 1,505 feet. If it had been 1,500 feet, you wouldn't be talking to me. It was that close. We were falling like a rock."

But the aircrew didn't ride ejection seats that individually fired through escape hatches above each member's seat. The first three prototype B-1s were equipped with ejection capsules. The cockpit structure ejected from the rest of the bomber as a single assembly with the crew strapped to their seats within it.

Only three other U.S. military aircraft—the F-111, XB-70 Valkyrie, and B-58 Hustler—have employed similar capsule ejection systems. Operating properly, the capsule would separate from the aircraft via a rocket motor and a series of explosive charges. A drogue chute would deploy to stabilize its forward flight, followed by deployment of three 70-foot main parachutes that would arrest its forward flight and descent. Explosive charges on the harness linked to the main chutes would then fire to orient the capsule in a horizontal position, allowing it to land upright on a series of impact-cushioning airbags.

Ship-2's capsule separated successfully, and its drogue chute deployed as advertised. But an explosive charge on one side of the main parachutes' harness didn't fire, suspending the capsule by one corner in a nose-down position. Reynolds says the main chutes provided little apparent deceleration.

Nine seconds after separation, the ejection capsule hit the ground with a thud that amounted to a 40-G impact. "The capsule bounced back 12 feet," Reynolds explains, adding that it landed in close proximity to the wreckage of the prototype and the fireball from the 90,000 pounds of fuel left in its tanks. The fireball melted the main parachutes as the capsule impacted the ground.

"A pretty hard time"

"It was kind of chaotic," Reynolds recalls. "Doug had a basilar skull fracture. His seat broke off its mounts, slid forward, and his head hit one of the cockpit structural members. I was determined to do what I could for him. But I was paralyzed from the waist down."

Reynolds reached for Benefield to try to help, but "realized there wasn't anything I could do for him. He died shortly after that.

"I could hear the chase F-111 orbiting. I explosively blew out the window to my left. Unfortunately several of the capsule parachute risers were hanging down over it and a lot of the glass came back in on us. I pulled a handkerchief out of my pocket and stuck my hand out the window to try and signal the chase plane, but there was no way they could see it.

"We were there for about 30 or 35 minutes. Otto and I were talking back and forth about our conditions. We were both badly injured. It was a pretty hard time."

An Edwards-based UH-1N Huey arrived at the crash site. The crew members and local first responders extricated the B-1 aircrew. Reynolds and Waniczek were flown to the base hospital. Waniczek suffered two collapsed lungs, a bruised heart, broken ribs, and several lacerations. Four weeks later, he was back on flying status and went aloft in a T-38.

Reynolds had a longer road to recovery. His back was broken in multiple locations with damage to several vertebrae. The night of accident he was transferred to Antelope Valley Hospital in Lancaster, California, where surgery was performed to try to decompress his spine and allow his nerves to function again. It took most of a year, but by the summer of 1985, Reynolds was walking again. In the interim, he endured uncertainty and experienced compassion.

It took investigators only a couple of days to understand what had caused Ship-2 to depart and crash. The crew was to blame, having forgotten to adjust the bomber's CG. "I thought my career was over," Reynolds says.

The B-1 program, canceled in 1977 by President Jimmy Carter and resurrected in 1982 by President Ronald Reagan, had been high profile and plagued by politics since its inception. Reynolds says he learned that there were conversations at the Pentagon about court-martialing the survivors of the tragedy. "That got my attention!"

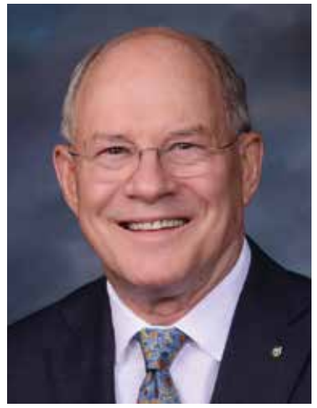
But there were also positives. "A week after mishap I got a handwritten note from Ronald Reagan and a note from a friend named Doug Pearson, a retired two-star contemporary of mine."

Maj. Gen. Doug Pearson, a fellow test pilot and, like Reynolds, a later commander of the Air Force Flight Test Center, sent the B-1 test pilot a letter that helped him "recalibrate his thinking." Reynolds adds, "I owe him a debt of gratitude."

Later in Reynolds' recovery but before he could walk, Col. Kenneth Staten, then commander of the 412th Test Wing at Edwards, visited. "He said, 'We know what happened, we kind of know why it happened. I just want you to know that if you get healthy enough to get back on flying status, we're going to put you back in the cockpit of the B-1.'"

Says Reynolds, "It was one of the most colossal acts of forgiveness." ✈

Aftermath & Lessons Learned



Just about 11 months after Ship-2 crashed, then Maj. Dick Reynolds returned to the air.

The aircraft was a DeHavilland Beaver, and the invitation to fly it came from Col. Jimmy Doolittle III, the grandson of the famous Army Air Corps/USAF pilot who led the renowned one-way raid on Japan with 16 B-25Bs in April 1942. "He was my test pilot school class leader," Reynolds explains. "He became my boss later in my career and a dear friend. He was on the test pilot school staff at the time. We went for a flight in a DeHavilland Beaver. We flew around low and slow."

"It made me feel good that I had done it. It was kind of a milestone. I like flying anything. I'm the kind of guy that will enjoy a sailplane or a fast jet at 500 knots. I get an equal thrill out of both."

Thereafter, he re-qualified in the KC-135 and flew several more aircraft, including a single flight in the B-2, taking advantage of his position as the B-2 system program office director between 1994 and 1996.

Reynolds self-deprecatingly describes the B-1 accident as "kind of a tragic story about a really dumb accident."

Lessons learned begin with the Ship-2's crew composition on August 29, 1984. "As much as anything it was the mismatch in our experience, Doug's and mine, and to a certain degree our relationship—which was good both professionally and personally—that bore on the outcome of the mishap," he says.

Reynolds was the aircraft commander for the test flight and accepts full responsibility for the accident, even though it resulted from a combination of errors made by the flight crew and flight engineers in the program's mission control room. Technically, Benefield was responsible for adjusting the aircraft's CG with the MAC percentage control knob.

"We should have set the CG, twisted that little knob, moved the bug, and let the fuel transfer. Then, slowly swept the wings forward and put the gear, flaps, and slats down.

"But we skipped the fuel step. The fuel system was Doug's responsibility, but it was my responsibility to be sure Doug did that."

Poor communication between the flight crew members and between the aircrew and the ground flight-test engineers was also cited as a factor in the accident as well as the planning and sequence of the flight test points. Finally, "warning fatigue" was cited as a contributor, causing the aircrew to disregard clues about the aircraft's center of gravity.

Reynolds views the accident as "a lesson in risk, how you think about risk, how you manage it and mitigate it and some of the traps we put ourselves in."

He says some of the lessons of the tragedy were applied to the B-2 and other subsequent USAF flight-test programs, but adds that there are still lessons that "haven't been learned very well."