

The Gulfstream IV operator had all the appearance of a good operation but the flightcrew lacked cockpit discipline

NTSB finds widespread non-compliance with checklist use and control checks, leading to this tragic BED runway overrun crash.



Source: Massachusetts State Police

Flightcrew failure to review the checklist and release the gust lock prior to the takeoff run of Gulfstream IV N121JM on BED's 7000-ft Rwy 11 as well as failure to be time-sensitive and abort the takeoff before running out of runway length led to destruction of the aircraft and the deaths of all occupants aboard.



By Robert Sumwalt
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Gulfstream IV N121JM was frequently used for air transportation both domestically and overseas by Lewis Katz, the well-known and highly respected publisher of *The Philadelphia Inquirer* newspaper.

As often is the case in corporate aviation, the passengers were running a few hours late. The 2 pilots and flight attendant decided to pass the time by ordering a pizza and eating in the comfort of the cabin of N121JM, the Gulfstream IV they had operated for 7 years. When the billionaire principal showed up with 3 other passengers, they boarded the GIV for the 45-minute flight to ACY (Atlantic City Intl, NJ).

The day had started with the expectation of it being an easy day. The weather was good and there would be 4 short legs with an early afternoon departure and an evening return. The crew departed ILG (New Castle, Wilmington DE)

at 1325 edt for the short hop to ACY, where they picked up the 4 passengers and flew them to BED (Hanscom Field, Bedford MA). After the passengers attended a charity event, the plan was to return them to ACY and then reposition the Gulfstream back to its home base at ILG.

Tragically, the evening didn't end that way. Steeped in a lethal brew of carelessness and complacency, and fueled by poor cockpit discipline, the flightcrew members attempted to take off without disengaging the flight control gust lock. During the takeoff roll, once realizing the gust lock was still engaged, instead of promptly rejecting the takeoff the pilots wasted valuable time attempting to

Event	Time (EDT)	Groundspeed (kts)	Distance from runway threshold (ft)	Distance to runway end (ft)	Distance to runway safety area end (ft)
Airplane turns onto runway 11	2139:20	4	96	6915	7935
Brakes released and power increased	2139:34	9	200	6811	7831
Autothrottle engaged	2139:43	44	569	6442	7462
“Couldn’t get” comment on CVR	2139:46.6	65	898	6113	7133
80-kt call on CVR	2139:51.3	90	1516	5495	6515
V ₁ call on CVR	2139:57.5	119	2612	4399	5419
Rotate call on CVR	2139:58.9	125	2899	4112	5132
First reference to “lock” on CVR	2139:59.9	129	3113	3898	4918
FPSOV activated	2140:05.7	150	4479	2532	3552
Brake pressures start to rise	2140:10.0	162	5638	1373	2393
Peak groundspeed	2140:10.3	162	5694	1317	2337
Last reference to “lock” on CVR	2140:12.6	157	6315	696	1716
Power reduced	2140:14.0	156	6685	326	1346
Reference to stopping ability on CVR	2140:14.3	155	6763	248	1268
Airplane exits runway onto paved overrun area	2140:15.3	151	7011	0	1020
Thrust reversers deployed	2140:15.5	149	7072	-61	959
Airplane exits paved overrun area onto grass	2140:20.0	105	8031	-1020	0
Sound of impact on CVR	2140:21.0	97	8206	-1195	-175
End of FDR data	2140:23.9	90	8662	-1651	-631
Surveyed main wreckage location	n/a	0	8880	-1869	-849

Time, Speed & Distance from Rwy Threshold chart showing takeoff time and crash time of GIV N1121JM at BED’s Rwy 11 during aircraft’s takeoff roll.

troubleshoot the problem. The delay in rejecting, along with a poorly executed reject, led to a high speed overrun. The attempted flight ended—along with the lives all 7 onboard—as the aircraft careened off the runway end and became impaled across the banks of the Shawsheen River. The aircraft came to a dead stop, decelerating from around 90 kts to a complete standstill almost instantaneously. The aircraft was immediately consumed in a fireball.

The accident sequence

The 2 Rolls-Royce Tay engines were started shortly after the passengers boarded at 2128 edt. In the left seat was the PIC, a 12 year full-time pilot of SK Travel, the private holding company that managed the GIV for its 2 owners. The SIC was a 61 year-old SK Travel chief pilot and director of maintenance who had been employed by the owners for 27 years.

During the 11 minutes that elapsed between engine start and reaching the runway, the cockpit voice recorder (CVR) registered minimal verbal communications between the pilots and there was no discussion or mention of checklists or flight control checks. As N121JM was maneuvered on to BED’s Rwy 11, the PIC commented that the rudder limit annunciation had appeared on the engine instrument and crew advisory system (EICAS) display. Although the pilots may have realized this annunciation meant the rudder had reached its stop and could

not move further, they most likely did not realize it was an indication the rudder travel was severely limited because the gust lock was engaged.

When pushing the throttles forward for takeoff, the PIC commented on difficulty setting takeoff thrust. The NTSB determined the resistance was due to the throttles encountering the gust lock/throttle lever interlock that was designed to prevent takeoff power from being applied when the gust lock was on. At this point, the engines’ exhaust pressure ratio (EPR) was 1.42, whereas takeoff target EPR was 1.7. Additionally, the throttles lever angle (TLA) position would have been approximately half of where it should have been for a normal takeoff.

Despite difficulty setting target EPR and despite encountering this abnormal throttle lever position, the PIC did not simply pull the throttles back and discontinue the takeoff. Speed at this point was less than 50 kts so the airplane could have easily been stopped. Instead, the PIC engaged the autothrottles and possibly manually nudged the throttles, which allowed the engines to accelerate to 1.6 EPR. Although this EPR setting was less than the target setting of 1.7 EPR, the PIC continued the takeoff run. NTSB determined that engaging the autothrottle and possibly manually pushing the throttles acted to shear a pin in the gust lock handle mechanism. This defeated the gust lock/throttle lever interlock and allowed a higher power setting even though the gust lock was still engaged.

When the GIV gust lock is engaged, the elevator is

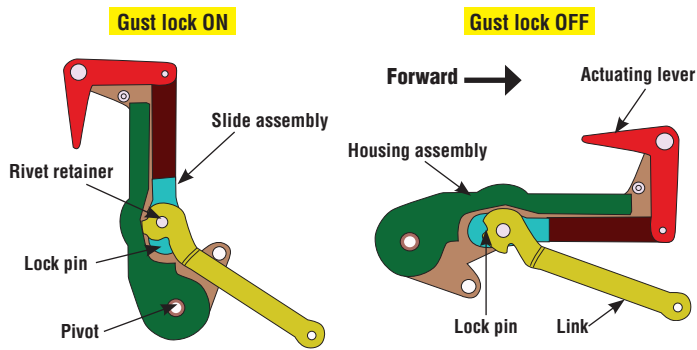
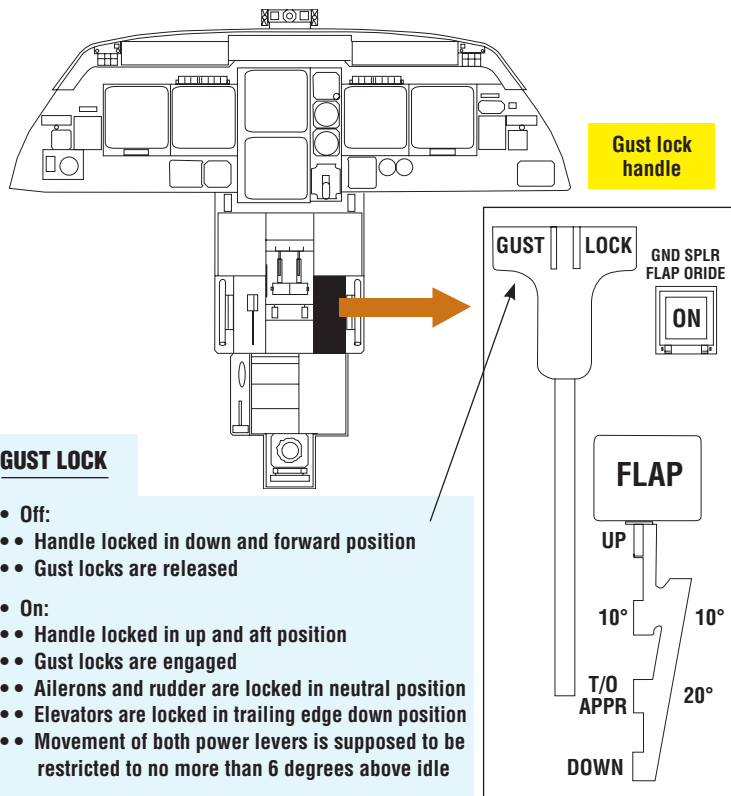


Diagram of a gust lock handle in the ON and OFF positions



GUST LOCK

- Off:
 - Handle locked in down and forward position
 - Gust locks are released
- On:
 - Handle locked in up and aft position
 - Gust locks are engaged
 - Ailerons and rudder are locked in neutral position
 - Elevators are locked in trailing edge down position
 - Movement of both power levers is supposed to be restricted to no more than 6 degrees above idle

Cockpit location diagram of the gust lock itself for the GIV. Gulfstream has redesigned and improved gust lock design for their newer models.

locked in the full nose-down position. As the aircraft accelerated through 60 kts, the pilots missed a required check to confirm that the elevators are free and the control yoke has moved from the full forward position to neutral as aerodynamic forces act on the elevator. Realizing the yoke remained at the full-forward position could have been another indication that something was awry.

The SIC called “rotate” at 125 kts. One second later the PIC stated, “steer lock is on,” a statement he repeated 6 more times over the next 12.7 seconds. There is nothing on the GIV known as a steer lock, so it is highly likely the PIC was referring to the gust lock. When he made the 1st “steer lock on” comment, the aircraft’s groundspeed was 129 kts and there was 3900 ft of runway ahead of him. With the addition of the 1000 ft runway overrun, there was 4900 ft of pavement ahead of him.

Now 6 seconds after the 1st “steer lock is on” comment, the aircraft was accelerating through 150 kts, and hydraulic power to the flight controls was shut off with the flight

power shutoff (FPSOV) handle. Gulfstream IV pilots know once the engines are started, hydraulic pressure from the engine-driven hydraulic pumps applies pressure to the flight controls. Because of hydraulic loads on the gust lock hooks, the gust lock cannot be released once engines are started. If engines are started with the gust lock engaged, the only approved method of releasing the gust lock is to shut down engines, allow hydraulic pressure to fully bleed down, then release gust lock and restart the engines.

However, around the Gulfstream community, many pilots knew of an unauthorized technique: If engines were mistakenly started with the gust lock on, hydraulic pressure could be relieved by pulling the FPSOV. This would supposedly kill hydraulic pressure to the gust lock hooks without having to shut down engines. Although unauthorized in the first place, the technique was only intended as a way to work around having to shut down engines at the ramp, and never intended as something used while running down a runway at high speed.

It’s been now 11 seconds after the “rotate” callout, and with a groundspeed of 162 kts, one of the pilots began a moderate application of brakes. Just under 1400 ft of runway remained at this point, but with the addition of a 1000 ft runway overrun, there was about 2400 ft of pavement ahead of them. Throttles were retarded 4 seconds after the brake application. The PIC said, “I can’t stop it,” which was the only verbal communication between the 2 pilots after the pilot first verbalized “steer lock is on.”

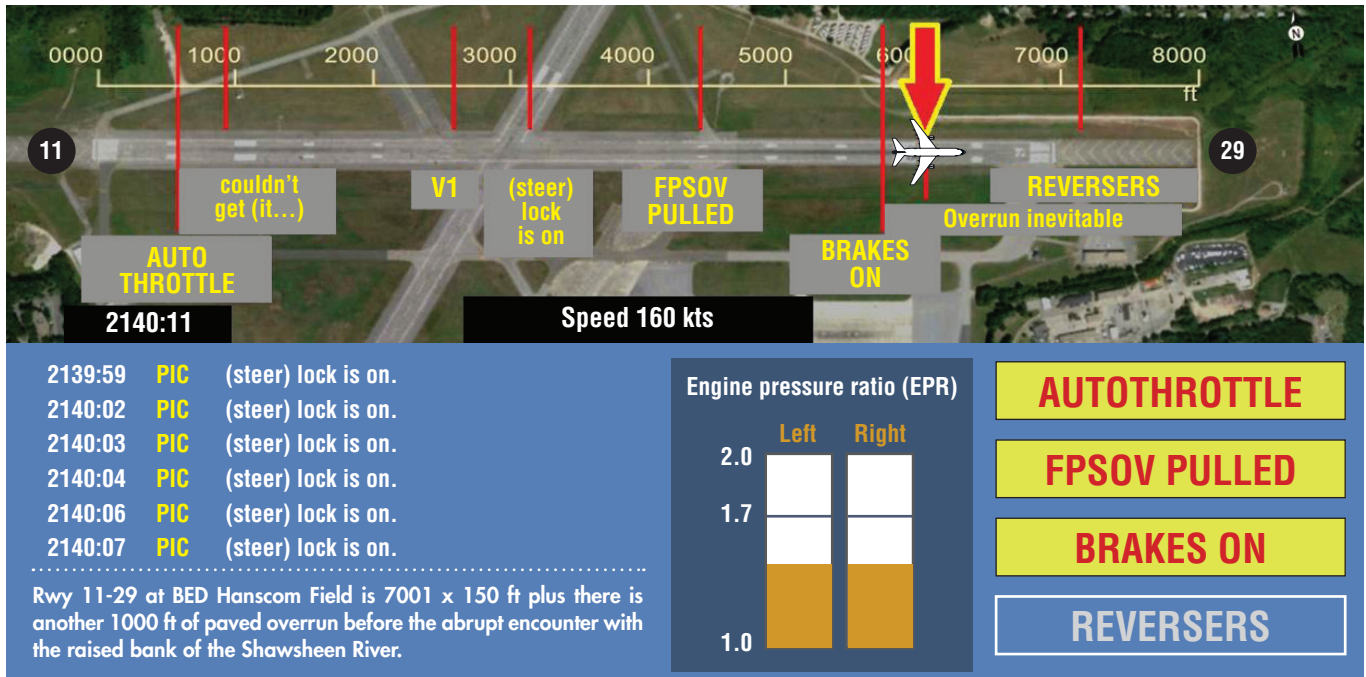
Then 5.5 seconds after brake pressure began to rise, thrust reversers were deployed. This was as N121JM departed the runway at 151 kts and traveled onto the paved overrun surface. By the time the aircraft departed the paved overrun, groundspeed had decreased to 105 kts. As the aircraft traveled across grass and a service road, it sheared off 3 nonfrangible approach light stanchions and part of the localizer antenna. The flight data recorder (FDR) ended as the aircraft was still in motion at 90 kts, likely indicating the aircraft came to a dead stop at it impacted the banks of the Shawsheen River.

Witnesses reported that the aircraft became engulfed in flames “almost instantaneously.” The investigation determined that the impact forces were likely survivable but the occupants succumbed to smoke inhalation and thermal injuries. The PIC was found kneeling on his seat with his head leaning against the left cockpit wall. His oxygen mask compartment was found in the open position with the oxygen mask laying on the floor near him. One passenger was found in the aisle next to and facing the forward entry door.

Like so many, it was a crash that should never have happened. There are several protective layers of defense intended to prevent such a catastrophe – layers such as cockpit checklists and flight control checks, as well as an aircraft system that was designed to prevent throttles from being set to high power settings with the gust lock on. However, as the investigation revealed, those protective layers were riddled with holes.

Cockpit layers of defense

Releasing the gust lock is the 4th item on the GIV Starting Engines checklist contained in the airplane flight manual (AFM), as well as the FlightSafety checklist used by the pilots in training. Not only did the CVR reveal this checklist was not verbalized, but neither of the 4 remaining check-



lists were verbalized either. Although it's possible that the checklists could have been accomplished silently, which would have been contrary to their training which called for "challenge-response" checklist execution, the NTSB noted there was no discussion of checklists before, during, or after engine start or throughout taxi, and there were no cockpit statements recorded to denote the checklists were completed. Furthermore, a contract pilot who had flown with one of the pilots a few years before the crash told investigators that the pilot did not use checklists, but rather, had memorized a way of doing things. The NTSB concluded "the crewmembers' lack of adherence to industry best practices involving the execution of normal checklists eliminated the opportunity for them to recognize that the gust lock handle was in the ON position and delayed their detection of this error." Obviously, there was a big hole in the checklist layer of defense.

Another cockpit layer of defense that could have detected locked flight controls was, of course, the flight control check. The FDR revealed no such check was performed for this ill-fated flight. NTSB made an even more troubling discovery when examining a quick access recorder. Of the 175 previous flights, a complete flight control check was skipped on all but 2 flights. "Given that the flightcrew neglected to perform complete flight control checks before 98% of the crewmembers' previous 175 takeoffs in the airplane, the flightcrew's omission of a flight control check before the accident takeoff indicates intentional, habitual noncompliance with standard operating procedures," stated the NTSB. Another big hole in the layers of defense.

Aircraft layers of defense

The final protective layer of defense that could have prevented a takeoff with the gust lock engaged was a throttle interlock that would prevent significant throttle lever advancement with the gust lock on. However, this layer was ineffective due to a defective design.

FAA certification regulations for transport category aircraft specify that if the gust lock is engaged, the system

must "limit the operation of the airplane so that the pilot receives unmistakable warning at the start of takeoff." To comply with that regulation, Gulfstream designed, and FAA approved, a throttle interlock that was supposed to prevent the throttles from moving more than 6 degrees throttle lever angle (TLA) from the idle stop if the gust lock was engaged. To put this movement into perspective, total TLA range of movement from idle to full throttle on the GIV is 59 degrees.

Post-accident testing on the accident airplane's throttle quadrant found the throttles could be moved to 22 degrees TLA with the gust lock engaged. Furthermore, NTSB tested several in-service GIV's with the gust lock on. Like the accident airplane, the TLA of those in-service Gulfstreams could be moved 3 to 4 times greater than the designed 6-degree limit. As a result, NTSB determined the GIV gust lock system does not comply with certification standards. Gulfstream is working to create a fix, which is anticipated to be available in the coming months.

Deadly delay

Of course, it's easy to look back after the fact and say "if they had only done this." True, but it is important to dissect the sequence of events in order to discover ways future crashes can be prevented.

Once on the runway, the pilots had an opportunity to realize something was not right when the PIC had difficulty setting takeoff thrust. "Despite encountering this abnormal throttle lever position, the PIC did not immediately call out the problem or call for a rejected takeoff," stated NTSB. Instead, he engaged the autothrottles and possibly provided some manual force on the throttles to achieve a somewhat higher thrust setting and continued the takeoff run. "It is unclear why the PIC engaged the autothrottle, as it would seem extremely imprudent to continue a takeoff after encountering a substantial restriction to throttle lever movement while setting takeoff power," stated NTSB. However, what is clear is the aircraft's speed was less than 50 kts and the takeoff could have easily

been discontinued at this point.

Pilots are taught not to reject takeoff after V1, and for good reason. After all, accident files are full of cases where an aborted takeoff after V1 didn't work out well. However, one exception to this rule is if the airplane's ability to fly is in doubt. In the case of N121JM, the PIC was undoubtedly aware that the gust lock was still on when he tried to rotate, as evidenced by his calling out "steer lock is on" 7 times. Having the gust lock on obviously would prevent the aircraft from flying, so a rejected takeoff would be the only viable option at this point. However, instead of promptly rejecting the takeoff, he elected to troubleshoot the situation while the aircraft was accelerating approximately 3.5 kts per second.

NTSB determined that if the takeoff had been rejected immediately upon the PIC's 1st "steer lock is on" statement or anytime in the next 11 seconds, and had the proper RTO procedure been used, the aircraft could have been stopped on the paved surface. However, as noted by NTSB, "the flightcrew delayed initiating a rejected takeoff for about 10 seconds, and a further delay of 4 seconds existed between brake application and power reduction. Therefore, the rejected takeoff was not initiated until the accident was unavoidable."

Probable cause

On September 9 NTSB met to deliberate the crash of N121JM. The board adopted the following: "The NTSB determines that the probable cause of this accident was the flightcrew members' failure to perform the flight control check before takeoff, their attempt to take off with the gust lock system engaged, and their delayed execution of a rejected takeoff after they became aware that the controls were locked. Contributing to the accident were the flightcrew's habitual noncompliance with checklists, Gulfstream Aerospace Corporation's failure to ensure that the GIV gust lock/throttle lever interlock system would prevent an attempted takeoff with the gust lock engaged, and the FAA's failure to detect this inadequacy during the Gulfstream IV's certification."

NTSB issued 3 safety recommendations to FAA, 1 to International Business Aviation Council, and 1 to NBAA. The 71 page report is available at www.ntsb.gov. As one of the 3 board members who participated in adopting the report, I filed a concurring statement, which is contained in entirety in the sidebar.

On a personal note, in the 9 years I've been member of the NTSB, I've been involved in deliberating upward of 150 or so transportation accidents. This one was particularly disturbing because it was so preventable. We've certainly seen operators who were trying to skirt regulations, but this operator, I'm afraid, thought they were better than they really were. Their comfort led to complacency. Complacency kills. And it certainly did in this case. ✈️



Robert Sumwalt was appointed to NTSB in 2006 by President George W. Bush and reappointed in 2011 by President Barack Obama. He served as NTSB vice-chairman for two years. Prior to NTSB he flew for a major airline for 24 years and managed a Fortune 500 flight department. He was a regular contributor to Pro Pilot for 21 years.



Always use the checklist

Complacency and overconfidence can lead to disaster.

To all outward appearances, SK Travel had the hallmarks of a well-run flight department. They were operating a top-of-the-line business jet. They had long-time employment stability – something not often found with small aviation departments. They did their training at FlightSafety International instead of just trying to do it "on the cheap." The chief pilot was described as being very meticulous about the airplane's maintenance. They had undergone 2 voluntary industry audits and were preparing for their 3rd audit, which is a remarkable feat.

The auditor for their 2nd voluntary audit had the following glowing comments:

- "The Safety Management System (SMS) of this operator is well-developed."
- "Best practices are consistently employed in all facets of the program."
- "Continuous SMS improvement is actively pursued."
- "The flight operations manual is remarkably well-written and comprehensive."
- "Safety culture within the department is shared among all team members."
- "Open reporting of hazards is consistently encouraged by management."
- "Solid safety program, maturing nicely."

Despite these positive comments, our investigation revealed an operation in which checklists and flight control checks were not accomplished by the flightcrew, as specified in their training and the aircraft operations manual. In order to successfully complete training, neither of these omissions would have been acceptable. However, considering that each crewmember successfully completed recurrent training 8 months before the crash, they obviously knew and demonstrated they were aware of these requirements.

Given that they knew how they were supposed to operate, why did these flightcrew members perform to the contrary? Why did they intentionally act one way when being checked, and perform another way—a way contrary to basic good airmanship—in actual operations?

Complacency is one explanation that comes to mind. Perhaps an overconfidence developed out of routine, wherein the flightcrew believed their method of operations didn't require these procedural items. Whatever the reason, the result proved catastrophic.

Although the flightcrew members may have become complacent, I have to believe the owners of this airplane expected the pilots to always operate in conformity with—or exceeding—training, aircraft manufacturer requirements, and industry best practices. Yet, as evidence showed in this investigation, once seated in their cockpit, these crewmembers operated in a manner that was far, far from acceptable.

There is a saying: "You can fool the auditors, but never fool yourself." These pilots made the critical mistake of attempting to fool both. And this mistake was costly, unfortunate and tragic.

I hope the lessons from this crash can be used to emphasize the critical need to combat complacency, eradicate intentional noncompliance and perform like true professionals. Passengers who place their lives in the hands of flightcrews deserve and expect no less. □