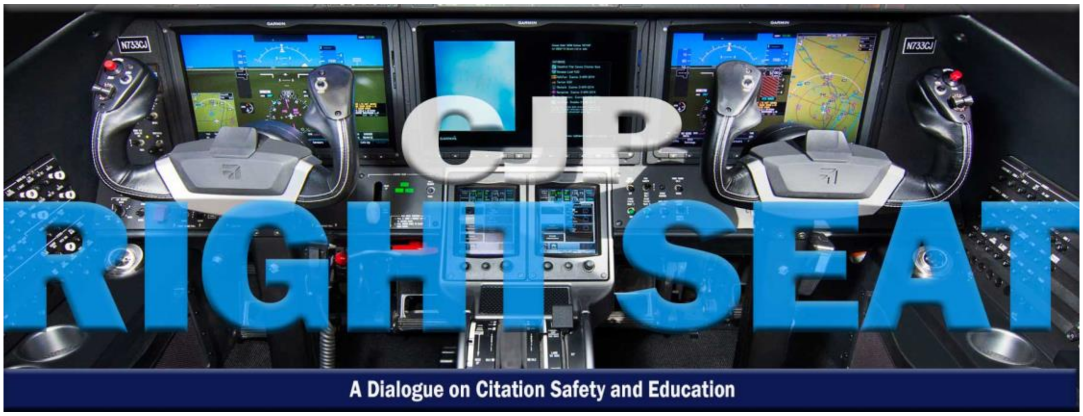
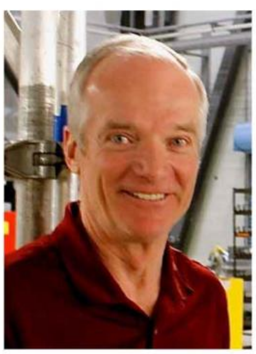
CITATION Jet Pilots
OWNER PILOT ASSOCIATION

August 2019



— LATEST BRIEFING —

All Systems GO for Colorado Springs Convention



by Charlie Precourt, CJP Safety Committee Chairman

We're really looking forward to seeing everyone at the Broadmoor during the first week of September. We have another nice lineup of safety content to build on last year's convention. Be sure to register if you haven't already!

One of the topics we'll address in our Safety Standdown on Thursday came out of member feedback following my March Right Seat column that covered lessons from the Boeing 737 Max. In that article, I reviewed some of our own Citation trim failures and trim runaway procedures. Several members commented that in their simulator training they had been taught *not* to follow the memory item procedure, but to use a non-standard procedure (or technique, depending on who you ask) that worked easier. This alternative was essentially the memory item in reverse – first pull the trim circuit breaker, then correct the out of trim situation manually (wheel or electric backup trim in the CJ4), then disconnect the autopilot. The rationale being if the autopilot is holding the aircraft stable, this sequence avoids having a lot of stick force to deal with when you hit the red button. The premise here is that the autopilot can hold stably in the out of trim situation and not disconnect, which is a topic of the analysis we'll share at the Standdown. Several of our members asked that we look into this apparent discrepancy as they weren't certain this was policy endorsed by either the manufacturer or the simulator providers. So, your safety committee has indeed looked into this, and we'll provide a nicely detailed briefing that was prepared by representatives from both Textron Aviation and FlightSafety.

In the course of looking into the trim procedure issue, we analyzed an accident involving a CJ1 in 2003 that ditched in waters near Seattle after suffering a full nose down runaway trim failure. Peter Basile from Textron will go through the details of that accident – very interesting stuff. We also looked at a *simulator scenario* a client encountered more than ten years ago where a full nose-down trim failure was introduced while on ILS final in the weather. The pilot did not recognize the trim failure while flying the approach, and when he disconnected the autopilot after breaking out of the weather, he encountered an uncontrollable full nose-down pitch change. Ouch!

These two scenarios will be examined in our session so we can provide you some deeper understanding and guidance on how to deal with the trim failure mode. The good news is the likelihood of a runaway trim failure in our Citations is very remote, and today it is even more remote due to design changes incorporated after the CJ1 accident. However, the consequences of this failure are very serious and deserve the attention we've been giving it. This is a great example of what your Safety Committee is doing for the members. We've had outstanding support from both Textron and FlightSafety in addressing these scenarios (now "FlightSafety Textron Aviation Training" after their merger).

You'll see that our trim scenario analysis truly follows our philosophy of "we don't tell you how to fly your jet, we give you good things to think about when you do!" The case study is an excellent examination of pilot judgment and decision-making. I have often described alternatives to manufacturer's procedures that surface in the system as "folklore" or normalization of deviance, which we don't condone. But this scenario will really make you think, so be sure to join us at the Safety Standdown. Thanks to all of you who provided us the feedback that got us to look into it – keep the cards and letters coming!

We begin our safety content on Wednesday, for those who can arrive in time. Erik Eliel will give a four-hour seminar on radar that is truly best in class. Then on Thursday, we open the Safety Standdown with Peter Basile of Textron briefing the accidents and incidents in our fleet from the past year. He's done this at the last two conventions and his presentations are a real hit. It is obvious that runway overruns/excursions and loss of control remain our two nemesis issues in the Citation fleet. So, following Peter's annual accident/incident review, we'll dive into the trim issues already introduced here, and then also look at loss of control at altitude, like the Cedar City fatality in January 2016. There's also the loss of control that occurred in Europe in December 2013 where a CJ2+ lost control climbing above FL400 in VS mode. Recall that our CJP Standard Operating Practices recommend not using VS mode (a controversial SOP at that) in high altitude climbs because of the possibility of having the speed get too low and leading to a stall. That's what happened in this incident, nearly losing the aircraft.

As "homework" for the Safety Standdown, consider reading through the article on this CJ2+ incident provided by Capt. Quintin Cairncross who wrote us recently about research he was doing on the incident. You can read about Quentin here.

Quentin wrote the attached analysis on the CJ2+ LOC. The aircraft was nearly destroyed in high G rolls after stalling in the flight levels. The pilot managed to get the aircraft on the ground with no one hurt, but the fuselage suffered major structural damage. You can also review the CJP SOPs for your Citation to refresh our guidance on climb modes and climb speeds. Quentin's article is found at the end of this column and is an excellent pre-read for the convention.

I'd like to point out a couple of items addressed in Quentin's article. First, he discusses the manufacturer's recommended climb schedule. Most of us are familiar with the climb schedule in the aircraft flight manual and normal operating procedures checklist, which is principally a Cruise Climb profile. In the CJ2+, that is basically 230 kias until intercepting .55 Mach. There are two other climb profiles you may want to review: minimum time to climb and minimum fuel to climb. One source for these profiles is the CesNav Performance Calculator App (they aren't in the Flight Manual). On the Planning Tab in that App, in the Climb section, you can select from three different climb profiles. I've attached at the end of this article a comparison of the Cruise Climb and Minimum Fuel Climb profiles for the CJ2+ to give you an idea of how they differ. I personally like to use the minimum time to climb profile unless I have a really good tailwind all the way up, in which case I'll use the cruise climb. The point is to make you aware of the differences and to be aware of what happens at altitude. Our CJP SOP calls for FLC or pitch mode at high altitudes in the climb so you avoid VS climb rates that insidiously decrease airspeed to the point of a stall.

Quentin also discusses in his article the reasons an autopilot would typically disconnect in flight (which was a factor in the CJ2+ incident). This also takes us back to my first topic on trim runaway procedures. If the alternative technique of going for the circuit breaker is "better" because it relies on the autopilot "holding" stable flight, then you have to also consider an uncommanded autopilot disconnect and its consequences. Again, more to come at the Safety Standdown. But for now, from Quentin's list, autopilots will typically disconnect under the following conditions:

- Attitude limits are exceeded;

- Running out of aileron authority;
- Running out of elevator authority;
- Running out of elevator trim authority;
- Activation of high-speed warning;
- Activation of stall warning;
- Pushing disconnect buttons or manual operation of trim.

The final portion of our Safety Standdown will cover circling issues (the Teterboro Learjet fatal circling accident), takeoff and landing runway excursions and low altitude level offs. We have now seen two fatal accidents involving low altitude level offs, where the aircraft climbed rapidly through the clearance altitude and the pilot lost control attempting to correct the situation. One was the Cleveland CJ4 accident and the other was the Citation 560 accident in Atlanta. We will go through our SOP recommendations for these scenarios. Judicious use of pitch mode could have prevented both of these accidents.

On Friday, we will have a guest speaker from NetJets, Rob Switz, who will share best practices in the operations of their fleet. He will be a great addition to our lineup.
Our Saturday sessions will include a discussion with the simulator instructors who will give us an update on the FSI/TRU merger, as well as a review of common errors they see in our simulator training sessions.

We will also present the next in our series of “What Good Looks Like” videos. Once again, David Miller and Neil Singer have done an outstanding job with these vignettes. This year, they will cover many of the topics in the Safety Standdown like circling, low altitude level offs, high altitude LOC and runway overruns. These will be a highlight of our event. We will then close the convention sessions with an accident review by Greg Feith, former NTSB investigator, who will go into the behind the scenes details on several accidents and incidents.

I’ll close this Right Seat with an update on our efforts with the insurance underwriters. I suspect you are all by now aware of how the insurance market is tightening. David Miller and Andrew Broom have been working with the underwriters to demonstrate the value of our safety initiatives, with a good bit of success. This underscores the importance of pursuing our Gold Standard Safety Award. We will have two of the underwriters attending the convention, QBE and Old Republic. QBE is already offering a 10 percent discount on premiums for those who attend the convention and another 2.5 percent for those who achieve Gold Standard. Hope to see many of you get the Gold Coin this year!

CJ2+ Min time to climb schedule (source CesNav)

Climb Schedule

Altitude	6187	10000	15000	20000	25000	30000	35000	40000	43000
KIAS	250	250	263	238	215	192	172	152	141
MACH	0.41	0.45	0.52	0.52	0.52	0.52	0.52	0.52	0.52

CJ2+ Cruise Climb (230 kias to .55 Mach)

Climb Schedule

Altitude	6187	10000	15000	20000	25000	30000	35000	40000	43000
KIAS	230	230	230	230	226	203	181	160	149
MACH	0.38	0.42	0.46	0.51	0.55	0.55	0.55	0.55	0.55

Note the min time to climb starts out 20 knots faster than the cruise climb schedule but ends up 8 knots slower than cruise climb upon reaching FL430.
In CesNav, you can select a desired climb schedule (cruise, minimum fuel or minimum time) on the Planning tab of the performance APP.

Fly safe!

Charlie

Losing Control

By Quintin Cairncross

At 1100 universal coordinated time (UCT) on 31 December 2013 a Cessna 525A Citation CJ2+ is flying from Leeds Bradford Airport in the UK to Palma de Majorca in Spain. Seated in the cabin is one female passenger. The occupants are no doubt looking forward to spending New Year's Eve in the somewhat warmer climate of their Mediterranean island destination.

The accident aircraft N380CR (Credit: Jetphotos.net Javier Rodriguez – Iberian Spotters)

Nearing its cruising altitude of 43,000 feet (FL430), the aircraft suddenly stalls and departs controlled flight in a series of five rapid 360-degree rolls to the right. The pilot briefly regains control before the aircraft stalls again. The aircraft's wings are structurally damaged as excessive g-force is applied during the recovery from this second stall.

Background

The aircraft is being flown by its owner as a single pilot. He has a Private Pilot's Licence with 3900 hours of which 600 hours are on type. He has flown 16 hours in the last 90 days and 5 hours in the last 28 days. He is accompanied by one female passenger who sits in the middle of the cabin on the right side. She is (fortunately) secured by a three-point harness. Three small dogs are also in the cabin.

Smaller business jets such as the Citation CJ2+ are certificated under FAR Part 23 airworthiness requirements in the Normal Category. These requirements specify a maximum positive load factor (limit load) of +3.6g. with flaps retracted. The limit load is the load level that the aircraft's structure must be capable of sustaining without permanent deformation or damage to the structure. In addition, FAR Part 23 also prescribes a safety factor of 1.5. Taking the limit load value of +3.6g and multiplying it by the safety factor, we get an 'ultimate' positive load factor of +5.4g. When the structure is subjected to a load of between limit load (+3.6g) and ultimate load (+5.4g), it must be able to withstand that load, but the structure may permanently deform.

The CJ2+ is equipped with one angle of attack (AOA) sensing system. This consists of a rotatable vane on the side of the fuselage to measure airflow and suitable avionics which convert the sensed position of the vane into 'normalised' AOA data. Normalised angle of attack is the ratio of actual angle of attack to stalling angle, a stall being indicated by a value of '1.'

Typical AOA Sensing Vane

For stall warning, the aircraft is equipped with a ‘stick shaker’ which should trigger at a normalised AOA value of 0,87 to 0,88. This gives warning of an approaching stall at least 5 knots before it occurs. In addition, the aircraft is equipped with stall strips on the inboard leading edge of each wing which create turbulent airflow at high AOA. The resulting aerodynamic buffet also warns the pilot of approaching stall conditions.

The aircraft was not fitted with a flight data recorder or a cockpit voice recorder and this was not required by the certification regulations. Like many modern aircraft, it was fitted with an electronic Aircraft Recording System (AReS) which is primarily a maintenance tool, but does record data that can also be useful to an accident investigation.

Flight Description

On the day of the flight, the owner conducts a pre-flight inspection and notes no defects. The forecast weather is occasional stratus cloud at 600 ft above ground level (agl) with tops at 1000 ft agl. The freezing level is 4300 ft agl. There is broken cumulus and stratocumulus between 2000 ft agl and 8000 ft agl. Altocumulus and altostratus is forecast above these heights. Between FL290 and FL350 cirrus cloud was likely. The temperature was -57 deg C at FL400 rising slightly to -55 deg C at FL430.

The passenger boards and the flight departs. Take-off and initial climb proceed without incident. The climb is conducted with the autopilot on. Maximum continuous thrust (MCT) is set for the duration of the climb. The vertical autopilot mode used is “Vertical Speed” (VS) mode. Initially a VS of 2000 ft/min is selected. As the aircraft climbs, the pilot gradually reduces the commanded VS as the available engine thrust reduces in the thinner air at altitude.

1053:45 UCT - the aircraft is passing FL356 with speed at 180 knots indicated airspeed (KIAS) airspeed. Commanded VS is 1400 ft/min.

1056:41 the aircraft is passing FL395 with speed at 158 KIAS and commanded VS has been reduced to 1000 ft/min. Passing FL410, the aircraft is climbing at the commanded rate 1000 ft/min, but the speed has now dropped to 150 KIAS and continues to reduce to 140 KIAS one minute later. The pilot notices that the IAS is now below the green “donut” index on the speed tape which depicts 1.3 X stall speed (1.3Vs).

Realising that the aircraft is now too slow, the pilot reduces the demanded VS from 1000 ft/min to 500 ft/min. He is familiar with this aircraft and believes that this reduction in commanded VS should be sufficient to trade climb energy for acceleration and allow the aircraft to accelerate to a more appropriate climb speed. The data recording shows that this VS reduction to 500 ft/min occurred at 1059:17 UCT. The speed at the time was 128 KIAS. However, over the next 50 seconds, the speed gradually reduces to 116 KIAS. Pitch attitude slowly increases to 11,5 degrees (deg) nose up in order to produce the demanded 500 ft/min vertical speed.

1100:08 Climbing between FL420 and FL430 the pilot goes “head down” and looks inside at his tablet on the right seat. He wants to compare the indicated upper wind readout displayed on his primary flight display (PFD) with the forecast wind chart of his preflight briefing. He hears a ‘click’ and looks up to find the aircraft rolling right to 57 deg bank with the nose pitching down to 9,5 deg. The ‘click’ is the autopilot disengaging.

The roll attitude reverses rapidly to 66 deg left and then, in the space of the next 23 seconds, the aircraft completes 5 complete rolls to the right at an increasing rate. The roll rate recorded on the last roll is 181 degrees per second. The rolls are accompanied by pitch oscillations with nose-down values reaching -68 deg.

1100:34 Engine power is reduced to idle. The nose is rises from -68 deg to -3.6 deg in a +3,25g pull-out. The airspeed reduces rapidly to zero in this pullout and the aircraft departs controlled flight again, with a further complete roll to the right. The nose pitches down into the vertical at -89,7 deg. Pointed straight down, the airspeed rises rapidly.

1100:58 In the recovery from the vertical pitch down, the pull-out registers +4.48g with the trajectory bottoming out at FL270. There is an overspeed with the aircraft reaching 297 KIAS or Mach 0.77. The average rate of descent has been about 20,000 ft/min.

1101:13 The aircraft then continues to pitch nose-up to +70 deg with speed reducing to 44 KIAS at the top of the trajectory, rolling 115 deg to the right in a fully stalled condition.

1101:28 The aircraft now pitches -40 degrees nose-down and bank angle reaches 80 deg left. The aircraft descends out of cloud and with a visible external horizon to aid recovery, the pilot regains control at around FL280.

1101:43 The nose is roughly level. The pilot believes he has engaged the autopilot and releases the controls. The aircraft immediately adopts a nose-up attitude and climbs 2000 feet.

1101:58 The pitch attitude reaches 40 degrees nose-up with speed reducing to 93 KIAS before control is finally regained. At around this time the pilot realises that the autopilot did not engage and that the pitch trim is fully nose-up.

1103:10 The airspeed increases through 200 KIAS. Pitch, roll and heading begin to stabilize over the next 90 seconds the aircraft is trimmed and the autopilot is re-engaged.

The pilot confirms that his passenger (and 3 small dogs) are not injured, but notes damage to the upper surface of the left wing while his passenger reports similar damage to the right. Weighing all factors, he decides to return to his departure airfield, Leeds Bradford, which is some 25 to 30 minutes behind him. He notes that the aircraft handling appears to be unchanged despite the damage that it has sustained.

Inspection after the accident flight reveals that the aircraft wings have been damaged in overload. Five ribs in the outboard wingbox are damaged by buckling and the bonded joints between the ribs and the upper and lower wing skins have failed. The upper and lower wing skins are permanently deformed with significant loss of aerofoil shape. The Cessna wings contain integral fuel tanks. Fortunately, this part of the structure has maintained its integrity and there were no fuel leaks, with the wing skins remaining attached to the front and rear wing spars. There is also wing skin buckling above the main wheel wells close to the fuselage. The damage is consistent with symmetrical ‘pullout’ loads between +3.6g (limit load) and +5.4g (ultimate load). Both Ailerons show evidence of skin wrinkling along the trailing edge of the upper and lower surfaces.

Right Wing rib damage at approximately mid-span of the aileron (Credit: UK AAIB)

Analysis

This accident presents us with many learning opportunities. In the interest of brevity, we will limit our discussion to the following.

Upset Prevention and Recovery Training Programs commonly emphasize the following:

- **Upset Prevention** (timely action to avoid progression toward a potential upset);
- **Recognition** (timely action to recognise divergence from the intended flight path and interruption from the progression toward a potential upset);
- **Recovery** (timely action to recover from an upset in accordance with manufacturer procedures).

Upset Prevention

Prevention incorporates such topics as crew discipline, situational awareness, monitoring, aircraft/system knowledge and adherence to standard operating procedures (SOPs).

Aircraft climb speeds are established during certification. Generally, best rate of climb is achieved at an indicated airspeed where excess power is greatest. This speed will decrease with altitude. It also follows that flying at a speed faster or slower than the specified climb speed will result in degraded climb performance. The optimum climb speed should be known and flown accurately.

Climb profile information is available to Citation CJ2+ pilots in a number of documents. The CJ2+ Pilot Training Manual requires the following: “Climb at 230 KIAS until reaching 0.55 indicated Mach at approximately 30,000 feet."

The CJ2+ Operating Manual - Flight Planning and Performance section, provides greater detail in a number of Cruise Climb Table pages which cater for various conditions. Each Cruise Climb Table page specifies the basic profile: “CRUISE CLIMB 230 KIAS/0.55 INDICATED MACH.” This is followed by four tables providing data for:

- Time, Distance, Fuel and Rate of Climb;
- Wind effect on climb distance;
- Step Climb;
- Cruise Climb Speed.

One of the four tables, Cruise Climb Speed, is reproduced below.

CRUISE CLIMB SPEED - KIAS									
PRESSURE ALTITUDE - FEET									
0	5000	10000	15000	20000	25000	30000	35000	40000	45000
230	230	230	230	230	226	203	181	160	142

Table 1 Cessna CJ2+ Cruise Climb Speeds

This table provides more detailed indicated speed information versus pressure altitude. The data agrees with the basic 230 KIAS/M0.55 profile. There is a small area of the envelope between 25,000 feet and 30,000 feet, where the pilot may have to climb at a slightly reducing IAS until achieving M0.55 at about 30,000 feet, should it be necessary to extract optimum climb performance from the aircraft. Above 30,000 feet, the KIAS values specified correspond to a constant M0.55.

Like many business jet types, the CJ2+ has a number of auto-flight system vertical modes that can be used to guide the aircraft in climb or descent either with the autopilot engaged, or via flight director guidance to the pilot in manual flight. These modes are typically Pitch, Flight Level Change (FLC), Vertical Navigation (VNAV) and Vertical Speed (VS). The FLC and VS modes are pertinent to this accident.

How do these modes work? Assume our aircraft needs to climb from FL200 to FL430 and that the pilot has set Maximum Continuous Thrust (MCT). The current speed target is 230 KIAS.

If FLC is engaged, the autopilot elevator channel will simply command a pitch attitude (within certain limits) that will maintain 230 KIAS. About the time the aircraft passes 30,000 ft, the avionics will change the speed reference from KIAS to a corresponding Mach number. As the aircraft continues to climb, the autopilot elevator channel will maintain a constant M0.55 which, as it turns out, mirrors the constantly reducing IAS in the Cruise Climb Table above. By design, the system is climbing at very close to optimum rate of climb. As the thrust produced by the engines decreases with increasing altitude, the autopilot will counter the resulting tendency for the speed to decay by continually lowering the nose to maintain the target speed of M0.55 throughout the climb. Conversely, should there be a momentary speed increase due to turbulence for example, the autopilot will raise the nose slightly until the speed is stabilized once more at M0.55. FLC mode is therefore inherently safe as it protects the aircraft speed.

Under certain circumstances such as turbulence, rapidly changing upper winds or rapidly changing temperature, FLC mode can result in pitch variations which some may find uncomfortable. As an alternative in these circumstances, the aircraft can be climbed in VS mode.

Assuming once again that MCT is set and the current target speed is 230 KIAS. If VS is engaged, the autopilot elevator channel will command a pitch attitude (within certain limits) that will maintain whatever vertical speed the pilot has requested. Should the requested VS be less than the what the MCT thrust is capable of producing, the elevator channel will still maintain the desired VS but the speed will increase above the optimum 230 KIAS.

Conversely, should the requested VS be more that what the MCT thrust setting can produce, the elevator channel will maintain the desired VS but the speed will begin to decay below the optimum 230 KIAS.

In VS mode then, the pilot is required to pay careful attention to what his speed is doing. Should the speed increase, he will need to increase the VS target until the optimum 230 KIAS (or M0.55 above 30,000’) is regained, and then adjust it again to maintain that speed. Conversely, should the speed decrease, he will have to reduce the VS.

As the aircraft climbs, the thrust produced by the engines is decreasing. This will require constant VS target adjustment on the part of the pilot to maintain optimum climb speed. It can be a demanding task. Inattention can result in off optimum climb, overspeed or worse, entering the area of reversed command (back of the drag curve) and getting close to the stall.

The manufacturer and training organisations therefore recommend FLC.

As an aside, I am told that to really extract maximum climb performance from the CJ2+, the pros will climb in FLC and gradually reduce the speed target from 230 KIAS at around FL200 to around 203 KIAS passing FL300. Thereafter the climb will be continued at a constant M0.55 that is the “sweet spot” optimum climb speed.

Recognition

Getting back to our accident flight, we know that the pilot elected to use the autopilot VS mode. The accident report does not mention what speed target was set by the pilot, but given the final outcome, we know that during the latter stages of climb the VS selected was clearly too high for the for the energy state of the aircraft:

1053:43 Passing FL356 at VS+1750 fpm airspeed M0.55
1056:41 Passing FL395 at VS+1400 fpm airspeed M0.53
1057:38 Passing FL410 at VS +1000 fpm airspeed M0.52;
1058:24 Passing FL417 at VS+1000 fpm airspeed M0.49;
1059:17 Passing FL420 at VS+500 fpm airspeed M0.46;
1100:08 Passing FL426 at VS+500 fpm airspeed M0.43 **Stall**.

From this timeline, we can see that this climb really started going wrong passing FL395. A timely correction at 1056, either selecting FLC or setting the VS to a more reasonable value may well have made all the difference. At altitude, where the speed has dropped significantly below climb speed, it may be necessary to set VS to 0, or even a small negative value, in order to regain sufficient energy. After 1056, with speed decaying, the undesired aircraft state took just 4 minutes to develop.

Apart from the obvious speed cue, in the latter stages of the climb, the pitch angle rose above 10 degrees. Above FL400, for any aircraft other than a fighter, that could be considered excessive.

The pilot needs to avoid distraction at all costs when climbing in vertical speed, particularly at high altitude.

Recovery

To recover from undesired aircraft states, typical methodologies will usually entail generic memory items similar to those in the table below. In all cases, specific manufacturer guidance will be overriding.

Recognize and confirm	
Disconnect (A/P & A/T)	
Unload	Thrust and Drag as required
Roll	
Stabilise	

Table 2 Generic Upset Recovery Methodology

These simple actions may create the impression that recovery is straightforward. It is not. There would be significant startle factor as the aircraft stalls, pitches and rolls. We can imagine all the horizon displays on the PFD's filling with brown 'earth' symbology and rotating rapidly anticlockwise as they faithfully indicate this extreme nose-down, rapid right roll. There would be disorienting physiological sensations of pitching down, fluctuating 'g' forces and rapid rolling motion.

These confusing cues are accompanied by loud aural warnings and flashing warning lights. Tremendous resilience would be required to quickly recognise and recover the situation before more extreme attitudes develop, limitations are exceeded, and the possibility of recovery diminishes.

With regard to the autopilot pitch control, most business jets will have an autopilot pitch channel providing elevator commands to a servomotor, which in turn moves the elevator either directly or indirectly via hydraulic actuators. The system will also be equipped with an auto trim system.

Following an autopilot pitch input, the auto-trim winds in an appropriate amount of trim to provide a stick-free control so that the autopilot pitch servomotor no longer has to apply any torque to the elevator circuit to hold the desired attitude.

Generally, autopilots will typically disconnect under the following conditions:

- Attitude limits are exceeded;
- Running out of aileron authority;
- Running out of elevator authority;
- Running out of elevator trim authority;
- Activation of high-speed warning;
- Activation of stall warning
- Pushing disconnect buttons or manual operation of trim.

The operation of the stall warning is important to this accident. With the autopilot engaged and the aircraft approaching an unaccelerated stall, the activation of the stall warning about 5 knots prior to the stall would result in autopilot disconnect. Importantly, the auto-trim would also stop trimming at this point and the aircraft would essentially be flying in trim at 5 knots above the stall. Re-establishing a safe flight condition would simply require keeping the wings level and a gentle push forward on the control column. Such is the safety inherent in the design.

On the accident aircraft, it could be deduced from the AReS data that the AOA vane would intermittently stick, despite aircraft pitch changes. Investigation of the AOA unit showed that a seal inside the unit was displaced. This allowed moisture to enter which could freeze and restrict the movement of the AOA vane.

This subtle, dormant failure removed the protection offered by the stall warning and stick shaker. With the pilot's attention diverted, there was no timely warning of the impending stall to the distracted pilot. In addition, without the stall warning to signal an automatic or manual disconnect, the autopilot kept flying and importantly, trimming the aircraft until it was actually fully stalled. The autopilot eventually disengaged when full left aileron input could not prevent the right wing from dropping to 57 degrees right bank.

The recovery of a fully stalled aircraft in an unusual attitude is complicated at the best of times. The fact that it had been trimmed into the stall added a whole new level of difficulty to the recovery. Who looks at trim position during a dynamic unusual attitude recovery? Abnormally high forward elevator control inputs would be required to recover from the stall. Imagine a stall recovery with a powerful bungee cord pulling the control column fully back to the aft stop.

With the aircraft in an extremely nose-down attitude, the speed would tend to build up rapidly. Elevator trim is a powerful control and can be difficult or impossible to overpower at high speed. Very strong pitch-up forces would be experienced stick-free as the aircraft naturally attempts to regain its low in-trim speed.

PFD Display: Left = Normal, Right = 'Declutter' mode (Credit: UK AAIB)

Conclusion

It is said that the superior pilot is one who uses his superior judgement to avoid situations which may require the use of his superior skill. The adage has a lot in common with the Prevention – Recognition – Recovery philosophy applicable to upset training.

The best strategy is to avoid upsets and loss of control altogether. How do we do this?

Preflight, be aware of aircraft weight, tropopause height and still air temperature at cruise altitude. Observe upper winds and consider any resulting mountain wave activity. They are a clue as to the performance you can expect. Keep an eye on these parameters during the climb.

Know the manufacturer's climb profile, associated ballpark pitch settings and the resulting performance you could expect throughout the flight envelope. In the CJ2+, any speed less than M0.55 above FL300 should be cause for concern to a situationally aware pilot. In most business jets, you never want to see pitch attitudes above 5 degrees above FL400. If you find that the aircraft cannot climb to its cruise level at optimum climb speed, then the climb should be stopped and a lower level requested. Most aircraft are going to perform marginally at high altitude and need to be flown with care. Always be prepared for the unexpected when operating at the edge of the aircraft's performance.

Understand how to get the auto-flight system to achieve the climb profile safely and accurately. Understand its limitations. FLC is a mode with inherent safety advantages, the main one being speed protection. In a busy flight environment with many distractions and adverse weather, FLC can reduce workload while keeping you safe.

As always, if automation is not producing the flight path or smoothness desired, then the pilot should intervene. If VS must be used, understand the safety implications. VS mode should imply a more sterile cockpit environment and acknowledgement that the pilot flying (or single pilot) cannot be distracted from the primary task of flying the aircraft. If distraction subsequently becomes unavoidable, go back to FLC mode while you deal with it.

In this unfortunate accident, the pilot had received Upset Recovery Training. It is highly recommended that all pilots do so. The goal, however, is to pay sufficient attention to prevention and recognition so that the only time you are called upon to exercise your recovery skills is during training.

Take care up there.

Update by FlightSafety Textron Aviation Training Platinum Partner

An Interview with Brian Moore, CEO of FlightSafety Textron Aviation Training.

By Trent J. Corcia, Product Director and Relationship Manager (CJP), FlightSafety

Trent: "Brian, tell us about the new joint venture."

Brian: "FlightSafety Textron Aviation Training began operations on April 1, 2019. This new joint venture was created to provide training services for Textron Aviation's product line of business and general aviation aircraft. We provide the highest quality training for Cessna, Citation, Beechcraft, King Air and Hawker aircraft models at 17 locations using a fleet of 89 simulators. As of August 1, 2019, Clients are now able to train on their current agreements at any of our learning centers, with some minor exceptions at Carlsbad and Tampa."

Trent: "How do CJP Members schedule at one of the learning centers?"

Brian: "This is an exciting time as a customer in that you will know that you will receive high-quality instruction with even more locations to choose. Be sure to contact the center of your choice for your next training event. Our new website is www.FlightSafetyTextronAviationTraining.com, which is full of information including the list of aircraft programs and learning centers."

Trent: "What new projects are you and the FlightSafety Textron Aviation Training team working on?"

Brian: "We are very excited about many of our projects on our plate for continuing to innovate and provide the best customer experience. Two projects that are rolling out shortly are the Mustang G1000 NXi upgrades in Wichita and Orlando, and the new Blended Recurrent for Mustang Clients initially being offered in Wichita for FAA Clients. Be sure to contact the Wichita East Learning Center for more details. We look forward to letting you know about more of the great things coming soon."

Trent: "What offerings do you have that support the CJP Gold Standard Safety Award?"

Brian: "We have numerous offerings that directly support the Gold Standard Safety Award for CJP Members. Of course, as a Part 142 school, we provide Initial, Recurrent and Prior Experience courses in Textron aircraft. We have CJ3 Advanced Upset Recovery Training which is available at the Wichita Cessna Learning Center. Also, we created the Citation Jet Pilot LOST scenarios to support training requests to experience more challenging and realistic single-pilot operations.

The Single Pilot Online Libraries were created to support the CJP membership. These libraries are designed specifically for the training needs of owner-pilots flying Citations and are available exclusively to current CJP members. The CJP Libraries are offered at the significantly discounted rate of $500 each. For more information or to purchase online, visit https://elearning.flightsafety.com/CJP."

Trent: "What else would you like to tell CJP Members?"

Brian: "A couple of highlights for CJP Members to be aware of…this has been a very exciting time within the company as we discuss, utilize and implement best practices from all of the teammates and centers. We will continue to offer online ground school at Carlsbad and Tampa in the CJ3, CJ4, CJ3+, M2 and other programs.

If you are a former TRU Simulation + Training Client and took advantage of the Online Ground School Courses (OGS), then you need to be aware that beginning August 1, 2019, the OGS will now be found at https://ogs.flightsafetytextronaviationtraining.com. The old site will be decommissioned on September 30, 2019. We look forward to being able to provide OGS on a broader scale for more aircraft programs at more centers in the future.

Our email addresses have recently changed to FirstName.LastName@FSTATraining.com.

Lastly, as an original partner since the beginning of CJP in 2008, we are proud of our partnership with CJP over the years, and we thank you for your friendships and business. We look forward to seeing many of you in Colorado Springs at the 2019 CJP Annual Convention and appreciate being a Platinum Partner with CJP. We share the same love and passion for aviation, and we are passionate in training our clients to ensure safety in our industry. We stand by to answer any questions that you may have and look forward to another successful Convention."
