

HAWKER STALL TESTS

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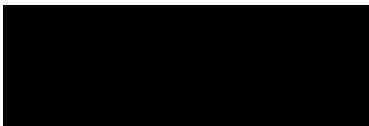


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Introductory Comments

I am not an author, nor an engineer. I am writing this from 25 years of flying stall tests on Hawker HS125s. I hope the reader bears with me. I apologize for its organization, its repetition and my sophomoric understanding of some areas, I'm certain it is not an interesting nor easy read. Please let me enter a conversation where I have not been clear. It is my hope that this writing will generate some ideas that lead to an elimination of accidents and incidents performing Hawker Stall Tests. This is my only objective.

There are usually only two occasions in the life of an airplane when it is officially test flown to ensure it meets airworthiness requirements. The first is as a prototype when it is tested to show compliance with them. After compliance is verified it is awarded a type certificate. The current Airworthiness Standards for Transport Category Aircraft regulations are US FAR 25. The current Type Certificate is A3EU Rev. 44.

The initial certification basis for the Hawker was UK CAR 10, equivalent to US CAR 4b, modifications to many models have shown compliance with US FAR 25.

The second occasion is following the manufacture of an aircraft of the same type. US FAR 21 is titled Certification Procedures for Products and Parts. 21.127 Tests: Aircraft, states (a) Each person manufacturing aircraft under a type certificate must establish an approved production flight test procedure (PFTP) and flight check-off form, and in accordance with that form, flight test each aircraft produced.

(b) Ground and flight tests are specified to ensure the manufactured aircraft retains the same performance as the prototype.

The PFTP is an abbreviated test to ensure a manufactured aircraft meets the airworthiness requirements for the type. When it is complete an aircraft is awarded its initial Airworthiness Certificate.

The ONLY procedures that have been written (and approved) for the Hawker to ensure the airworthiness of stall characteristics is the PFTP. (A factory proprietary document that has not been provided to line pilots)

Line pilots typically know nothing of Part 25, Part 21 or even have access to Instructions for Continued Airworthiness. They have no reason to.

Appendix H to Part 25 is titled Instructions for Continued Airworthiness. These Instructions are required prior to aircraft type certification. H25-1 (b) . . . “the Instructions for Continued Airworthiness for the airplane must include the information essential to the continued airworthiness of the airplane.”

The only reason to have a requirement for a stall test in an Instruction for Continuing Airworthiness is about airworthiness.

Most aircraft do not have flight tests in their Instructions for Continued Airworthiness. Once the PFTP establishes initial airworthiness by flight test, line pilots who have been schooled on the normal operation of the aircraft and mechanics following their manuals participate together to ensure the aircraft remains airworthy throughout its operating life by writing discrepancies and performing maintenance and inspections.

Examples of flight tests exclusively in the Hawker PFTP, which are not repeated are:

1. The PFTP has an altimeter test at FL390 and Mach .75. The tolerance for an altimeter split is 80 feet. It is assumed that pitot/static, ADC recertification and other inspections and maintenance will retain an airworthy altimeter tolerance. Altimeter splits do occur in fielded aircraft in flight but there is no flight airworthiness data in the maintenance or flight manual. The only operational requirement is within 200' for RVSM.
2. The PFTP has a test of the pressurization system and operation of mixer valves. There are inspection and maintenance procedures in the maintenance manuals to determine airworthiness of the pressurization system on the ground. This test is also not repeated. Line pilots need to know how pressurization systems work and what normal operation feels like in their aircraft.

Continued Airworthiness is heavily dependent on pilots writing accurate discrepancies

Again, most aircraft do not have flight tests in their maintenance manuals; Hawkers, Lears, and other aircraft (especially of this vintage) have one exception. This is a flight test to confirm continued airworthiness of stall characteristics. The Hawker is the only aircraft that DOES NOT state that the test must be flown by factory test pilots.

Why Is The Hawker Stall Test Performed?

The Hawker has maintenance procedures that, when followed, will potentially render stall characteristics un-airworthy due to adjustable stall spoilers.

I cannot speak for the 1964 British Hawker Siddeley Flight Test organization. But, there are some hints and clues in the maintenance documentation today. Installation instructions, drawings, inspection requirements, into wind tolerances for surface steps, fillet sealer

height and vortex generator condition seem critical, particularly stall spoiler position. Current instructions only require an airframe log entry when a TKS distribution panel is removed and assumes a stall test will be logged. No other pre stall test inspections are logged with the exception of the required stall system test. I have not experienced stall test failures due to sealant, skin gaps or steps, or damaged vortex generators. I inspect these on pre-flight and correct before flight.

The maintenance manual has instructions under certain conditions to install or adjust the stall spoilers to *the standard setting*. See the drawings in SRM 57-41-00. This standard setting of stall spoilers *usually results in unairworthy stall behavior*. Normally in the roll controllability tolerance.

Using 91.407 language, adhering to the maintenance procedures for the Hawker, “may appreciably change its flight characteristics or substantially affect its operation in flight.”

Is It Possible to Make Stall Characteristics Worse During Maintenance?

Yes, it is theoretically possible that a line pilot miscommunicate the behavior of the aircraft and it is also possible that a technician mis-applies an adjustment in the wrong direction. This would result in an aircraft likely behaving worse than one where spoilers are set at the standard setting. I have not flown aircraft that are at the full travel of the adjustment slot. The maximum adjustment is .050 from standard. The adjustment slot allows for more than .050 from standard but approval from Textron is required. I participate with technicians on adjustments so for the few I have flown which needed adjustment I have not experienced adjustments in the wrong direction. Technicians are instructed to make adjustments .020 at a time.

In the factory, where adjustments were common, test pilots were experienced describing discrepant behavior. Technicians had regular opportunities to adjust stall spoilers for corrections. In the field few pilots can describe and few technicians have experience correcting discrepant stall characteristics.

Why a Test Pilot?

Factory test pilots (test pilots in general) always evaluate systems and handling qualities to descriptions and tolerances of required performance. The only purpose for flight tests is to determine airworthiness, to show compliance to standards, or verify compliance. Test pilots, from training and experience, understand and anticipate flight test results and outcomes before flight is initiated. Flight Test safety is paramount. The test pilot normally must comply with or have waived (by the FAA) normal operating rules and limits. Every test flown is a dynamic environment and each flight may have small dynamic variations, but from training and experience the test pilot will interpret the actual behavior of the aircraft to

a description of standard or targeted behavior. This requires the developed judgement of the test pilot. This judgement comes from experience. For a prototype, airworthiness standards are verified by experienced FAA flight test pilots. For ongoing production flight tests, sample aircraft are audited by the FAA on a sample schedule periodically. Flight tests are conducted under FAA safety surveillance.

Note: There are no licenses or authorizations for test pilots other than those granted to Designees by the FAA for airworthiness projects. There are no licenses or authorizations because there is no authority to govern this. The Type Certificate holder is the only potential authority, as with other models, by statements in type required documents (Flight and Maintenance).

The Hawker Stall Test has a narrow scope with clearly defined behavior and tolerances in the PFTP. It can be performed by a trained test pilot in less than 30 minutes. The flight involves evaluation of stall warning indications, warning compared to instrument markings, stall system speed activation and stall characteristics at the point of Stall Identification. A maintenance inspection is required of the stall warning system and wing elements prior to test flight. It is critical to ensure an airworthy system, leading edge and wing condition before the stall test. The stall system test is usually recorded in the airframe log. However, I have experienced maintenance facilities that do not have the stall box required by this test. The maintenance manual should be adhered to by technicians. Test pilots should follow PFTP procedures.

Hawker AFM/POM appropriate to the model, and the maintenance manual contain the following warnings:

SRM 57-41-00: CAUTION: The most frequent reason for stall behavior being unacceptable is rolling at the stall, generally due to asymmetric stalling of the inner wings. It is also possible for aileron snatch to occur just before, at, or after the stall. Note that, *ideally the airplane should not roll at all*, it is acceptable for a moderate roll to occur provided that coarse use of the aileron can limit the roll angle to 20 degrees. There should be no aileron snatching or over-balance at any point in the stall. If the stalling characteristics of an airplane are unacceptable the wing should be inspected to see if any of the following wing profile defects are present. (defects listed outside the Caution, paragraph continues) (Aileron snatching is indicative of a defect in the wing leading edge in front of the aileron)

My note: Many three channel aircraft will not roll. In the evolution of removal of the third channel, some aircraft roll some do not. There is no ideal, only the Airworthiness Standards.

AFM/POM: CAUTION: A frequent reason for unacceptable stall characteristics is a tendency to roll at the stall. It is acceptable for a moderate roll to occur, provided that normal use of ailerons can limit the roll angle to no more than 20 degrees.

Aileron snatch may occur at or prior to stall and is not acceptable. The aileron snatch may be strong enough to affect recovery using aileron input, in which case the elevator control must be moved forward to decrease the angle of attack and allow the return of normal aileron control. In such an event the pilot must be prepared to recover from an unusual attitude.

Pilots conducting stall checks should have prior experience in performing stalls in the Hawker and must be prepared for unacceptable stall behavior at any point leading up to and throughout the maneuver.

My Notes:

1. Hawker simulator stall behavior will not roll at the stall. The use of ailerons during stall recoveries in the simulator is not taught. Use of ailerons to restrict roll angle is a test procedure not a recovery technique.
2. FAR 25.203 Stall Characteristics uses the terminology “normal use of aileron”. Typically when an aircraft rolls at the stall it requires application of full aileron travel in the opposite direction of the roll, as the aircraft is recovering from the stall. The standard is to measure the roll from the point of stall identification through the recovery. As the Hawker stall identification speeds slow due to configuration changes aileron power also decreases.
3. Line pilots who have experience performing stalls in the Hawker do not typically have the skills for a stall test in an aircraft with unacceptable characteristics. They have experience demonstrating stalls that have been tested for acceptable behavior. Usually by a test pilot. Test pilots that have flown Hawkers with stall spoilers installed at the standard position will have experience with Hawker stalls that are unacceptable.
4. Could this caution, which leans the qualifications toward line pilots, be confusing? “Stalls in the Hawker”. Could this be interpreted as stalls in the Hawker simulator?

Interpreting the Hawker Stall Requirement

The Hawker 125 Series SRM, one of the manuals approved as Instructions for Continued Airworthiness dated 1 October 2024, 57-41-00 Paragraph 2. Stall Test Requirements A. General states, “In accordance with Flight Manual procedures the airplane must be test flown by a pilot familiar with the stall identification system and stall characteristics of the

750, 800, 800XP, 850XP and the 900XP series if:” . . . (and lists the maintenance activities that occasion the test)

A few notes on this statement:

1. There is no reason for having a flight test in an Instruction for Continued Airworthiness unless it is about continued airworthiness. It is the first line under the heading “Stall Test Requirements.”
2. The statement “familiar with” is an ambiguous statement, here are a few common interpretations:
 - a. The “experience” interpretation: Anyone with “familiarity” with the behavior of the stalls in the Hawker could perform a test to a procedure they think is correct in whatever configuration they decide. However, if interpreted this way, and the paragraph is read in full, the pilot would need experience across the entire HS-125 800 model series as listed. Experience in Hawker stalls does not produce the ability or skill to interpret airworthiness. Airworthiness standards descriptions, procedures and tolerances are provided only in the PFTP.
 - b. Every relevant Airworthiness Standard for Transport Category Airplanes (UK CAR 10, US CAR 4b, US FAR 25) has a regulation titled “Stall Characteristics” that defines acceptable airworthy behavior. Familiarity with the airworthiness standard applies across all models. If the term “stall characteristics” were capitalized I believe it would capture the intended meaning from 1964.
 - c. When a factory test pilot flies this test he does not use “procedures” from the AFM, nor from his experience. He uses the PFTP, as he was trained because there is no other procedure.
3. There are NO “procedures” in the Flight Manual
 - a. There are conditions for stalls
 - b. There is a technique for stalls
 - c. There is a description of stall characteristics
 - d. But, there are no procedures for determining the airworthiness of stall characteristics.
 - e. The 900XP POM Section V, Sub-section 1, pages 1-16 and 1-17 contain these conditions, techniques and descriptions. As a striking contrast, the next page, 1-18, titled Wing General – Roll Test Requirements, is a test procedure out of the PFTP.
 - f. There are no data in the flight manual for the CG range for the test (the chart referenced is at full forward CG), no required configurations, no adjustment

to the referenced speed chart, no guidance that stall tests be performed at idle, no tolerances for achieved shaker or pusher speeds, no safety speeds at which to abort the test, as there are in the PFTP.

- g. There are no definitions for aileron snatch or overbalanced ailerons in the maintenance manual or the flight manual. These are not common terms.
- 4. This term “familiar with” has also been borrowed in other repair approval flight tests for wing repair. I have seen at least three repair approvals that include a requirement that the aircraft be flown by a pilot “familiar with” the high speed handling of the Hawker. These test procedures state that the test should be discontinued if the pilot experiences high speed characteristics he is *not familiar with*.

Airworthiness

Airworthiness is a seal of approval by a governing authority on the design, manufacture and operation of aircraft. The FAA doesn't give a formal description but indicates that something that is airworthy meets type design (including proper system operation) and is safe to fly. Airplanes operating on Special Airworthiness Certificates may not meet type design but must always be safe to fly.

Airworthiness is a paramount concern in aviation. There are regulations for airworthiness standards in design, for ensuring airworthiness in manufacture, airworthiness in operations and also that airworthiness is maintained over the life of a product. Airworthiness is a central concept and bears heavily on the subject of Hawker Stall Tests.

My Background

I worked at Raytheon Aircraft Company and Hawker Beechcraft Corporation from 1995 until 2012 in several positions, mainly in production flight test but also in post-refurbishment, completion and customer maintenance test operations. I was a Chief Test Pilot on the Hawker for 10 years. I have flown nearly 400 stall tests. I have been to shaker speeds and evaluated stall characteristics over 1600 times. I performed 100 stall tests during my time at the factory in all operations.

I participated in very few initial Hawker flights of green aircraft in Wichita where stall characteristics were evaluated and adjusted. Stall spoiler adjustments to produce airworthy characteristics had already been made prior to entry to the Completion Center where I worked. Even though we re-flew the stall test after completion these flights rarely, if ever, required stall spoiler adjustments.

Since leaving HBC I have flown nearly 300 stall tests. Every stall test I have flown and signed off has been to PFTP procedures. As with all flight test, I learned on-the-job from

experienced flight test pilots before me. My stall tests have been limited to Hawker 700, 800A, 800XP Honeywell and Proline, 1000, 750, 850XP and 900XP.

Differences Between Factory and Fielded Aircraft

Factory stall tests were performed on new aircraft under a production certificate quality system, pursuing initial airworthiness with new components at weight and CG that were always controlled.

In the field there can be confusion on weights and CG. Stall components can fail during the test. Other functional challenges need to be assessed as well as the stall performance. In-flight anomalies occur that were not experienced in the factory: altitude and airspeed splits, SSU failures, ADC failures, inhibit switch failures, premature warnings, AHRS precession, third channel system failures and, there can be airspace difficulties not experienced near the factory.

There are challenges to the factory test pilot performing stall tests on in-service aircraft, especially as the aircraft ages. Yet, the continuity of the performance, of the airworthiness of the Hawker stall characteristics, is expected to the same standard as the prototype. This is achievable.

Where factory aircraft were typically flown on special airworthiness permits fielded aircraft are on standard airworthiness certificates and in varying conditions dependent on owner maintenance. There are crusty old aircraft and shiny superlative ones. Evaluating overall airworthiness of a test aircraft is a requirement.

History of the Hawker

- Initial application date for CAA-UK Certification of the Hawker was 28 September 1960.
- Flight testing on the 125 commenced on 12 December 1962
- Hawker Siddeley DH.125-1A was approved under UK CAR 10, 25 September 1964
- US FAA Certification under CAR 4b was also 25 September 1964

(I tell people for perspective - this was before the moon landing)

- Hawker Siddeley DH.125-3: certified 15 February 1968
- Hawker Siddeley DH.125-400: certified 15 November 1968
- Beechcraft Hawker BH.125-600: certified 17 August 1972
- Hawker Siddeley HS.125-700: certified 20 May 1977
- British Aerospace Bae.125-800A: certified 12 July 1984
- British Aerospace Bae.125-1000: certified 31 October 1991
- Hawker 800XP: certified 28 July 1995

- Hawker 850XP: certified 28 February 2006
- Hawker 900XP: certified 24 August 2007
- Hawker 750: certified 8 February 2008

Certification bases for the Hawker is complex. It began with UK CAR 10 which was equivalent to US CAR 4b, modifications to many models have been accomplished to US FAR 25. Each of these certification bases are Airworthiness Standards for Transport Category aircraft. Stalling characteristics of the Hawker were certified to UK CAR 10 and US CAR 4b airworthiness standards.

Each of the Hawker models above have continuing stall test requirements due to similar wing elements and adjustable stall spoilers.

Accident History – Stalls and Stall Tests

- 20 September 2003, Hawker 700 Stall Training Accident, Beaumont, TX, NTSB DEN03FA155, 3 fatal. The 700 has no pusher. 25 witnesses described the aircraft “falling like a leaf”. Likely in a deep stall. The 700 AFM has a caution to lower the nose as soon as buffet occurs.
- 4 May 2006, Hawker 800A Post Maintenance Stall Test Lincoln NE, NTSB CHI06A127, This aircraft was flown by an untrained factory marketing pilot. This incident had a weather element. Slight ice accretion on aerodynamic surfaces. The aircraft aerodynamically stalled while on the autopilot before the shaker. It entered a below layer of clouds. Likely it didn’t get into a deep stall because of increased stall speed. I have no evidence but I have heard there was inappropriate elevator control input for recovery. The terrain was at 1000’. The aircraft was overstressed in the visual recovery but is still flying.
 - I was a Chief Test Pilot at the Raytheon Aircraft Company Completion Center at the time. Several changes were made after this incident.
 - The statement in the maintenance manual regarding pilot qualifications was weighted toward any pilot “familiar with” stalls in the Hawker, following Flight Manual “procedures”.
 - The Flight Manual was changed to address pilots performing “stall checks”. But no “procedures” were provided.
 - The stall test became required after a leading edge change which elevated the number of stall tests required. Prior to the incident a stall test was not required when an existing leading edge was removed and reinstalled.

- The flight test procedure for testing the disconnect of the autopilot at the shaker during the first approach to stall was removed on fielded aircraft.
 - There was an company internal stop on all stall tests until it could be verified that company pilots were trained and authorized to perform the stall test. I participated as one of the trainers.
 - An inadequate Stall Training Syllabus was developed but was not issued to operators.
- 3 December 2019, Hawker 800A, Normal ILS in Icing conditions, Detroit MI, NTSB CEN20LA028, no injuries. The aircraft was running TKS fluid but the crew neglected to add the 10 knots to the Vref for icing conditions. The aircraft stalled in the flair, rolled right, struck the ground and skidded into the infield. It demonstrated what a little ice accretion can do to stall speed. The crew did not get a shaker before the stall. The captain and copilot had over 9000 hours combined in Hawkers.
 - 7 February 2024, Hawker 900XP, Attempted Stall Test, Grand Junction, CO, NTSB Preliminary WPR24FA083, 2 fatal. This accident also had a weather element and likely inappropriate elevator control input to effect recovery. The pilot seemed confident but was not within the pre-conditions for the test when it was initiated. The aircraft entered a below layer of cloud. The terrain was 5500'. When the crew exited the clouds there was insufficient altitude for a recovery.
 - 16 October 2025, Hawker 800XP, Attempted Stall Test, Battle Creek MI. 3 fatal. No report yet but in the video I have seen this aircraft seems to behave like the witness descriptions from the Beaumont accident. My guess is it was a deep stall.

What is Not Apparent in Accident Investigations

What is not seen in the NTSB accident investigations is research into previous stall test sign-off history. Who performed the test? What were their qualifications? Were adjustments made on earlier tests? It doesn't seem to be a factor in the weather element accidents due to increased stall speed but in the Michigan case it might be enlightening.

Stall spoilers will not be adjusted except for cause. The aircraft could be in an unacceptable condition by actions suggested by a previous line pilot years before the next stall test is required. If that pilot was unqualified, the aircraft's stall spoilers could have been maladjusted.

Maintenance logs containing history on critical components of wing elements would be helpful. Spoiler dimensions from the last successful stall test would be valuable data.

Accident analysis has not concluded that the root cause is a Hawker stall behavior problem. If it were the FAA would ground them. There is no evidence that a mechanic can

do anything to the wing in maintenance that would bring the aircraft out of the sky as they have, but there are things pilots can do.

Line pilots can be mindless about normal aircraft limits when tasked with a flight test. In the Hawker, at test weight and 0 flap the minimum speed in icing conditions (with any residual ice accretion) is 180 knots. Pilots of incident Hawkers have had residual accretions of ice and slowed the aircraft below this speed for a test and encountering aircraft stall before a warning. In performing the PFTP trained pilots do not operate outside of normal limits. If they cannot achieve test pre-conditions in the local weather they move the aircraft geographically where they can.

Untrained pilots of incident Hawkers also seem to apply improper elevator input when unexpected stall sensations occur. Sensations they have not experienced in a simulator.

Notes on Airworthiness Standards for Stalls

All transport category aircraft must show compliance to a thousand plus rules – 3 of those are grouped under the heading “Stalling Characteristics” (CAR 4b) or “Stalls” (FAR 25).

1. Stall Demonstrations (25.201): Describes the configurations, trim requirements and deceleration rates for stalls wings level and at 30 degree bank. (The stall test in the PFTP only requires wings level)
2. Stall Characteristics(25.203): Describes the acceptable behavior of the aircraft at the identification of the stall.
3. Stall Warning (25.207): If the natural stall behavior is unacceptable an automatic stall warning and identification system must be certified to prevent an aerodynamic stall.

Note: 25.207 discusses stall warning for transport category aircraft in icing conditions. The Hawker has no stall warning or stall ID in icing conditions.

Protection during icing conditions in the Hawker is procedural. AFM charts give maximum and minimum airspeeds in cruise flight in icing and reference safety speed increases for landing.

Why does the Hawker have a shaker and a pusher (an artificial stall warning and stall identification system)? Because the Hawker's natural stall characteristics are not certifiable.

The Hawker PFTP provides all the parameters for demonstrating stall airworthiness in FAR 25.201 and CAR 4b.160: Power at idle, trim setting at 1.4 Vs, deceleration at 1 knot per second, in all configurations.

The PFTP also describes the acceptable characteristics noted in 25.203 and CAR 4b.160: the roll occurring between the stall and the completion of the recovery limited to 20 degrees maintained by normal use of aileron.

Another Thing, a Very Important Thing

25.103 is titled Stall Speed, this regulation is mathematically complicated but it refers to V_{sr} or Stall reference speed. AC25-7d states V_{sr} cannot usually be determined by the ship's pitot/static instrument. The Hawker AFM contains two charts titled "Power Off Stalling Speeds". Both are flight test data at full forward CG.

- AFM Figure 5.05.6 provides data for pusher activation speeds for different weights and configurations. This chart is Indicated Airspeed (IAS) uncorrected for position or calibration errors appropriate to 15,000'.
- The test table from the PFTP is Figure 5.05.6 decreased 2 kts for a CG of 22-26% MAC (not full forward CG) for weights and configurations at 200 lb. increments.
- AFM Figure 5.10.4 contains the minimum airspeed obtained during certification stall testing given in Equivalent Airspeed (EAS). EAS is the IAS value corrected for pitot static position error and compressibility effect. (The definitions for EAS and IAS are in the Hawker AFM). This chart is also constructed at full forward CG and no higher than 15,000'.
- AFM Figure 5.05.10 provides correction to the airspeed indicator for position and compressibility error. (IAS to EAS)
- A 900XP test weight with crew and 6000# fuel, after takeoff and climb to 15,000' is usually 22,200#.
- At 0 flap the target pusher speed for the 900XP is 111 kts IAS.
- At the same weight and configuration the minimum airspeed obtained during certification was 107 kts EAS. (4 kt margin)
- Correcting the airspeed indicator for position and compressibility error reduces IAS 2 knots, or to 109 kts EAS. (2 kt margin)
- It makes sense on the Figure 5.10.4 chart to also reduce the minimum speed obtained in certification by 2 knots because the aircraft is at test CG, not full forward.
- This would result in a 4 kt margin between the pusher and the aerodynamic stall.
- This makes sense in the PFTP as we are instructed to abort the test at pusher -3kts in the absence of a pusher.
- AC25-7d suggests this margin between the activation of automatic stall identification and the aerodynamic stall be 2 knots or 2%, whichever is greater.
- This is true at all configurations.

- If an inexperienced and untrained pilot responds to the pusher or to an unexpected sensation at the pusher with the wrong elevator control input a deep stall could be 4 kts away.

How Swept Wing Aircraft Stall

Swept wing aircraft stall wingtips first and when this happens aileron control (roll) is degraded or lost. The description of stall characteristics in AC25-7d includes this. Even with degraded roll the aircraft must not roll beyond 20 degrees with normal use of aileron. When the wingtips stall the center of pressure on the wing moves forward tending to raise the nose, increasing pitch. As the stall progresses deeper the aircraft begins to descend increasing the angle between the wing and the relative wind. There comes a point when the tail flies into the turbulent air from the wing and laminar flow is lost over the tail. Elevator and rudder control is degraded or lost. This condition is, or at least in Hawker incidents has been, unrecoverable from the altitudes the stall has been entered. Prototypes are fitted with drogue shutters to get the nose down and airspeed recovered.

Advisory Circular 25-7d – More Complicated Than it Seems

AC 25-7D is called “Flight Test Guide for Certification of Transport Category Airplanes”. This flight test guide is 495 pages. Chapter 8 is titled “Flight: Stalls,” paragraph 8.1 is “Stall Testing,” this section is 17 pages long. Chapter 42 “Airworthiness: Miscellaneous Items” begins at 42.1 “Design and Function of Artificial Stall Warning and Identification Systems” this part of the guide is 5 pages. Certifying stalls in Transport Category aircraft is complicated.

Stall Test Requirements – Ambiguity Interpreted in the Wrong Direction

After the Lincoln Incident in 2006 Engineering Flight Test at Raytheon Aircraft Company (RAC) inserted the phrase “In accordance with Flight Manual procedures” into the stall requirement language in the maintenance manual. This resulted in weighting an ambiguous statement toward an “experience standard”. However, at the same time, internally at RAC, a stop was ordered on all stall testing until determination was made that pilots performing stall tests were trained and authorized. I was one of the trainers. RAC semantically weighted the statement towards an experience standard while mandating training and authorization in house. This seemed a corporate hypocrisy.

Following the Lincoln incident, as noted in the Additional Information section of the Lincoln NTSB report, the company committed to issuing a stall test training syllabus. One was created, but never issued. Another example of manufacturer expectation of special training needed for pilots while maintaining that any pilot with experience could do the stall test.

The Hawker community reflects this ambiguity. Some operators demand a “professional” to perform a stall test and some expect their pilots to perform it. The “professionals” who are not factory test pilots do not have the PFTP procedure and standards. Only a limited number of stall tests are completed by trained factory test pilots. Generally, I am the only one and I have trained one other pilot.

In the organization of the technical writing of the maintenance manual the stall test requirement presumed the test would be flown by pilots who understood the demonstration and handling standards. It assumes the test flight will be performed completely in all configurations to determine if there are unacceptable results. It does not offer suggested procedures until the paragraph titled “Correction of Unacceptable Stall Handling Characteristics.”

From line pilots who have “done them” and those who have reported what they heard from those who have “done them” I have heard many disappointing accounts. Pilots who perform one configuration to a shaker only. Pilots who perform one configuration to a pusher and “let go” during the recovery. Pilots who experience roll at the pusher and make no aileron correction, letting the aircraft roll beyond aerobatic. Pilots who have performed the stall test with the pushers inhibited. I once counseled a pilot who explained he went out to perform a stall test “and just about died . . . twice” because he had a small accretion of ice on the wings. I recently heard a report of a pilot who “went inverted and lost 7000 feet” performing a stall test. With no procedures pilots are free to perform stall tests by any method.

Insufficient FAA Oversight?

The Hawker has had a US Type Certificate (A3EU) since 1964. Assembly and Production Flight Tests began in the US in 1995 under Raytheon Aircraft Company. The Type Certificate was transferred to Hawker Beechcraft Corporation in 2007, transferred to Beechcraft Corporation in 2013, and finally transferred to Textron Aviation Inc. in 2016.

After the Lincoln incident in 2006 the FAA approved the changes to the Instructions for Continued Airworthiness and Aircraft Pilot Operating documentation by Raytheon Aircraft Company that weighted the interpretation of the requirement to allow untrained but “experienced” pilots to perform stall flight tests. While at the same time, within Raytheon Aircraft Company only trained and authorized pilots could perform the same tests.

The FAA is ultimately responsible for airworthiness regulation and guidance. *If the stall test is a test for airworthy stall characteristics, and there are no procedures issued to line pilots, and line pilots have been doing them, how can the airworthiness of any Hawker be assured?* This is a potentially messy problem.

Summary Statements

The only reason to have a stall test requirement in an Airworthiness Instruction is airworthiness.

There is only one procedure for determining the airworthiness of stall characteristics on the Hawker – the Hawker PFTP appropriate to the model.

Just having the procedure is not enough. Training for the test by someone experienced and knowledgeable about the test is essential. In post-production aircraft outside a factory additional training is needed.

Factory Test Pilots are trained and experienced on-the-job for stall tests. There are no schools that teach this.

There are no procedures published and no training offered to line pilots for the stall test on the Hawker. Familiarity in a simulator is inadequate. This applies to all models.

It has been a regular practice that untrained line pilots fly and sign off this stall test before passengers can be aboard, so there is, by 91.407 some admission that the flight characteristics could be appreciably changed. There have been incidents and fatal accidents. Reported and unreported.

Other manufacturers of other types do not have these incidents and accidents. They require factory test pilots to perform stall tests.

If there are no published procedures and untrained line pilots perform these tests it will be difficult to know which Hawker's stall characteristics are airworthy.

It is possible stall tests could be reduced if spoilers are measured from a stable datum and recorded in the airframe log. If the stall test is critical then the maintenance inspections and procedures leading to the test are also critical.

It is also possible to reduce stall tests by removing the requirement for a stall test after removal and reinstallation of an existing leading edge.

Solutions

- Solve the ambiguity in the Instruction for Continued Airworthiness on all Hawker models by requiring stall tests to be performed by factory test pilots, or at least factory trained and authorized stall test pilots.
- Change the AFM and POM for all models to remove the assumption that any experienced pilot could perform the stall test. Add language prohibiting line pilots from performing stall tests.

- Provide current factory test pilots the training needed on out-of-production Hawkers.
- It is not enough to fly the stall test flight. Stall test pilots must be able to describe accurately the unacceptable behavior that matches a maintenance manual condition in order for the technician to make adjustments to stall spoilers to correct the unacceptable behavior. Recognize not many technicians have this experience.
- The Type Certificate holder must be the authority controlling stall test performance. They should maintain a list of authorized pilots who can be accessed in a reasonable fashion by Hawker owners.
- If anyone lacks experience they should recognize this and ask.

Hawker Stall Test Training Notes

- Everything in Flight Test is learned on the job.
- Acceptable and unacceptable flight tests are always determined by the test pilot's judgement.
- The Hawker is difficult because it is out-of-production.
- Proper training may require a leased Hawker. Choose one that has relatively large adjustments observed on the stall spoilers by noting the amount of adjustment slot showing under the stall spoiler. Measure these spoilers and then place to the standard setting. Fly the aircraft and advise on the incremental adjustments by the maintenance manual. At the end of training place the spoilers back in their original positions.
- It is important for the factory test pilot to understand how the regulations compliment. Become familiar with the relevant stall portions of CAR 4b, Part 25, AC 25-7d, Part 21.127, and especially 91.7, 91.407, and 91.715.
- For aircraft in the field, 91.407 mandates that pilots fly aircraft that have been approved for return to service and all maintenance record entries made. 91.7 requires pilots fly aircraft in an airworthy condition. There is a caveat in 91.715 – a foreign registered aircraft's airworthiness certificate may expire while in maintenance. A pilot either needs an unexpired foreign airworthiness certificate or a special flight permit issued by an FSDO. Not to be confused with a Special Airworthiness Certificate . . . The US FAA can't issue an airworthiness certificate to a foreign registered aircraft but they can permit it to be flown in US airspace.
- The stall test is an investigation of potentially unairworthy characteristics, but the aircraft must otherwise be airworthy.
- Stall tests in foreign countries require license validation either for the state of operation or the state of registry, usually the state of registry.

- If you walk up to a Hawker that has an oxidation line on the TKS panel adjacent to the stall spoiler the spoiler has been moved. It's advisable to adjust the spoiler to cover the oxidation line before the stall test. Or just expect unacceptable characteristics.

Could the Hawker Stall Test be Eliminated?

It may not be possible to completely eliminate the stall test requirement for the Hawker. It may be possible to eliminate many stall tests. However, it is possible to eliminate stall test accidents and incidents for sure.

The Hawker Instructions for Continued Airworthiness contain procedures that may render stall characteristics unairworthy. This is because the airplane has adjustable stall spoilers. I'm convinced if they were fixed at a position with acceptable characteristics no further tests would be needed. Replacement would be done to a stable measurement.

90% of the stall tests I perform to the PFTP are acceptable. This may indicate that 90% could be eliminated. In the last 12 years, on 300 stall checks including 3 re-wing projects (2 new and 1 salvage) I have had 4 failures. 2 other test failures occurred after spoiler adjustment to standard settings because of inadvertent movement of the spoiler.

- One had an unknown cause, an 800A with API winglets, the aircraft needed three flights with two adjustments to correct for excessive roll.
- Another had an unknown cause, the first test failed, one adjustment to one spoiler corrected for excessive roll.
- One had experienced suspected movement of the stall spoiler due to a toolbox or mechanic leaning on it. Customer Support suggested to reset the spoilers to the standard setting. The technician had measured the spoiler location before the reset to standard. After the first flight failed in roll I asked him to move the spoilers to where they were before they were reset to standard. The aircraft passed at that setting.
- One had both TKS panels where the stall spoilers are mounted removed to repair delamination. The shop would not work on the panel without the spoilers removed. The spoiler location was not measured and they were reinstalled at the standard setting. Three flights and two adjustments corrected unacceptable roll.
- One new wing project passed at the standard setting but the spoiler was not secured after the test. On the next inspection it was found that the spoiler had traveled to the end of its adjustment slot. I requested the spoiler be adjusted to the standard setting and the test passed on the initial flight.

- A mechanic was getting up off the floor and used the spoiler as a hand hold. The spoiler moved. But the MRO had measured the adjustment on an incoming inspection and the stall test passed on the initial flight.

I have never had a failed stall test flight that rolled beyond 45 degrees. Loss of altitude is usually less than 1000'. I fly in a block altitude of 14000'-16000' and perform the test around 15500'-14500'.

I believe directed and robust changes to the maintenance manual under the advice of experienced Hawker technicians with service engineering oversight could reduce the overall number of stall tests over time.

Another Concern

The new language in pilot and maintenance documentation to require pilot training and authorization needs to be strong enough to withstand changes in market conditions. The customary execution of the stall test by line pilots has been so commonplace that very strong language is needed to change the culture for new pilots, mechanics, repair stations, existing pilots and pilots returning to the Hawker. Flight Safety and CAE could help reinforce the new direction.

Maintenance Considerations

The only maintenance manual I can access is for this discussion is the HS-125 800 SRM including the 750, 800, 800XP, 850XP and the 900XP.

Stall Spoiler Measurements

The 800 stall spoiler location is measured with a straight-edge on the bottom of the wing extending beyond the apex of the spoiler. The dimension is between the straight edge and the apex of the spoiler at the inboard and outboard edges.

The 750, 800XP, 850XP, and 900XP stall spoiler measurement is taken by flexible ruler from the aft edge of the TKS panel at the inboard and outboard edges.

The stall spoiler is to be reinstalled at the standard setting if the TKS panel is replaced.

Recommendation – The stall spoiler measurement should be taken from an edge that does not change due to fitment of a new TKS panel, i.e. the wing skin edge.

One MRO I work with checks the torque of the locking screws on the incoming inspection. They also do an incoming measurement of the spoilers. I presume they keep a record of this.

Initial Settings

It has been my experience if you set the stall spoilers for airworthy behavior at the factory and this remains unchanged there will be no change to the stall characteristics. But, there is evidence there have been unqualified pilots flying stall tests and asking for unnecessary adjustments so there can be no confidence any aircraft has retained its initial setting. Yet, it is just as possible that a line pilot has only tested to the shaker and made no adjustments.

Notes on Stall Test Requirements

Paragraph 2 of the Stall Test Requirements lists the maintenance activities that require a stall test.

1. The leading edge assembly was removed as a whole for any reason.
 - a. I have not had a stall test failure as a result of an existing leading edge being off the wing. This occurs frequently for inspections and fuel leaks. The fillet sealer can be applied improperly. This simply requires trimming.
 - b. In my experience it is rare to replace a leading edge. I have seen TKS panels and the titanium leading edges replaced due to damage.
 - c. There are procedures in the manual for leading edge removal and reinstallation that places the leading edge exactly where it came off. In the past there was no requirement to do a stall test for existing leading edge remove/reinstall.
 - d. Prior to stall tests inspections must be made of TKS to leading edge and leading edge to wing skin gaps and steps. If these measurements were recorded before and after the removal it could ensure no change. No stall test would be needed.
 - e. There is also a pre-stall test requirement to inspect fillet seal condition and vortex generator condition. These inspections could also have a critical sign-off and inclusion in the airframe record.
2. Two or more TKS wing distribution panels on one side are removed or installed.
 - a. I have not had a failure of a stall test due to any number of TKS panels being removed or installed. When all TKS panels come off and are reinstalled I have not had test failures. Again, fillet sealer may be raised and in need of trimming. Gaps and steps and fillet sealer should be considered critical but the stall spoiler location is the most critical.
3. Either of the one-piece titanium leading edge sections are removed or installed.
 - a. I have not had a failure after either or both of these were removed or installed.

4. Either of the stall triggers (spoilers) is adjusted, replaced, or removed/installed.
 - a. Setting the stall spoiler to the standard setting may render the stall characteristics unairworthy.
 - b. The only reason to make an adjustment is after a failed stall test, then another test is required.
 - c. Stall spoilers that are replaced should be installed at the same location previously measured and no stall test would be necessary. The size and shape of a new stall spoiler will match the old one exactly.
 - d. Removal and installation should always be at the same location measured.
 - e. Measurements should be recorded and located in the airframe log.
 - f. The maintenance manual directs the stall spoilers to be installed at the standard setting at the removal and installation of new, replacement or repaired leading edges. This may be the only occasion where a stall test is necessary. On a salvage wing I would leave the stall spoilers at their original setting. On a replacement or repaired wing I would initially retain the measurement from the previous installation and perform the stall test.
 - g. If the spoiler is measured from the wing skin and recorded these measurements can be used for initial settings when TKS panels and leading edges are replaced.

Maintenance Recommendations When Stall Tests Are Required

AHRS realignment – The Proline Aircraft AHRS precess over time. The slip skid indicators from pilot to copilot will disagree. Trim is critical during a stall test. A few pixels out of trim will induce a roll. One MRO I work with routinely accomplishes an AHRS realignment before the stall test.

Third Channel – Third channel stall boxes are often found to be defective on the stall test. When this happens I complete the stall test as a two channel aircraft. The replacement of a third channel assembly does not require a stall test. A circuitry test of the third channel is incorporated into the required stall system test. However, the actual operation of the third channel isn't tested until the B2 inspection. The MROs I work with test the third channel operation before I come for the stall test. When they are observed as failed during the test it is typically on the out date for maintenance for return to the owner. Parts can be difficult to find and it takes a day to change and test. This can be frustrating for an owner. I recommend Textron make the removal engineering retroactive to all HS125s, at least all 800XP and 800XP Proline aircraft (some 800XP Proline, all 750, 800XPi, 850XP and 900XP aircraft have no third channel)

Airframe Log Sign Off – It is very important that a stall test is signed off in the airframe log. Many 135 organizations only make the entry in their journey logs. 91.407 requires a sign-off in the aircraft logs. This is the only way to show compliance that a stall test has been completed.

A flight test record should be developed and completed noting the weight, target speeds, actual speeds, amount and direction of roll, noting any aileron snatch or overbalance. This record should be located in the aircraft log. It can be a good indicator of past behavior if a new stall test is required. Owners and Operators should be advised of the critical nature of needing stall system measurements and test records in the airframe log. They won't want to pay for unnecessary stall tests.

Conclusion

It does not appear to me, as an outsider, that many of the parties in the investigation of recent Hawker stall test accidents have a comprehensive knowledge of flight test, of the coordination between airworthiness standards, manufacturing regulations, maintenance instruction requirements and operating regulations as they work together to provide safe aircraft, ensuring continued airworthiness and safe operations. The FAA holds Flight Test organizations accountable for safety protocols in test operations. Flight test pilots routinely evaluate an operating environment to ensure test pre-conditions can be met. They often move the aircraft to ensure these pre-conditions are met. The flight test environment may include rather normal looking operations but the flight test activity produces a safety mindset that is different from the mindset of a pilot whose objective each day is air transportation. This has been fatal for a few. Stall Test Pilot training and authorization will not be an easy improvement to Stall Test safety. It is not common for the NTSB to investigate accidents in a flight test environment. The FAA has not, in history, made the connection between these stall test accidents and maintenance manual or flight manual pilot qualifications. The certificate holders through many transfers have not realized this hidden Stall Test mess they inherited. It has all just happened. The move from where we are to where we need to be may take some time but I am confident with the participation of the NTSB, the FAA and the Type Certificate holder that a safer environment for Hawker stall tests can be achieved. I believe these stall test accidents and incidents can certainly be eliminated. I offer my assistance in any way I can to achieve this end.