A320 Alerting Issues – Stall

1. Initiating Condition: High altitude airspeed decay with turbulence, autopilot engaged

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
Visual Alerts	Reversion to alternate law is alerted on ECAM display	Driven by whatever malfunction or failure caused the aircraft to revert to alternate law	The reversion to alternate law occurs as a result of, and simultaneous with, a failure of some other system or systems; this potential workload spike and distraction may hamper the pilots' effectiveness in recognizing the reversion to alternate law or its implications.			
	Loss of low speed protection is alerted on PFDs by green dash marks on airspeed tapes changing to amber x marks.	Reversion to alternate law		Salience?		
	At stall onset, In alternate law flashing red MASTER WARN lights on each side of glareshield	AOA adjusted for slat/flap position, speed/mach, and flight control law			Inhibited on the ground	
	Autopilot disconnect displayed in red on ECAM as "AUTO FLT AP OFF"	A/P disconnects at alpha-prot value plus 1 degree	Disconnection of autopilot creates a workload spike/distraction if noticed; or it may not be noticed among the other alerts/cues, which may lead to loss of control	Autopilot disconnect may occur earlier if it is driven by whatever caused the reversion to alternate law (e.g., FAC failures)		
	At autopilot disconnect, flashing red MASTER WARN lights on each side of glareshield	A/P disconnects at alpha-prot value plus 1 degree	Disconnection of autopilot creates a workload spike/distraction if noticed; or it may not be noticed among the other alerts/cues, which may lead to loss of control	Autopilot disconnect may occur earlier if it is driven by whatever caused the reversion to alternate law (e.g., FAC failures)		

A320 Alerting Issues – Stall

1. Initiating Condition: High altitude airspeed decay with turbulence, autopilot engaged – Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
Aural Alerts	At stall onset cricket sound and "STALL" aural	AOA adjusted for slat/flap position, speed/mach, and flight control law			Inhibited on the ground	
Tactile Alerts	None					
Visual Cues	At stall onset, airspeed indicator decreases to VSW (top of red/black barber pole region on PFD	Airspeed compensated for vertical-g			VSW display inhibited from touchdown until 5 seconds after liftoff	
	In the stall condition, possible uncommanded pitching moment on PFD		Uncommanded aircraft pitch, roll, or descent can result from other causes besides stall			
	In the stall condition, possible uncommanded rolling moment on PFD		Uncommanded aircraft pitch, roll, or descent can result from other causes besides stall			
	In the stall condition, possible uncommanded descent rate on PFD		Uncommanded aircraft pitch, roll, or descent can result from other causes besides stall			
Aural Cues	Autopilot disconnect tone	A/P disconnects at alpha-prot value plus 1 degree	Disconnection of autopilot creates a workload spike/distraction if noticed; or it may not be noticed among the other alerts/cues, which may lead to loss of control	Autopilot disconnect may occur earlier if it is driven by whatever caused the reversion to alternate law (e.g., FAC failures)		

A320 Alerting Issues – Stall

1. Initiating Condition: High altitude airspeed decay with turbulence, autopilot engaged – Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
Tactile/ Somatic Cues	In alternate law, low speed stability function introduces gentle nose-down pitch input which may be noticeable through somatic cues (vertical g)	Threshold for onset is 5-10 knots above stall warning speed, g-compensated to some degree. This function not available in "alternate law without reduced protection" so dependent on the nature of the failure that drove the aircraft into alternate law.	Salience reduced because there is no tactile cueing from sidestick movement as the flight control computer introduces the nose-down input; also, automatic trimming prevents the pilot from receiving nose-heavy cues as airspeed decreases			

Expected Pilot Response(s)

- Thrust levers- TOGA.
- Bank angle- roll wings level.
- Speedbrakes- check retracted.
- Avoid ground contact; maintain airspeed close to VSW until safe to accelerate.
- If below 20,000 feet, extend flaps to position 1.
- When out of stall with and clear of obstacles, retract landing gear.

Possible sources of confusion with regard to pilot response(s)

- If pilots do not notice the degradation to alternate law, they may be expecting the alpha-floor function to operate (which would prevent the stall); may be surprised by the stall warning; or even intentionally control the aircraft into the stall as in the windshear recovery procedure
- Non-moving control sidesticks do not provide salient cues to other pilot's control inputs
- Under normal and alternate law, the aircraft maintains constant 1-g vertical load factor absent pilot input, but does not exhibit speed stability; this may make it more likely for a low speed deviation and stall to occur if unprotected in alternate law. Also, with auto-trimming it does not provide tactile cues to a deviation from desired airspeed.

Issues with regard to multiple concurrent non-normal conditions

- Condition may devolve to engine surge and/or wing-walking (roll reversals from stall exacerbated by pilot rudder/sidestick inputs).
- Possible passenger injuries and aircraft damage.

A320 Alerting Issues – Stall

2. Initiating Condition: Increasing load factor in nose-low, high bank upset, autopilot disengaged

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
Visual Alerts	Reversion to alternate law is alerted on ECAM display	Driven by whatever malfunction or failure caused the aircraft to revert to alternate law	The reversion to alternate law occurs as a result of, and simultaneous with, a failure of some other system or systems; this potential workload spike and distraction may hamper the pilots' effectiveness in recognizing the reversion to alternate law or its implications.			
	Loss of low speed protection is alerted on PFDs by green dash marks on airspeed tapes changing to amber x marks.	Reversion to alternate law		Salience?		
	At stall onset, In alternate law flashing red MASTER WARN lights on each side of glareshield	AOA adjusted for slat/flap position, speed/mach, and flight control law			Inhibited on the ground	
	VSW moves up towards the indicated airspeed in response to increased vertical g	Airspeed compensated for vertical-g			VSW display inhibited from touchdown until 5 seconds after liftoff	

A320 Alerting Issues – Stall

2. Initiating Condition: Increasing load factor in nose-low, high bank upset, autopilot disengaged – Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
Aural Alerts	At stall onset cricket sound and "STALL" aural	AOA adjusted for slat/flap position, speed/mach, and flight control law			Inhibited on the ground	
Tactile Alerts	None					
Visual Cues	At stall onset, airspeed indicator decreases to VSW (top of red/black barber pole region on PFD)	Airspeed compensated for vertical-g			VSW display inhibited from touchdown until 5 seconds after liftoff	
	In the stall condition, posssible uncommanded pitching moment on PFD		Uncommanded aircraft pitch, roll, or descent can result from other causes besides stall			
	In the stall condition, possible uncommanded rolling moment on PFD		Uncommanded aircraft pitch, roll, or descent can result from other causes besides stall			
	In the stall condition, possible uncommanded descent rate on PFD		Uncommanded aircraft pitch, roll, or descent can result from other causes besides stall			
Aural Cues	Wind noise		Wind noise is not a reliable cue to angle-of-attack, but loud wind noise may potentially mislead pilots into thinking they are not stalling during a high-speed stall			

A320 Alerting Issues – Stall

2. Initiating Condition: Increasing load factor in nose-low, high bank upset, autopilot disengaged – Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
Tactile/ Somatic Cues	In alternate law, low speed stability function introduces gentle nose-down pitch input which may be noticeable through somatic cues (vertical g)	Threshold for onset is 5-10 knots above stall warning speed, g-compensated to some degree. This function not available in "alternate law without reduced protection" so dependent on the nature of the failure that drove the aircraft into alternate law.	Salience reduced because there is no tactile cueing from sidestick movement as the flight control computer introduces the nose-down input; also, automatic trimming prevents the pilot from receiving nose-heavy cues as airspeed decreases			

Expected Pilot Response(s)

- Thrust levers- TOGA.
- Bank angle- roll wings level.
- Speedbrakes- check retracted.
- Avoid ground contact, maintain airspeed close to VSW until safe to accelerate.
- If below 20,000 feet, extend flaps to position 1.
- When out of stall with and clear of obstacles, retract landing gear.

Possible sources of confusion with regard to pilot response(s)

- If pilots do not notice the degradation to alternate law, they may be expecting the alpha-floor function to operate (which would prevent the stall); may be surprised by the stall warning; or even intentionally control the aircraft into the stall as in the windshear recovery procedure.
- Also, if pilots do not notice the degradation to alternate law or retrieve/apply its implications, they may be expecting the automatic bank angle protections to roll the aircraft back no more than 30 degrees bank angle, which will not happen in the existing condition.
- Non-moving control sidesticks do not provide salient cues to other pilot's control inputs.
- Under normal and alternate law, the aircraft maintains constant 1-g vertical load factor absent pilot input, but does not exhibit speed stability; this may make it more likely for a low speed deviation and stall to occur if unprotected in alternate law. Also, with auto-trimming it does not provide tactile cues to a deviation from desired airspeed.

A320 Alerting Issues – Stall

2. Initiating Condition: Increasing load factor in nose-low, high bank upset, autopilot disengaged – Cont.

Issues with regard to multiple concurrent non-normal conditions

- Condition may devolve to engine surge and/or wing-walking (roll reversals from stall exacerbated by pilot rudder/sidestick inputs).
- Possible passenger injuries and aircraft damage.

A320 Alerting Issues – Stall

3. Initiating Condition: Wing ice accumulation

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
Visual Alerts	None					
Aural Alerts	None					
Tactile Alerts	None					
Visual Cues	In the stall condition, posssible uncommanded pitching moment on PFD		Uncommanded aircraft pitch, roll, or descent can result from other causes besides stall	Flight control inputs made by the autopilot and/or flight control systems (without tactile feedback to pilots) could mask the aerodynamic cues of a stall		
	In the stall condition, possible uncommanded rolling moment on PFD		Uncommanded aircraft pitch, roll, or descent can result from other causes besides stall	Flight control inputs made by the autopilot and/or flight control systems (without tactile feedback to pilots) could mask the aerodynamic cues of a stall		
	In the stall condition, possible uncommanded descent rate on PFD		Uncommanded aircraft pitch, roll, or descent can result from other causes besides stall			
Aural Cues	None					
Tactile/ Somatic Cues	None					

A320 Alerting Issues – Stall

3. Initiating Condition: Wing ice accumulation – Cont.

Expected Pilot Response(s)

- Thrust levers- TOGA.
- Bank angle- roll wings level.
- Speedbrakes- check retracted.
- Avoid ground contact, maintain airspeed close to VSW until safe to accelerate.
- If below 20,000 feet, extend flaps to position 1.
- When out of stall with and clear of obstacles, retract landing gear.
- Note: This procedure is in the FCOM but apparently not in the QRH or ECAM.

Possible sources of confusion with regard to pilot response(s)

- If pilots do not notice the degradation to alternate law, they may be expecting the alpha-floor function to operate (which would prevent the stall); may be surprised by the stall warning; or even intentionally control the aircraft into the stall as in the windshear recovery procedure.
- If pilots realize the aircraft is in alternate law and retrieve/apply its implications, the absence of the expected aural and visual alerts for the stall onset may lead them to misinterpret any secondary cues to the stall condition (such as uncommanded roll, pitch, descent rate).
- Non-moving control sidesticks do not provide salient cues to other pilot's control inputs.
- Under normal and alternate law, the aircraft maintains constant 1-g vertical load factor absent pilot input, but does not exhibit speed stability; this may make it more likely for a low speed deviation and stall to occur if unprotected in alternate law. Also, with auto-trimming it does not provide tactile cues to a deviation from desired airspeed.

Issues with regard to multiple concurrent non-normal conditions

- Condition may devolve to engine surge and/or wing-walking (roll reversals from stall exacerbated by pilot rudder/wheel inputs).
- Possible passenger injuries and aircraft damage.

A320 Alerting Issues – Stall

4. Initiating Condition: False stall warning during takeoff rotation

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
Visual Alerts	Flashing red MASTER WARN lights on each side of glareshield (false indication)	False indication driven by AOA adjusted for slat/flap position, speed/mach, and flight control law	Conflict between highly salient, but false alerts and subtle, valid cues: Salient alerts that the airplane is stalled must be compared with normal rotation/climb performance under extreme time pressure, and ignored.		Inhibited on the ground, so the false alert begins during rotation when the aircraft becomes airborne	
Aural Alerts	Cricket sound and "STALL" aural (false indication)	False indication driven by AOA adjusted for slat/flap position, speed/mach, and flight control law	Conflict between highly salient, but false alerts and subtle, valid cues: Salient alerts that the airplane is stalled must be compared with normal rotation/climb performance under extreme time pressure, and ignored.		Inhibited on the ground, so the false alert begins during rotation when the aircraft becomes airborne	
Tactile Alerts	None					
Visual Cues	Airspeed is above VLS		Conflict between highly salient, but false alerts and subtle, valid cues: Salient alerts that the airplane is stalled must be compared with normal rotation/climb performance under extreme time pressure, and ignored.	This is a cue that the aircraft is not actually stalling (although it is possible for the aircraft to stall above VLS due to g-load and/or icing		

A320 Alerting Issues – Stall

4. Initiating Condition: False stall warning during takeoff rotation – Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
Visual Cues	Normal vertical speed, altimeter, and airspeed indications on PFD, as well as view through the windshield of the aircraft climbing (if VMC) are subtle cues that the aircraft is not stalling		Conflict between highly salient, but false alerts and subtle, valid cues: Salient alerts that the airplane is stalled must be compared with normal rotation/climb performance under extreme time pressure, and ignored.	This is a cue that the aircraft is not actually stalling		
Aural Cues	None					
Tactile/ Somatic Cues	Normal vertical acceleration from rotation into climb is a subtle cue that the aircraft is not stalling		Conflict between highly salient, but false alerts and subtle, valid cues: Salient alerts that the airplane is stalled must be compared with normal rotation/climb performance under extreme time pressure, and ignored.	If present and perceptible, this is a cue that the aircraft is not actually stalling		

Expected Pilot Response(s)

- Ignore false alerts.
- Do not reject takeoff.

Possible sources of confusion with regard to pilot response(s)

- Conflict between highly salient, but false alerts and subtle, valid cues: Salient alerts that the airplane is stalled must be compared with normal rotation/climb performance under extreme time pressure, and ignored.
- Pilots are trained to respond to stall warnings/alerts immediately and without deliberation, decreasing the likelihood of identifying the false warning through effortful analysis and suppressing the reaction to the false warning.
- Split-second decision to perform a late rejection or continue.

How does pilot know condition is resolved/recovered?

- Observe normal takeoff and climb performance

A320 Alerting Issues – Stall

4. Initiating Condition: False stall warning during takeoff rotation – Cont.

Issues with regard to multiple concurrent non-normal conditions

- None unless pilot takes unneeded actions, such as high speed RTO.