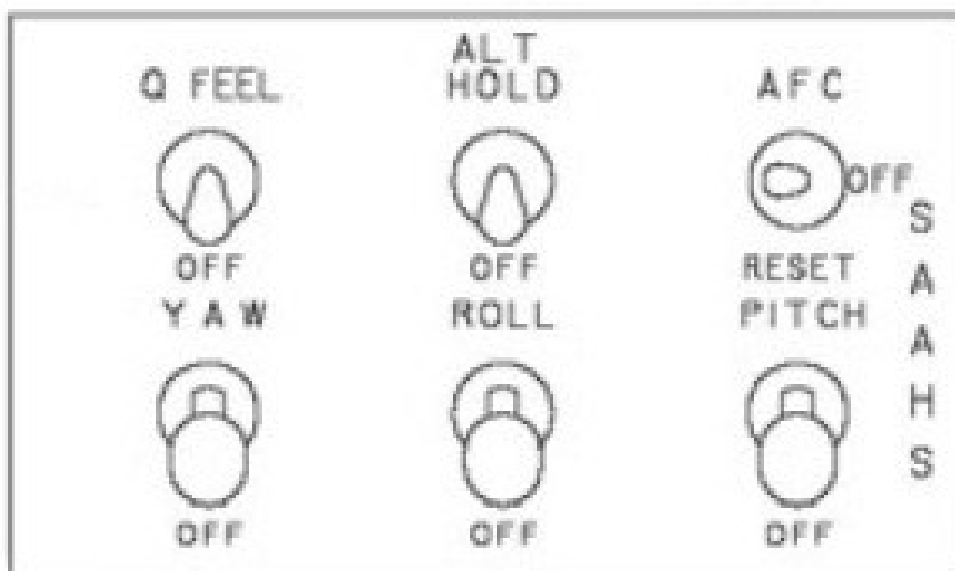


NOVENA ESCUADRILLA VIRTUAL

AV-8B STABILITY AUGMENTATION AND ATTITUDE HOLD SYSTEM (SAAHS).

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The two basic **Stability Augmentation and Attitude Hold System (SAAHS)** modes of operation are the Stability Augmentation System (SAS) mode and the Automatic Flight Control (AFC) mode.

The mode selection controls are located on the SAAHS panel on the left console just forward of the

throttle nozzle quadrant.

1. Stability Augmentation System (SAS).

The three SAS mode selection controls are the **PITCH, ROLL and YAW switches** which engage the stability augmentation in the corresponding aircraft axes.

The stability augmentation system increases aircraft stability and improves the response to pilot inputs in maneuvering flight throughout the entire flight envelope.

The yaw SAS also provides a lateral stick to rudder interconnect for improved turn coordination.

The SAS switches may be engaged and disengaged individually to provide stability augmentation in any desired combination of the three axes.

Disengaging individual SAS switches degrades departure resistance (DEPRES) which greatly increases the possibility of violent departure in certain flight regimes.

An interlock between the yaw SAS switch and the weight-on-wheels switch on the main gear inhibits the yaw stability augmentation when the aircraft is on the ground.

Pressing the emergency SAAHS disengage switch (paddle switch) located on the control stick grip interrupts the stability augmentation system in all three axes and also removes rudder trim.

Releasing the paddle switch restores stability augmentation to those axes selected by the SAS switches and restores the rudder trim.

Departure Resistance

The DEP RES improves lateral / directional handling at low to moderate AOA and resists out-of-control departures at AOA below and above the maneuvering tone. DEPRES is at all AOA and varies in function depending on airspeed, Mach number and AOA.

Above 4° AOA, lateral stick commands increasing rudder in the direction of the roll and decreasing aileron in order to reduce adverse sideslip and improve high AOA roll performance.

Lateral stick also commands nose-down stabilator to reduce AOA build-up from inertial and kinematic coupling.

The maximum rudder commanded by the SAS is equivalent to 1/2 pedal and occurs at 8°AOA and above with lateral stick at the high speed stop.

The departure resistance incorporates a roll rate feedback and increased gain to the ailerons at low airspeed that improve Dutch roll damping at high AOA and lessen wing rock. Wing rock is greatly reduced or eliminated above 120 KCAS above the maneuvering tone.

Above 3° AOA and 10° AOA respectively, rudder and ailerons are commanded in a direction to reduce sideslip excursions.

To improve Dutch roll damping and lessen wing rock, rudder and ailerons are also commanded in the direction to oppose the rate-of-change of sideslip.

The ability of DEP RES to control sideslip is degraded to varying degrees by overriding the lateral high speed stop, by large rudder pedal deflections, by large lateral weight asymmetries, and by installation of the inflight refueling probe.

These effects are cumulative and in combination can overwhelm the ability of DEP RES to prevent departures. The departure resistance in the absence of the air refueling probe, eliminates rudder induced departures at all AOA.

Departures, when they occur, have been softened by the DEP RES. Autorolls may occur following recovery from post stall gyrations. These additional rolls have been termed positive AOA autorolls. Opposite rudder will aid recovery.

Departure resistance is intentionally inhibited at all airspeeds with the gear down and STOL flaps selected. It is also inhibited below 0.3 Mach if either the gear is down or STOL flaps are selected.

Spin Mode

Departure resistance is effective in preventing departures and/or reducing the severity of a departure. However, should a spin develop after departure, departure resistance will not resist the spin and could reduce ailerons and rudder authority needed by the pilot to recover from the spin.

Spin logic disengages all feedback and interconnect path (essentially SAS off) while recovering from a spin and reengages those paths once the spin is broken to resist a departure in the opposite direction.

The spin logic is as follows:

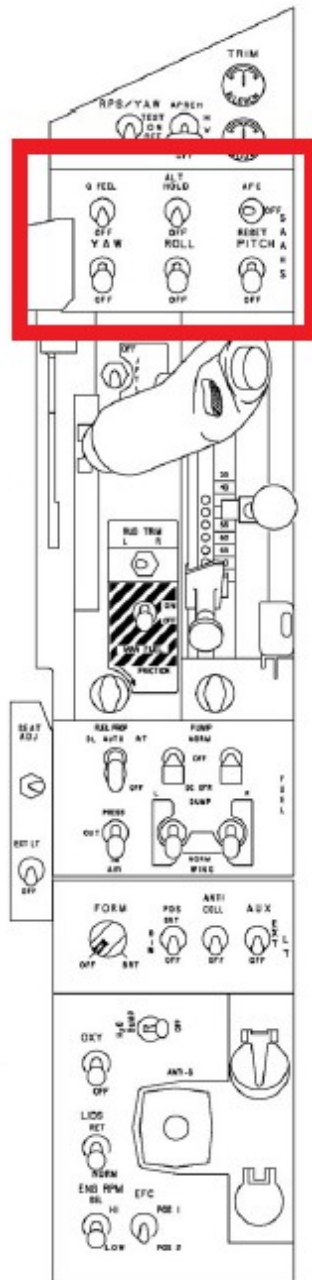
1. Fade out all feedback and interconnect signals within 0.5 seconds if angle of attack is greater than 25° or less than -7° and absolute yaw rate is greater than 18° per second for 4 seconds.
2. Fade in all feedback and interconnect signals if absolute yaw rate is less than 15° per second.

DEP RES Light

Alternate roll rate, lateral acceleration, AOA, and yaw rate and some alternatives to other parameters are available.

When the in-flight monitor (IFM) detects invalid sensor data, alternative inputs are selected automatically.

When this results in significant degradation in handling qualities, the DEP RES light comes on.



2. Automatic Flight Control (AFC).

The two AFC mode selection controls are the **AFC and ALT HOLD** solenoid held switches.

All three SAS switches must be engaged in order to engage the AFC mode selection switches.

Also, an interlock with the weight-on-wheels switch on the main gear inhibits engagement of the AFC mode switches on the ground and disengages the switches upon main gear touchdown on landings.

The AFC switch has three positions which provide the following functions:

- AFC – Solenoid held position. Engages the AFC mode.
- OFF – AFC mode is off.
- RESET – Momentary position. SAAHS reset.
- The ALT HOLD switch has two positions which provide the following functions:
- ALT HOLD – Solenoid held position. Engages altitude hold option of AFC mode.
- OFF – Altitude hold is off.

The AFC switch must be engaged with the INS switch in NAV or IFA in order to engage the ALT

HOLD switch.

The AFC mode may be disengaged by turning the AFC switch off. Disengaging the AFC switch also causes the ALT HOLD switch to return to the OFF position if it is engaged. Disengaging any of the three SAS switches will disengage the AFC mode.

The AFC and ALT HOLD switches will return to the off position if they are engaged. Pressing the paddle switch also disengages the AFC and ALT HOLD switches if they are engaged.

Both switches will remain in the off position when the paddle switch is released. The technique of “clicking” the paddle switch may be used to revert from the AFC mode to the SAS mode. Attitude references are to the aircraft waterline.

AFC Mode – AFC Switch Only Engaged

When the AFC switch is engaged and the ALT HOLD switch is in the off position, the AFC mode provides pitch attitude hold, roll attitude hold and heading hold.

At airspeeds above 50 knots, the AFC will capture and hold pitch attitudes in the $\pm 30^\circ$ range and roll attitudes within $\pm 60^\circ$ which are outside of the $\pm 5^\circ$ range about wings level.

Heading hold is provided inside the $\pm 5^\circ$ roll attitude range for airspeeds above 140 knots if gear and flaps are up or above 0.3 Mach if the gear is down or if STOL flaps are selected (but not both). Heading hold is inhibited at all airspeeds if both the gear is down and STOL flaps are selected. With heading hold inhibited, roll attitudes within $\pm 5^\circ$ are rolled to wings level.

Neither pitch nor roll attitude capture will occur for attitudes which exceed one or both of the $\pm 30^\circ$ pitch attitude or the $\pm 60^\circ$ roll attitude ranges.

The AFC switch will remain engaged, however, the pilot must control the aircraft in both pitch and roll as in the SAS mode until the attitudes are within both limits.

No cockpit indication is given to the pilot when he has maneuvered the aircraft outside the attitude capture limits.

With the AFC engaged, mild stick vibration or chatter in pitch may occur during landing approach due to abrupt movement of the forward reaction control valve caused by flight control computer noise. This is normal and should be disregarded.

At airspeeds below 50 knots, the roll attitude range is restricted to $\pm 20^\circ$ and the roll to wings level action extends to the full $\pm 20^\circ$ range. The pitch attitude capture and hold action is restricted to the $+3^\circ$ to $+12^\circ$ range.

Pitch attitudes outside this range but within -15° to $+20^\circ$ will be driven to the nearest of the $+3^\circ$ to $+12^\circ$ range boundaries.

The AFC switch will disengage and reversion to the SAS mode will occur if either the $\pm 20^\circ$ roll attitude range or the -15° to $+20^\circ$ pitch attitude range is exceeded. If the true angle of attack exceeds $+15^\circ$ with the airspeed greater than 60 knots, the AFC mode will be disengaged and reversion to the SAS mode will occur.

Automatic pitch and roll trim are provided the AFC mode. The automatic trim tracks the aircraft pitch and roll changes to keep the series servo actuators close to their neutral positions an effort to minimize disengage transients.

On aircraft with departure resistance, the lateral stick to aileron interconnect may prevent the roll auto

trim from keeping the aileron series servos near the center of the $\pm 6^\circ$ range.

The automatic trim rates correspond to approximately 0.25° per second stabilator and aileron surface rates and cause the control stick to move in the direction the trim change.

AFC Mode – AFC and ALT HOLD Switches Engaged

The ALT HOLD switch permits selection of altitude hold in place pitch attitude hold in the AFC mode.

The AFC switch must be engaged in order for the ALT HOLD switch to be engaged.

In addition, the airspeed must be greater than 160 knots and the climb or descent rate must be less than 2,000 feet per minute for the ALT HOLD switch to be engaged.

Altitude hold may be manually disengaged by “clicking” the pitch manual trim button as well as by turning the panel switch off.

The operation of the roll attitude hold, heading hold and automatic pitch and roll trim is identical that with the AFC switch only engaged. If either the pitch attitude limits of $\pm 30^\circ$ or the roll attitude limits of $\pm 60^\circ$ are exceeded, the ALT HOLD switch will be disengaged and reversion to the AFC mode without altitude hold will occur.

The ALT HOLD and AFC switches will also disengage if the displayed AOA exceeds $+16^\circ \pm 1^\circ$.

Altitude hold is also monitored by logic which will disengage the ALT HOLD switch and revert to AFC without altitude hold if any of the following events occur:

1. The altitude hold does not lock on to an altitude reference within ± 250 feet following manual engagement of the trim switch or following interruption of altitude hold by longitudinal stick forces exceeding 1 pound.

An altitude reference is established when the altitude rate is driven below 500 feet per minute by the altitude hold synchronization.

2. An excursion in altitude which differs by more than ± 250 feet from the altitude reference.
3. The altitude changes due to stick or trim inputs by a cumulative total of more than ± 250 feet following establishment of an altitude reference.
4. The altitude rate exceeds 2,000 feet per minute or the airspeed falls below 160 knots.

Maneuvering Flight In AFC Mode

The AFC mode includes a pitch and roll control stick steering (maneuvering) capability with the AFC switch engaged.

The pilot can use the control stick and the manual trim switch to maneuver the aircraft and lock the AFC onto new pitch attitude, roll attitude and heading references without disengaging the AFC switch during the maneuvers.

Pilot applied longitudinal and lateral stick forces in excess of approximately 1 pound interrupt the attitude and heading hold functions and inhibit the pitch and roll automatic trim allowing the aircraft to be maneuvered as in the SAS mode. Just as in SAS mode maneuvering, the pilot must trim out any stick forces prior to releasing the stick.

This is important because the auto trim capability may have been exceeded when significant trim changes were made as a result of maneuvering.

Small attitude changes can be made with stick forces below the 1 pound level by inducing aircraft motion with small stick inputs and “clicking” the manual trim switch.

Activating the pitch and roll manual trim switch interrupts the attitude and heading hold functions and automatic trim so that “clicking” the trim switch has the effect of updating

the attitude hold references to the current aircraft attitudes. If altitude hold is engaged, changes in the roll attitude can be made in the same manner. “Clicking” the pitch manual trim switch disengages the ALT HOLD switch which provides a convenient method for reverting to pitch attitude hold for making altitude changes.

ALT HOLD shall be disengaged whenever any pitch maneuvering is done. The ALT HOLD switch must be turned back on to re-engage altitude hold at the new altitude.

Heading changes can be made by banking outside the $\pm 5^\circ$ roll attitude range to interrupt the heading hold and Rolling to wings level on the new heading. Small heading changes of a few degrees can be made without banking by sideslipping the aircraft to the new heading with the rudder pedals, “clicking” the roll manual trim switch to capture the new heading reference, and slowly releasing the rudder pedal input to minimize the heading transient.

Attendency to hold a heading in a slight bank is indicative of a steady heading sideslip due to rudder mis-trim. This can be corrected by trimming the rudder.

AFC mode interrupts by stick force and manual trim switch inputs operate independently in pitch and roll within the AFC mode attitude limits of $\pm 30^\circ$ in pitch and $\pm 60^\circ$ in roll above 50 knots and -15° to $+20^\circ$ in pitch and $\pm 20^\circ$ in roll below 50 knots.

The pilot can maneuver the aircraft in pitch without affecting the roll attitude hold and heading hold functions or maneuver in roll without affecting pitch attitude or altitude hold.

During significant aircraft trim changes, such as those produced by engine nozzle rotation and aileron droop, the action of the AFC mode is to hold the aircraft pitch and roll attitudes.

The automatic pitch trim adjusts for the longitudinal trim change and the automatic roll trim adjusts for any roll trim changes due to asymmetric effects.

If the pilot opts to control the aircraft manually during such trim changes, the attitude hold and automatic trim functions will be inhibited and it will be necessary to retrim the aircraft manually in pitch and roll to smoothly restore the attitude hold functions.

Rapid acceleration or deceleration with asymmetric loaded stores may cause aircraft roll rates that exceed the response capability of AFC roll trim.

If this happens the pilot should take control of the aircraft until the acceleration or deceleration is over, manually trim the aircraft and then reengage AFC.

On aircraft with departure resistance, at the AOA where departure resistance becomes effective, a slow transition between AFC and departure resistance occurs.

Preflight Initiated Built-In-Test

With the weight-on-wheels and engine rpm less than 40 percent, preflight IBIT is initiated by pressing MENU, BIT, SAAHS on the DDI. Preflight IBIT tests all SAAHS functions which can be automatically checked. Pressing the paddle switch or increasing the rpm above 40 percent will stop the IBIT test.

In-Flight Monitor

The IFM operates when power is applied to the flight control computer. It checks series servo actuators, the flight control computer, rate sensors, accelerometers, plus data received from the air data computer and inertial navigation system.

If the IFM detects a failure it will usually shut off the affected axis except that the departure resistance SAS is usually reconfigured when a failure is detected. The AFC and ALT hold will be disengaged if engaged when a failure is detected.

A reset may be attempted by placing the AFC switch to RESET. If the failure was transient, the system will reset and the lost functions will again be available.

Q-Feel Switch

The Q-feel switch on the SAAHS panel is not part of the SAAHS.

Longitudinal control feel is provided by a hydraulic Q-feel unit powered by the HYD1 system and a non linear spring unit.

The spring unit provides stick forces independent of airspeed up to 165 knots.

Above 165 knots, the Q-feel unit increases stick forces as airspeed increases.

Hydraulic supply for the Q-feel is controlled by a valve which is energized open by the air data computer at 165 knots.

The Q-feel system may be shut off by placing the Q-feel switch, on the left console, OFF.

With the Q-feel off, airspeed over 500 knots may cause a pilot induced oscillation (PIO).

A bobweight is installed on the rear bellcrank which controls the stabilator actuator control valve.

The addition of the bobweight to the longitudinal flight control system improves the pilot's stick feel forces and the aircraft's pitch flying qualities.

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