Section - III
SYSTEMS DESCRIPTION

Sub-section 7
STALL WARNING/IDENTIFICATION

Table of Contents

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GENERAL

NOTE: This section applies to 800XP Pro Line 21 airplanes prior to Serial No. 258675. For airplanes Serial Nos. 258675 and subsequent, refer to Section VIII SUPPLEMENTS for Supplement P/N 140-590032-0041.

A stall warning and identification system is provided to emphasize the airplane's natural cues available at the point of stall.

The system functions are

- Stick shaker (warning)
- Stick pusher (identification)

The system consists of

- Two sensing channels, each utilizing an airflow angle sensor vane.
- Two Signal Summing Units (SSUs).
- Two stick shaker motors.
- A hydraulic operated actuator with two electro-hydraulic valves.
- A third sensing channel, which utilizes pitot pressure from the right pitot head, static pressure from the forward static plates and stall vent pressure from the left and right stall vents.
- A stall identification sensor.
- Annunciators and test switches.

SYSTEM LOGIC

1. It is impossible for a stick push to occur before a stall warning (stick shake).
2. No single active fault of an SSU or relay can cause the operation of a stall valve or the associated red STALL VALVE annunciator.
3. The autopilot is disengaged when a stall warning signal is initiated. This prevents the autopilot from attempting to counteract the resulting stick shake operation or a subsequent stick push.

CONTROLS and ANNUNCIATIONS

System faults are indicated on two groups of amber annunciators, one per pilot.

Three STALL switches are located in the TEST section of the overhead roof panel. Anti-icing heating of the airflow sensor vanes is controlled from the PITOT/VANE HEAT switches.

Indication of failure of the vane heaters is provided by the two amber L and R VANE HTR FAIL annunciators also located on the overhead roof panel and by the ICE PROT repeat annunciator on the MWS panel.

There are no control switches, the stall warning part of the system becomes armed on takeoff (no weight-on-wheels), while the stall identification part of the system becomes armed 6 seconds after takeoff.

OPERATION

STALL WARNING SYSTEM

The stall warning system uses an electrically driven stick shaker on each control column to provide a physical warning of an approaching stall to the pilots.

Angle of attack is derived from two electrically heated airflow angle sensor vanes mounted one on each side of the forward fuselage. Electrical signals proportional to vane angle are sensed in the associated Signal Sensor Unit which also receives inputs relating to flap angle. From the flap angle signal, the SSU calculates the point of stall warning. When the vane angle corresponds to that point the SSU provides an output to operate the stick shaker motor on each control column.

The stall warning system is inhibited while the airplane is on the ground with weight-on-wheels to prevent wind gusts triggering false stick shaker operations. At takeoff, the system is armed and begins monitoring the pitch attitude of the airplane.

STALL IDENTIFICATION SYSTEM

The stall identification system uses a hydraulic stick pusher to force the control column forward (pitch down) at the calculated point of stall. The stick pusher is powered by main hydraulic system pressure (backed by the main accumulator), the rate of operation being controlled by a fluid restrictor.

Control of the hydraulic pressure to the stick pusher is via two independent stall valves (A and B), connected in series and mounted integral with the stick pusher. Both stall valves must be open to activate the unit.

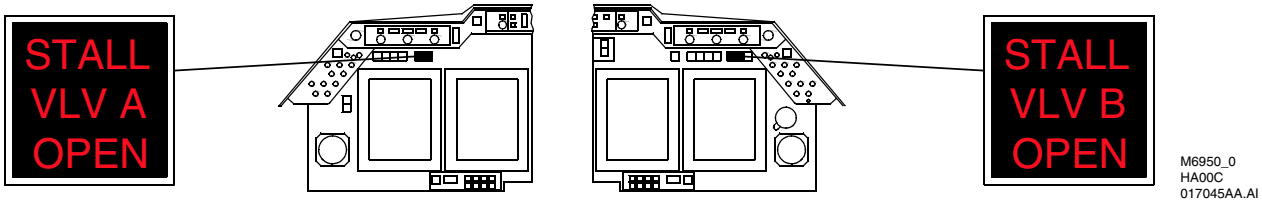


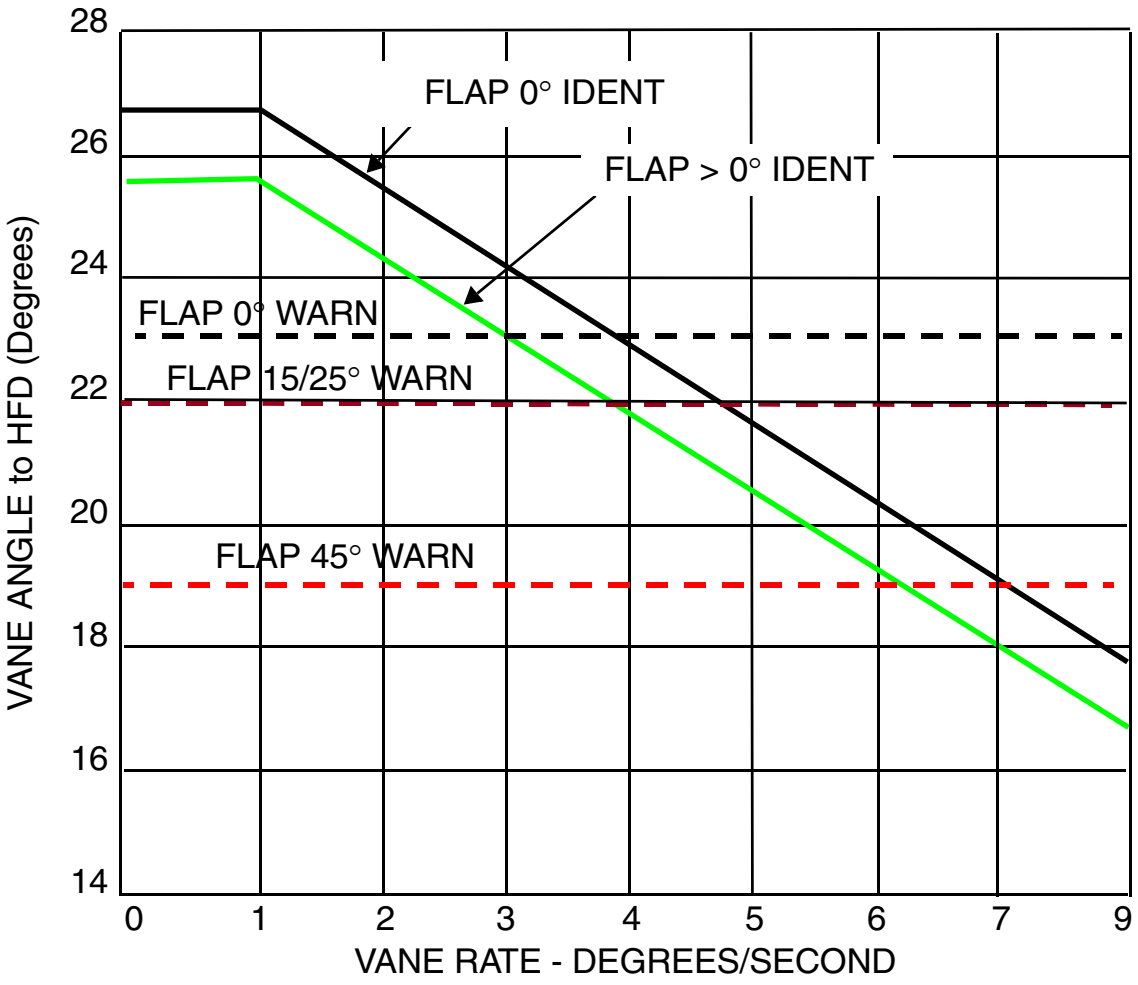
Figure 1
Stall Valve Annunciators

The output from one SSU energizes one stall valve, and an associated red STALL VLV (A or B) OPEN annunciator is illuminated to indicate that the valve is being signalled to open (reference Figure 1).

The SSU uses the vane sensor and flap angle inputs to calculate the point of stall. The rate of increase of vane angle may also modify the calculation, i.e. the point of stall being advanced when the rate of increase is high dynamic stall (reference Figure 2).

When the vane angle agrees with the calculated point of stall, the SSU produces an output (stall identification) to energize the associated stall valve and annunciator.

When a SSU produces a stall warning output, which is then followed by an identification signal, the warning signal latches the stall identification relay for the same channel (reference Figure 3). A warning signal from either channel will disconnect the autopilot and operate the stick shaker. The latch is removed when the warning output ceases. This makes sure the stick push is maintained until the airplane has reached a nose-down attitude well below the stall point.



NOTE: HFD is the Horizontal Fuselage Datum.

Figure 2
Variation of Stall Identification Angle with Rate of Increase of Vane Angle

THIRD STALL IDENTIFICATION CHANNEL

A third channel for stall identification is provided by a pitot/static system which uses pitot pressure (P2) from the right pitot head, static pressure (S6) from the forward static vents and a vent pressure (V) from left and right stall vents. The stall vents are located on the under-side of the left and right wings (reference Figure 4).

These pressures are sensed by a capsule operated stall detector, which is set to produce an output at a point between the settings for the stall warning and identification signals from the SSUs.

The output from the third channel sensor energizes a relay which connects the stall identification output from one channel's SSU to the stall valve of the other channel. Thus, with the third channel output activated, both stall valves A and B will open following a stall identification output from only one SSU, thereby ensuring system integrity should a SSU fail.

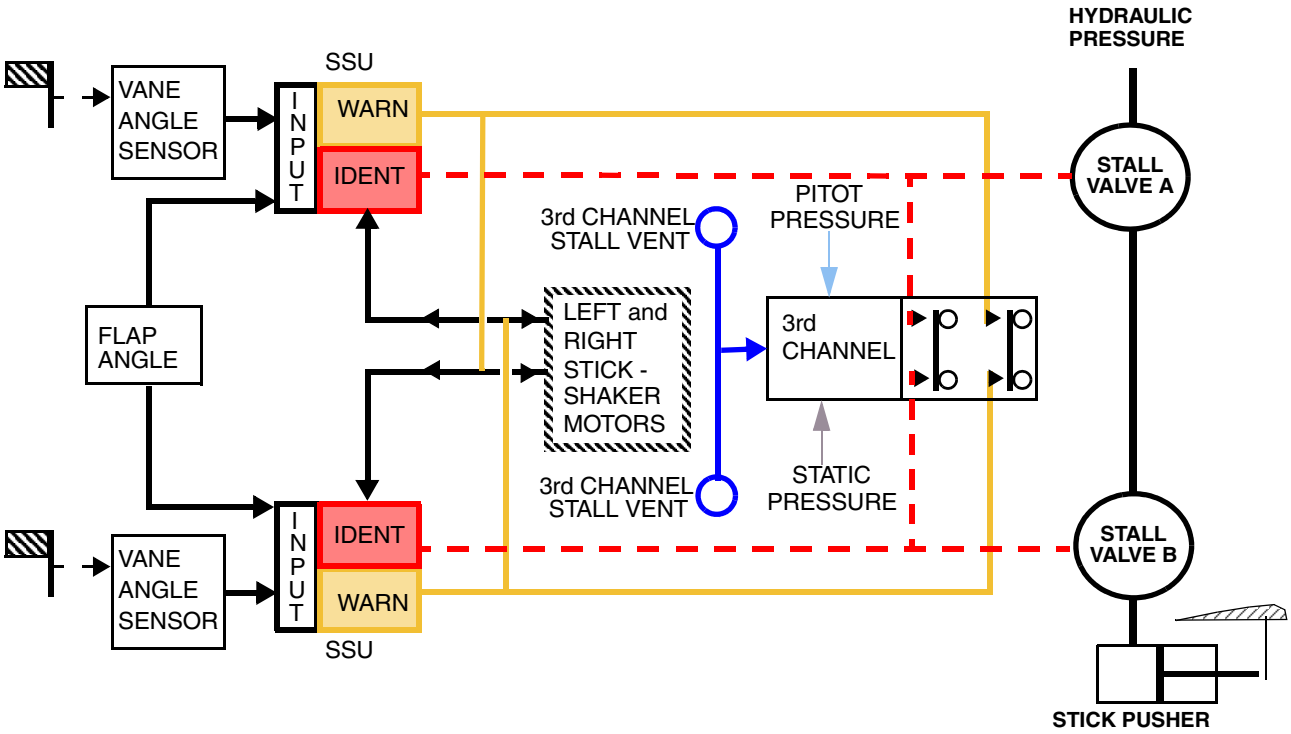


Figure 3
Stall Warning and Identification

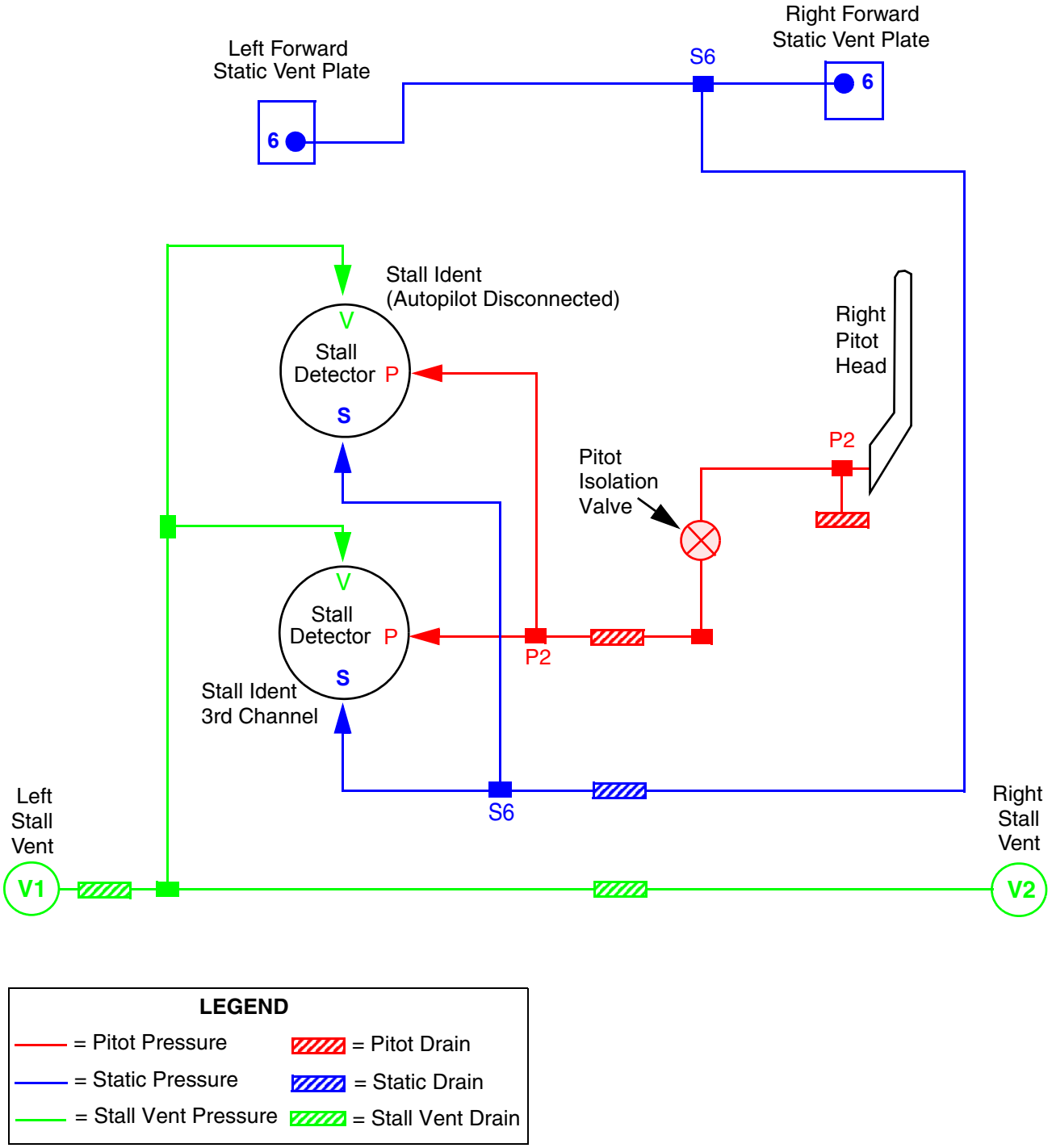


Figure 4
Stall System Pitot Static Block Diagram

SYSTEM FAULTS and ANNUNCIATIONS

The duplication of the stall warning system makes sure a single passive fault cannot prevent a stick shake occurring. Should an active fault develop, the faulty system can be isolated via the appropriate circuit breaker.

The remaining good system will still operate both stick shaker motors. The stall identification system is designed that a single active fault cannot give an inadvertent stick push, while making sure a single passive fault would not prevent a push operation occurring, when required.

All annunciator warnings in the stall warning and identification system will also cause a repeater STALL IDENT annunciator on the MWS panel to illuminate (reference Figure 5). The power to energize a stall valve is routed via the identification relay of one channel and the warning relay of the other channel.

A monitoring circuit will cause an IDENT 1 or IDENT 2 annunciator (depending on the channel at fault) to be illuminated after a 4 second time delay, if an identification signal from one SSU has been triggered without a warning signal from the other SSU.

The IDENT 1 or IDENT 2 annunciators are part of the IDENT/INHIB switches provided for both pilots. When an IDENT annunciator illuminates, either pilot can push the associated switch to inhibit the faulty channel. The INHIB annunciator part of the switch will then illuminate. The third channel sensor, together with the remaining SSU would provide a stick push operation when required.

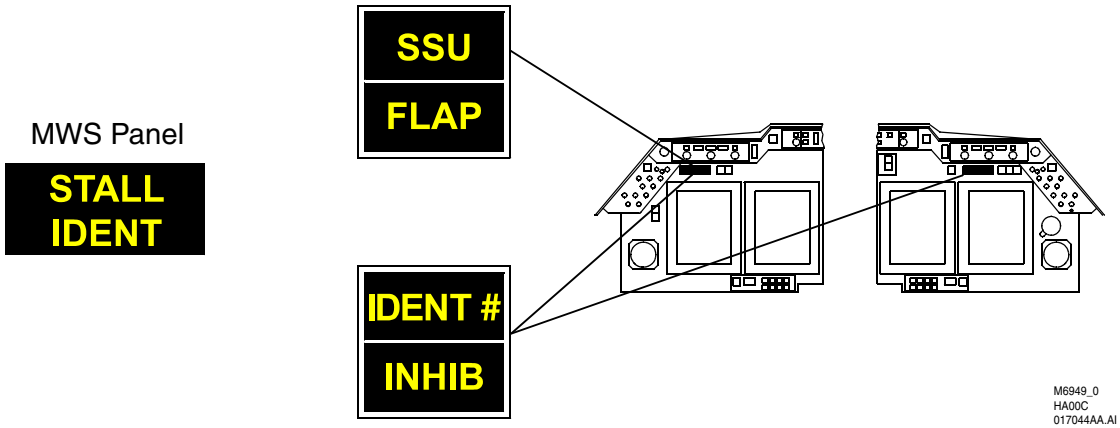


Figure 5
System Fault Annunciators

The pilots may attempt to reset the failed channel by operating an INHIBIT RESET switch located on the stall diagnostic panel (forward side of the Pilot's bulkhead).

Should the channel fail again after reset, it should be inhibited and left in that condition for the remainder of the flight.

FLAP ASYMMETRY

If asymmetry between the left and right flap positions exists for more than 2 seconds, then the FLAP annunciator (Pilot's group only) will illuminate.

WEIGHT-ON-WHEELS ASYMMETRY

If asymmetry between the positions of the left and right weight-on-wheels relays exists for more than 4 seconds, then a SQUAT annunciator (Copilot's group only) will illuminate.

SSU SELF TEST

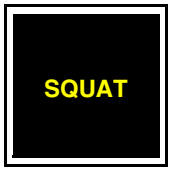
A built-in test within the SSU detects the following faults:

- Loss of 26 VDC supply
- Loss of internal power or short circuit
- Loss of airflow angle sensor excitation
- Loss of flap position input
- Airflow angle sensor transformer winding open or short circuit

If any of the above occur, an external relay causes a SSU annunciator to illuminate. If the weight-on-wheels switch is in the flight condition, a magnetic indicator associated with the faulty SSU will display white. The magnetic indicators are located on the stall identification diagnostic panel.

SYSTEM ANNUNCIATORS

Table 1: Summary of Annunciators

Function	*Annunciator*		*MWS Panel*
Airflow angle sensor left or right vane heating malfunction	VANE HTR FAIL L (R)		
Flap position asymmetry	FLAP		
Stall identification channel 1 (2) (3) fault	IDENT 1 (2) (3)		
Signal Summing Unit fault	SSU		
Weight-On-Wheels asymmetry	SQUAT		
Stall valve A (B) operating	STALL VLV A (B) OPEN		

SYSTEM POWER SUPPLIES

Table 2: Power Supplies

Panel Location Row/Column	*Circuit Breaker*	*Circuit or Equipment*	*Busbar*
DA-D B/1	STALL IDENT 1	26 VAC input to SSU 1	XS 1
DA-D B/4	STALL VLV A	28 VDC to stall valve 1 and annunciators	PS1(a)
DA-D B/6	STALL WARN MOTOR 1 (LH)	28 VDC to stick shaker motor 1	PS1(a)
DA-D B/2	STALL IDENT 2	26 VAC input to SSU 2	XS 2
DA-D B/5	STALL VLV B	28 VDC to stall valve 2 and annunciators	PS2(a)
DA-D B/7	STALL WARN MOTOR 2 (RH)	28 VDC to stick shaker motor 2	PS2(a)
DA-D B/3	STALL IDENT 3	28 VDC to SSU 3	PE

STALL WARNING and IDENTIFICATION LOGIC (Figure 6)

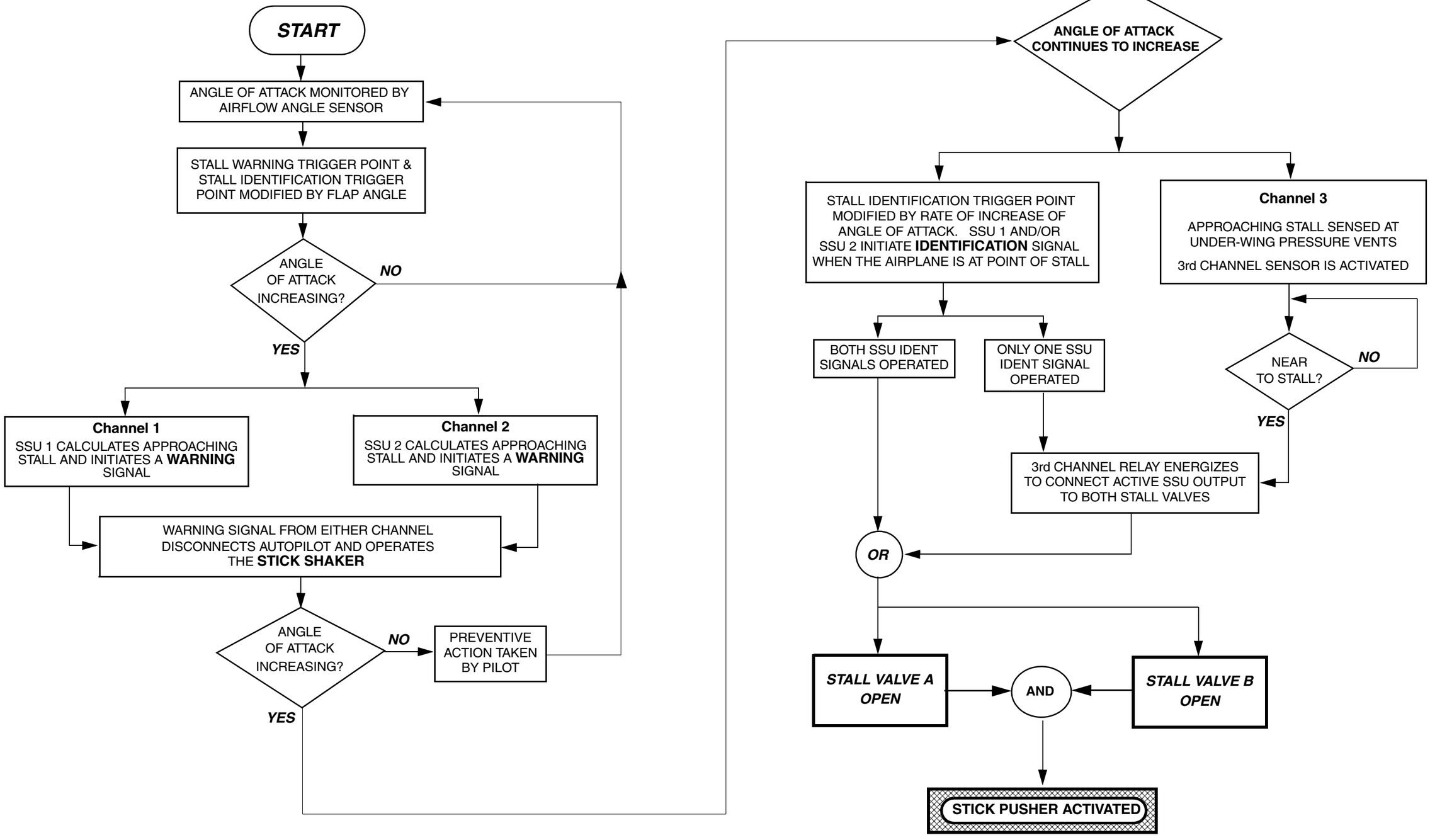


Figure 6
Stall System Flow Logic

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