

DCA24FA017

OPERATIONAL FACTORS/HUMAN PERFORMANCE

Attachment 14

Hawker Trim and Rudder System Guidance

January 24, 2025

A trim jack positions the left aileron trim tab operating rods that move the tab. Two rods connected to the right aileron inboard hinge move the right tab. When either aileron moves, the operating mechanism moves that aileron's geared tabs in an opposite direction. Total tab movement is $11^{\circ} 54' \pm 1^{\circ}$ up and $9^{\circ} 48' \pm 1^{\circ}$ down from neutral.

Aileron Trim

A trim box on the pedestal controls the left aileron trim tab. Trim tab movement is approximately 12° up and 10° down from neutral. The trim box consists of a handwheel that drives a cable drum through a shaft. A scroll plate pinned to the shaft has helical grooves that move a pointer that corresponds to trim tab position.



Figure 5E-7: Aileron Trim Box

Rotating the handwheel left or right from neutral rotates the cable drum. Cables and chains then transmit drum movement to a sprocket on the left wing rear spar. As the sprocket rotates, the trim jack moves linearly to move the trim tab up or down through two adjustable connecting rods.

Elevators

The elevators provide primary control of the aircraft in the pitch axis mechanically through control column movement or electronically through the autopilot elevator servo.

Each elevator attaches to the horizontal stabilizer rear spar with three hinges. Leads at the intermediate and outboard hinges bond the control surface to the aircraft structure. Primary stops (up and down) on the intermediate hinges of both elevators limit elevator movement to $24 \pm 0.5^\circ$ up and $9.12 \pm 0.5^\circ$ down from neutral.



Figure 5E-8: Elevators

Normally, the primary stops limit total elevator movement. If the primary stops are mis-adjusted, secondary stops under the cockpit floor limit elevator movement.

In response to control column or elevator servo inputs, the elevator quadrant in the vertical stabilizer moves the elevators up and down through two operating levers attached to the master hinges.

Elevator Trim

Each elevator has a mechanically operated trim tab controlled by a trim box on the left side of the pedestal and an electric trim motor under the pilot's seat pedestal.

The left and right elevator trim tabs also function as geared tabs. When the elevator moves up or down from the neutral position, offset position of the trim tab operating rods drives the geared tabs in the opposite direction.

A microswitch in each trim jack monitors elevator trim setting. If the elevator trim is set outside the takeoff range with weight-on-wheels, advancing the throttles above the 60% N_1 RPM position causes the microswitches to illuminate the MWS panel amber ELEV/AIL TRIM annunciator. Setting elevator within the takeoff setting range extinguishes the annunciator.

Manual Pitch Trim

The manual pitch trim system consists of a trim box that drives a trim jack on each horizontal stabilizer rear spar through cables, chains, and sprockets.

The trim box consists of a handwheel, shaft, scroll, pointer, tumblers, and tumbler stop faces. Rotating the handwheel turns a sprocket on the other end of a shaft.



Figure 5E-9: Manual Pitch Trim System

Six tumblers and stop faces limit trim tab movement and limit handwheel movement to 3.38 revolutions stop-to-stop. A helically grooved scroll drives a trim tab position pointer that moves across a graduated scale above the handwheel.

Rotating the handwheel turns the trim box sprocket. From this sprocket, chains and cables transmit handwheel motion to a sprocket on each horizontal stabilizer rear spar.

Through a shaft, each sprocket drives a non-reversible, screw-type trim jack. As the sprocket rotates, the trim jack extends or retracts to move the trim tab up or down through two adjustable rods.

Electric Pitch Trim

The electric pitch trim system uses the same operating mechanism as the manual pitch trim system. It consists of a PE bus-powered electric servomotor that drives the pitch trim system through a coupling that drives a shaft and sprocket under the pilot's seat pedestal. With the autopilot engaged, a double-pole switch on each control wheel controls the system. Each switch has a separate toggle for each pole with a movable latch that interconnects the toggles. System design prevents servomotor operation with only one toggle moved up or down.



Figure 5E-10: Electric Pitch Trim System

The electric trim system operates at different speeds, depending on flap lever position. With the flap lever in UP, the servomotor operates at slow speed. With the flap lever in any other position the servomotor operates at the fast speed (approximately twice the slow rate). Actuation of the flap lever operates a cam and lever, which in turn activate a microswitch that regulates electric trim system operating speed. Engaging the autopilot automatically isolates the pilot input to the electric trim system.

To check electric trim system operation, operate the split trim switches in both directions to verify the trim system moves in the appropriate direction. Raise the switch guard and operate each half of the switch; there should be no trim wheel movement. If the trim wheel moves, the system is unserviceable.

Mach Trim System (800XP)

During high-speed flight with the autopilot disengaged, the Mach trim system automatically adjusts elevator trim to stabilize the aircraft. This system receives Mach number data from the Air Data Computers (ADCs) and elevator trim position data from the electric trim servomotors. Supplied with this data, the Mach trim computer adjusts elevator trim via the electric trim servomotor.

Manually adjusting elevator trim with the trim wheel interrupts Mach trim system operation. The Mach trim system also disengages with autopilot engagement, operation of the trim wheel or electric trim switches, or if aircraft speed falls below the Mach number activation point. Loss of 28 VDC power also disengages the system. If the Mach trim system fails, the MWS panel amber MACH TRIM FAIL annunciator illuminates.

Rudder

The rudder, hinged to the vertical stabilizer rear spar, provides directional control about the vertical (yaw) axis. Full range of motion is $28 \pm 0.5^\circ$ left and right of neutral. A geared anti-servo tab (upper) and a geared anti-servo and trim tab (lower) hinged to the rudder's aft spar move in the same direction as the rudder to provide anti-servo action. The rudder is of conventional construction with aluminum alloy skins riveted to a main and trailing edge spar and ribs.

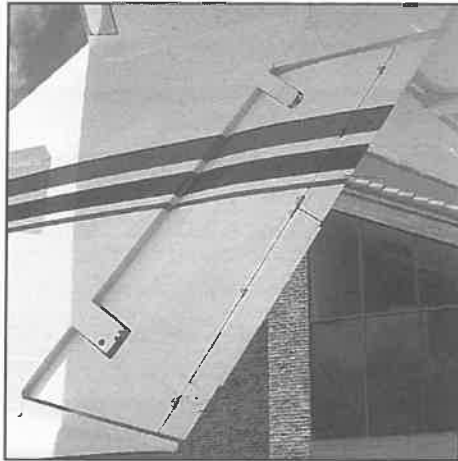


Figure 5E-11: Rudder

Top and bottom hinges secure the rudder to the vertical stabilizer rear spar. Adjustable primary stops on the rudder contact fixed stop plates on the bottom hinge to limit rudder travel. Secondary rudder stops are on the rudder pedal assemblies.

The rudder pedals move the rudder through connecting rods, a bellcrank, and a pulley drum under the cockpit floor. From the pulley drum, cables transmit pedal motion to a rudder quadrant attached to the rudder torque tube. A spring strut on the torque tube provides rudder centering action and an increasing control force, as rudder deflection increases. The autopilot rudder servo drives the rudder through cables attached to the rudder quadrant.

A pivot lever attached to the top hinge drives the geared tab in the same direction as the rudder through an adjustable rod. A fairing on the tab covers the rod and attach point.

A pneumatically powered rudder bias system counteracts asymmetric thrust by automatically deflecting the rudder toward the operating engine.

Rudder Trim

The manually operated rudder trim system deflects the geared anti-servo trim tab on the rudder. A rudder trim box in the pedestal connects through cables, chains, and a sprocket to a sprocket in the vertical stabilizer. The sprocket drives a non-reversible trim jack mounted to the aft side of the rear spar; the trim jack moves in and out to move the trim tab with two adjustable rods.

The trim jack to rudder hinge relationship moves the trim tab to provide anti-servo action when the rudder deflects.

Rotating the rudder trim handwheel on the top of the pedestal turns a cable drum through a shaft. Five tumblers freely rotate around the shaft to limit trim tab deflection and handwheel travel to 4.6 revolutions stop-to-stop. A helically grooved scroll plate pinned to the shaft drives a pointer that shows tab position against a graduated scale.



Figure 5E-12: Rudder Trim System

Rudder Bias System

The rudder bias system automatically reacts with rudder movement if an engine failure or malfunction occurs. A spring strut reduces the rudder bias effect at large rudder deflections.

Engine bleed air from the LP stage of each engine drives the rudder bias system. LP bleed air from each engine travels to opposite ends of a double-acting pneumatic strut. Under symmetrical power conditions, the LP bleed air pressures balance within the struts, resulting in no net rudder input. Under asymmetric power conditions, air pressure differential between the engines operates the pistons so the rudder moves to counteract the asymmetric thrust.

NOTE: The rudder bias switches must be ON and the systems operative during each takeoff.

A guard cover holds the RUDDER BIAS switches ON to prevent inadvertent shutoff. With one or both RUDDER BIAS switches OFF, an amber RUDDER BIAS annunciator illuminates. With one switch OFF, the rudder bias system produces less assistance.

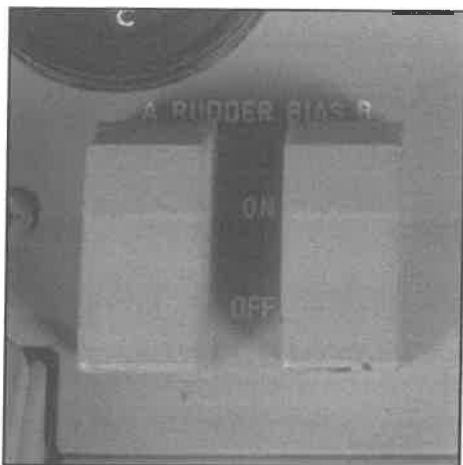


Figure 5E-13: Rudder Bias Switches with Guards Closed

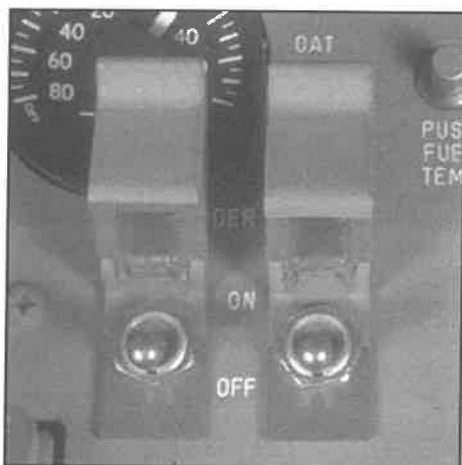


Figure 5E-14: Rudder Bias Switches

During flight with both switches OFF, no rudder bias assistance is available.

Two electrically heated elements embedded in a muff prevent strut icing (see Ice and Rain Protection).

Both rudder bias systems must be operative before takeoff. Check the rudder bias system while taxiing. Place both RUDDER BIAS switches in OFF then advance the left throttle to about 80% N_2 RPM. The rudder pedals should not deflect. Continue by placing the A switch ON with the B switch OFF then placing the A switch OFF and the B switch ON.

The rudder bias system should deflect the rudder in the appropriate direction to counteract asymmetric thrust from the left engine. Close the left throttle and repeat the same test for the right engine. After checking the system, place both RUDDER BIAS switches ON and close their guards.

Stall Warning and Identification

If the aircraft angle-of-attack approaches the stall, the stall warning and identification system shakes the control columns (stick shaker) to warn the flight crew. If aircraft angle-of-attack continues to increase, the system pushes both control columns forward (stall identification). This action pitches the aircraft nose down to decrease the aircraft angle-of-attack and thus, prevent a stall.

The stall warning and identification system is a two-channel system that uses a third channel (Hawker 800 and most Hawker 800XP but not the later models) to provide stall identification only. The first two channels each consist of a Signal Summing Unit (SSU) that receives inputs from an airflow angle sensor (stall vane) on the forward fuselage and flap position transmitters. Flap setting has a direct effect on the point where the stall warning and identification occur.

System logic prevents inadvertent operation of the stall identification system. A stick push cannot occur before stick shaker operation and no single active fault of an SSU or relay can result in stick pusher operation. System logic also disengages the autopilot during stick shaker and pusher operation to prevent the autopilot fighting the system.

The SSUs operate on 115 VAC provided by the XS1 and XS2 buses, while the PS1 and PS2 buses power the stick shaker motors. Main hydraulic system pressure powers the stall ident unit (stick-push actuator).

Stall Warning

Each SSU receives inputs from its stall vane, flap position switches, and weight-on-wheels relays. With weight-on-wheels, the stall warning system is inhibited to prevent erroneous stick shaker operation caused by wind gusts moving the stall vanes.

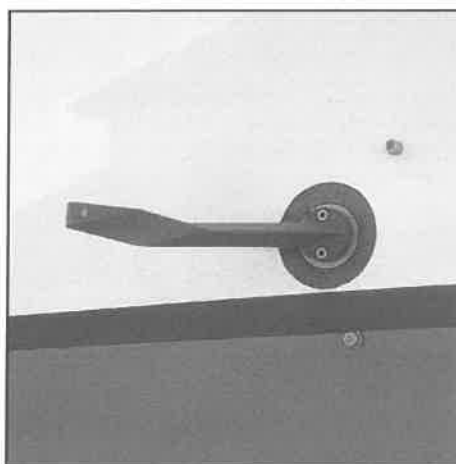


Figure 5E-15: Stall Vane

After takeoff, the weight-on-wheels relays provide an in-air input to the SSUs. The SSUs arm and, provided with flap position (0° , 15 to 25° , or 45°), calculate the necessary stall warning point. The stall warning occurs at a safe margin before actual aircraft stall.

When angle-of-attack reaches the warning level, the SSUs energize their associated warning relay.