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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

EXCERPTS FROM:
B-737-300/400
PILOT'S HANDBOOK
TRAINING

AIRPLANE TRIM TECHNIQUE

The following procedure outlines the steps to be taken when correcting an out-of-trim condition:

- Disengage autopilot.
- Check for engine thrust asymmetry, adjust N_1 as necessary to set even thrust.
- Check lateral fuel balance and redistribute fuel load as required. (A lateral unbalance will appear as a roll input.)
- Set aileron and rudder trim to zero.
- Level the wings with the control wheel, using attitude indicators, natural horizon or a combination of both. DO NOT TRIM.
- With wings held level, notice any turning tendency. Stop the turn with smooth rudder application and apply rudder trim to relieve rudder pedal force. (Heading bug can be used as a reference for turn determination.)
- Trim out wheel force with aileron trim. The wheel should be approximately centered for a normal (in-rig) airplane.
- Re-engage autopilot.

TURNS WITH AND WITHOUT SPOILERS

Turns at varying bank angles will be accomplished at high speeds and at maneuvering speeds. The trainee should note that in banks exceeding 30° the angle of attack is more nose-up at slow speeds than at high speeds and more power may be required to maintain speed. Also, relatively small pitch variations at high airspeeds cause large changes in rate of climb indications.

Turn practice improves trainee's smoothness, instrument scan pattern, ability to keep airplane in trim, and altitude and airspeed control.

Initiate roll rates not to exceed 30° bank angle at 300 knots with the spoilers ON or OFF. Note that with the spoilers ON, the roll rate is approximately double that with the spoilers OFF.

PARTIAL SPEED BRAKE

To make the trainee aware of the effect of double action spoiler while using partial speed brake, turns should be initiated while using partial spoiler, and partial spoiler should be applied while in a turn. The greatly increased roll rate and lateral sensitivity will be obvious. Use of speed brakes between DOWN DETENT and FLIGHT DETENT can result in rapid roll rates and is not recommended.

NOTE: Do not use FULL UP position in flight.

M_{MO} & HIGH SPEED BUFFET

Set MCT (Maximum Continuous Thrust) and accelerate to M_{MO}. If a shallow dive is required to reach M_{MO}, establish a rate of descent as required.

High speed buffet will occur at approximately Mach 0.78 to 0.82. This is caused by air separation over the wing due to the high Mach number. Rolloff at high Mach may also occur when buffet is felt if the airplane is trimmed with a small amount of sideslip. Separation over leading wing causes loss of lift, hence the rolloff. This rolloff is easily controlled with aileron. Rudder should not be used to level wings as this may aggravate the rolloff.

Establish airspeed of M.80. Induce buffet by smoothly increasing the bank angle until the buffet is noticable. Increase the rate of descent while increasing the bank angle to maintain airspeed. Do not exceed 45° of bank. If buffet does not occur by 45° of bank, increase control column back pressure until buffet occurs. When buffet is felt, smoothly roll out to straight and level flight. Notice that buffet onset is smooth and gradual and controls are fully effective at all times.

HIGH ALTITUDE APPROACH TO STALL

During training in the simulator, an approach to stall should be demonstrated at FL300 or above in a clean configuration.

At cruise altitudes, compressibility favorably affects the stall pattern of the wing. Separation starts at more inboard locations and at lower angles of attack. This in turn creates a stronger pitch down tendency and an earlier stall warning. Natural stall buffeting occurs prior to actuation of the stickshaker; it is more pronounced and is more easily recognized. The improved buffet warning and increased stall margins due to Mach number effects give greater protection during high altitude flight. Stabilize aircraft at FL300 or above, .74 Mach, autopilot engaged.

Reduce thrust to IDLE and decelerate in level flight. At the first stall warning indication, call "FIREWALL POWER" while advancing throttles, disengage autopilot, lower the nose and accept minimum loss of altitude.

As airspeed increases to 0 maneuvering speed, smoothly increase pitch to maintain 0 maneuvering speed, reduce to normal power and climb back to original altitude. Level off, accelerate to .74 Mach. Do not use flaps during recovery.

MANEUVERS AT MINIMUM SPEED (SLOW FLIGHT)

(Minimum altitude 10,000 feet above terrain in aircraft).

Slow flight maneuvers may be performed during training, if desired. This regime of flight will familiarize the pilot with control characteristics at and below takeoff and approach speeds. Slow flight also provides a good drill for power control versus angle of bank while maintaining a given airspeed.

Determine the gross weight of the aircraft and a V_{REF} speed for flaps 40. Set the "bug" on this speed. Extend gear and slow to appropriate flap speed schedule and extend the flaps to 15. Slow to and maintain "bug" speed (V_{REF} 40 flaps). Perform 15° banks in both directions while climbing and descending. Very little trim is required if aircraft was "in trim" at beginning of maneuver. However, trim should be used when needed. Maneuvering at "bug" speed (V_{REF} 40) is approximately 1.2 stall with flaps 15 and approximately 5 knots above stickshaker speed with flaps 15 in level flight.

STEEP TURNS

(Minimum altitude 10,000 feet above terrain in aircraft).

Steep turns shall consist of a 45° banked turn of 180° or 360° in each direction. Altitude, airspeed, and angle of bank in turn should remain constant. Power is adjusted as necessary to maintain 250 knots.

Establish a 250-knot clean configuration. Trim aircraft for hands off. Start normal, smooth entry. At 30° bank, check airspeed and altimeter trends. Add slight amount of power (300 lbs. fuel flow/engine).

Establish 45° bank and hold it constant. Scan the instrument panel. The primary instrument is the ADI; however, watch for trends on the altimeter, vertical speed indicator, and airspeed indicator. Maintaining constant bank is the key to pitch control.

Lead roll-out heading approximately 15°. Reduce power slightly going through 30° bank on recovery or reversal. The airplane will tend to climb as you roll out of turn. Be smooth, scan. Trimming while turning is optional.

ENGINE SHUTDOWN & RELIGHT

(Minimum altitude 4,000 feet above terrain in aircraft).

Engine shutdowns may be simulated at any time during training or may be actually shutdown at check pilot discretion for training. The throttle should be retarded to idle and the start lever moved to the CUTOFF position. If practicable, idle the engine for 3 minutes before actual shutdown. Maintain heading and altitude. Note windmilling RPM. Initial action items for the ENGINE FAILURE should be commanded by the trainee, then the checklist accomplished as practicable. For restart, the INFLIGHT START CHECKLIST should be used, with all applicable procedures and limitations observed.

APPROACHES TO STALL

GENERAL

NOTE: *In the aircraft, minimum altitude is 10,000 feet above terrain.*

Simulator training may be done at realistic altitudes for arrival, departure, and level flight maneuvering altitudes.

Approaches to stalls will be accomplished using different flap configurations and from straight and level, or level turning flight. The important factor is the trainee recognizing the approaching stall and taking corrective action in time. It is important to know that thrust in jet aircraft has little effect on lowering the stall speed. The stall speed and angle of attack at stall are essentially the same power-on or power-off for jet aircraft.

Configure aircraft for stall to be demonstrated, then stabilize in level flight above trim speed. Reduce thrust and decelerate in level flight. Trim only to trim speed. At the first stall warning indication, call "FIREWALL POWER, CHECK FLAPS*" while advancing the throttles to the mechanical stops. Establish a pitch attitude to maintain level flight, keeping altitude loss or gain to a minimum. Continue accelerating. Maintain the base altitude and begin flap and landing gear retraction as described in the individual stall recovery procedures.

*The flaps shall be checked by the non-flying pilot to ascertain that they are in the desired position, e.g., if the aircraft is in the takeoff phase of flight, check that the proper takeoff flap setting has been selected.

When a normal airspeed for the existing configuration is reached, reduce power to the normal engine operating range. A log book write-up containing the approximate amount of time the engines were operated at FIREWALL POWER must be made. The pilot not flying should insure FIREWALL POWER is attained and should note the engine EGT's and Tach readings.

NOTE: *Flaps do not have to be retracted fully when accomplishing a series of stalls; only on last stall of series.*

An approach to stall in any configuration may be performed while in a 15°—30° bank turn (normally 20°). If only one configuration is used during a check (others waived), it must be in a turn.

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APPROACHES TO STALL (cont'd.)

GENERAL (cont'd.)

For a takeoff configuration stall, set airspeed bugs for a flap 5 takeoff. For a landing configuration stall, set the airspeed bugs for a flap 40 landing.

CAUTION: ***During training in an airplane, the Instructor should limit the engine power used during stall recovery demonstration to go-around N_1. In aircraft training, do not fly slower than computed (anticipated) stickshaker speeds.***

CONFIGURATION						RECOVERY	
Flaps	**Gear**	**Trim Speed**	**Bank**	**Fuel Flow**	**Anticipated Stickshaker**	**Flaps**	**Speed**
0	UP	0 CHART MAN.	0°	1500# F/F	V_{REF} 40 + 35 kts	1	1 CHART MAN.
5	DN	V_2	20°*	2000# F/F	V_{REF} 40	5	V_2
40	DN	V_{REF}	0°	2500# F/F	V_{REF} 40 – 15 kts	15	V_2 for Flaps 15**

* DURING CHECKS WHERE ONLY ONE APPROACH TO A STALL IS REQUIRED, IT MUST BE PERFORMED IN A TURN. IT MAY BE IN ANY CONFIGURATION.

**V_2 FOR 15 = V_{REF} 40.

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APPROACHES TO STALL (cont'd.)

CLEAN STALL BELOW 20,000 FEET MSL

1. Set fuel flow to 1,500 lbs. Trim to 0 chart maneuver speed.
2. At stick shaker, call and apply "FIREWALL POWER, CHECK FLAPS".
3. Pilot not flying sets flaps at 1.
4. Establish a pitch attitude that provides a minimum loss or gain of altitude.
5. Accelerate to 1 chart maneuver speed and reduce power to the normal operating range.
6. Retract flaps on Flap Retraction Speed Schedule.

TAKEOFF STALL

1. Set fuel flow to 2,000 lbs., gear down, flaps 5, and establish a 15° to 30° bank angle (normally 20° bank angle).
2. Trim to V_2.
3. At stick shaker, call and apply "FIREWALL POWER, CHECK FLAPS", roll wings level, and establish a pitch attitude that provides a minimum loss or gain of altitude.
4. Pilot not flying assures that flaps are at the intended setting for takeoff.
5. In level flight, accelerate to V_2 and retract the gear. Reduce power to the normal operating range.
6. Retract flaps on Flap Retraction Speed Schedule.

LANDING STALL

1. Set fuel flow to 2,500 lbs., gear down, flaps 40.
2. Trim to V_{REF}.
3. At stick shaker, call and apply "FIREWALL POWER, CHECK FLAPS" and establish a pitch attitude that provides a minimum loss or gain of altitude.
4. Pilot not flying assures that flaps are at the intended setting for landing.
5. In level flight, accelerate to V_{REF}, retract flaps to 15, and retract the gear. Reduce power to the normal operating range.
6. Retract flaps on Flap Retraction Speed Schedule.

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DUTCH ROLL

(Minimum altitude 10,000 feet above terrain in aircraft).

Dutch roll is characteristic of all swept-wing airplanes. It occurs as a result of excessive "yawing" of the aircraft. It can be induced by the pilot using excessive rudder inputs or by turbulence. Generally, it is a combination of these two factors which upsets the directional stability of the aircraft and causes dutch roll.

If the aircraft is yawed to the right, the left wing (being swept back) advances into the relative wind, thereby increasing lift. At the same time, the right wing is receding and being partially blanked out by the fuselage, thereby reducing lift. This unbalance of lift causes a roll in the direction of yaw. The induced drag of the advancing wing, the exposure of fuselage side area into the relative wind, and the built-in directional stability of the particular aircraft type all act to attempt to return the aircraft to directional and lateral stability resulting in a yaw roll in the opposite direction. The aircraft will continue to "dutch roll" alternately right and left either increasing or decreasing in severity depending on the aircraft type and/or the action of the pilot. The B-737, if left alone, tends to "dampen out" after a few oscillations.

This maneuver is accomplished to afford training in the recognition of dutch roll and the corrective action to be taken.

- Turn the yaw damper OFF.
- Set airspeed bugs to landing reference speed, and establish landing configuration.
- Set power and establish a straight-ahead landing descent of approximately 500 FPM.
- Induce dutch roll by alternately yawing the aircraft left and right, then releasing rudder.

Recovery is accomplished by use of ailerons only by quickly "knocking down" the rising wing with a series of aileron inputs of short duration. Do not use any rudder inputs. After recovery, turn yaw damper ON.

RECOVERY FROM HIGH RATE OF DESCENT

(Minimum aircraft termination altitude — 5,000 feet above terrain in aircraft).

This maneuver shall be demonstrated by each pilot-in-command initially qualifying on turbojet aircraft. It should whenever practicable, be demonstrated in a simulator, rather than in the aircraft.

IT IS INTENDED AS A DEMONSTRATION OF AN UNDESIRABLE LANDING APPROACH PROFILE WHICH SHOULD BE AVOIDED IN LINE OPERATIONS. It appraises the pilot of altitude loss that can be expected with the delay in engine acceleration to a thrust level which will offset the drag of landing flaps with the gear extended. The high sink rate can be experienced with situations such as when engines have been allowed to remain at idle during a long descent at low airspeeds in a high drag configuration.

Determine the gross weight, V_{REF} 40 and go-around N_1. Descend at idle at V_{REF} 40 in landing configuration. At the selected altitude for level off, rapidly advance throttles to go-around thrust position and simultaneously rotate nose up to stop the rate of descent. Hold the airspeed at V_{REF} 40.

Note the time required for engine acceleration, the altitude loss, and the change of attitude required from start of recovery to level off. When engines are spooled up and altitude loss has ceased, maneuver is complete; execute go-around.

NOTE: It is extremely difficult to judge the point at which flare should be initiated from a steep, power off descent near the ground; therefore, they should be avoided.

(cont'd.)

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RECOVERY FROM HIGH RATE OF DESCENT (cont'd.)

- AIRSPEED BUG: V_{REF} 40 FLAP
- N_1 BUG: GO-AROUND N_1
- GEAR: DOWN
- FLAPS: 40

Reduce Power to IDLE.
Allow airspeed to decay to bug speed.
Maintain bug speed.