

The high-aspect-ratio wing is lift-efficient, rather than being optimised for high speed. Mach trim is now a part of the flight-guidance system and comes into operation at $M0.80$. By $M0.83$, response in roll to rudder inputs has reversed, with left rudder inducing roll to the right. "Negative anhedral effect at high speed," said Moss. A faint high-frequency rumble suddenly starts at $M0.825$, but gets no more pronounced up to the M_{MO} of $M0.84$. In turns at $20-25^\circ$ bank, slight buffet occurs, but flight control is unaffected, even when the aircraft is rolling at $10^\circ/s$.

DESCENTS AND STALLS

An emergency descent at idle thrust was made at 4,500ft/min to 15,000ft, with the nose just 5° below the horizon. At $M0.82$, using full airbrake induced buffeting, but lower down, at

320kt, this faded: sudden airbrake operation creates quite a bump.

The MD-90 is well-equipped with protections and warnings as it approaches the stall: autothrottle protection includes speed control above minimum airspeed for each flap/slat setting and below maximum airspeed for any configuration. The fuselage has nose strakes to give directional stability at high alpha, so roll again dominates at low speed, when the roll spoilers make the MD-90 agile. Reversed turns at 180kt felt "looser", but a wing was easily picked up in pre-stall buffet, while the rudder remained very effective.

The first warning of stall onset comes from the stick-shaker, followed by a red light and aural/vocal warning, and the stall is finally corrected by a stick-pusher. The nacelle strakes and large engine pylon assist natural pitch-

down at the stall. The pylon trailing edge also deflects 30° down when the control column is pushed fully forwards: this deflection takes about 2s.

Recovery from an incipient stall at 168kt and 16° alpha, with the stick shaking, was made first with minimum nose-down, gingerly using half thrust at 180kt. Next, in a full stall, I forced the nose down and applied 90% N_1 , following up the electric stick-pusher from 150kt and 19° alpha to recover in 1,200ft. On all fan engines the slower initial response from flight idle is a factor in timing stall recovery. The V2500 reaches full power quickly, in about 6s.

Stall recovery with 28° flap and gear down is aided by the PLI: as usual, it is an excellent guide to recovery attitudes. In this condition, there was light natural buffet from 125kt, the stick-shaker operated at 115kt and recovery from a 103kt push took 600ft. In this stall, the maximum alpha briefly went over 30° .

The slats are fully extended in the flap range $15^\circ-25^\circ$, but only half-extended in the $1^\circ-13^\circ$ range until stall-warning, when they extend fully, with powerful effect. Recommended pilot action at stall warning with the aircraft clean is to select slat out — to reduce stall speed — and call up the PLI display.

At 140kt, with 28° approach flap and full rudder (which required 35kg foot force), a 10° bank could be held steady to up to 20° of sideslip, after which direction wandered slightly.

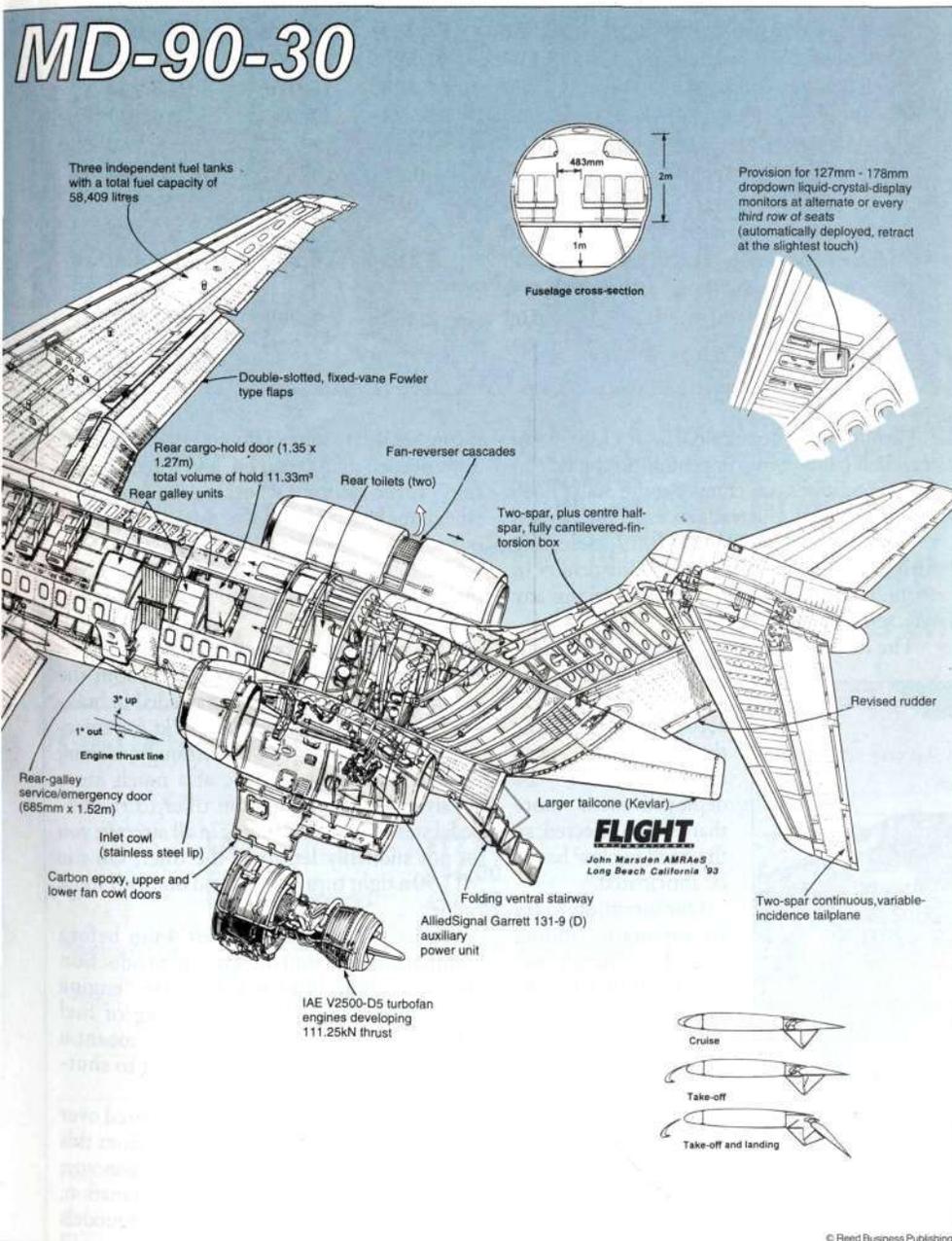
Maximum thrust at 15,000ft and, at 1.63 EPR, was less than sea-level thrust, but a single-engine climb in 15° flap take-off configuration at 117kt stick-shaker speed with half rudder gave an idea of control loads at minimum control speed. There should be ample rudder authority to correct for engine failure on take-off, without any need to bank into the live engine.

APPROACHES

On approach to Palmdale, a 15° eye angle over the nose gave a good 12° view down and ahead. At a weight of 54,500kg, $V_{REF} + 5$ kt approach speed was 138kt. In gusts in the 20kt headwind, the autothrottle added a further 5kt to the approach speed.

Manual flare from 20ft with 28° flap was leisurely with the powered elevator. Touchdown is easy to judge from an eye height of 24ft: the 30° downward view through the side window allows good peripheral vision to assist judgement. With the autothrottle engaged, power starts bleeding off as radio altitude passes 50ft. This worked well even from a flat angle of approach.

On the next approach, we flew through the centreline to Palmdale's runway 07 at 3.5km out, 1,500ft above the runway. In a tight 1200ft/min descending S-turn, with high bank angle, I regained a close high final at 400ft. The ground-proximity warning system muttered a brief reminder on descent rate as I briefly kept high airspeed, to regain the glides-



FLIGHT
John Marsden AMRAeS
Long Beach California '93