AIR-INDIA IS 25

Above, Air-India International Constellation 'Rajput Princess" at London Airport in 1948, the first year of Air-India's international services. Mail and freight are being loaded prior to departure for Bombay—reached in only 22hr elapsed time. Facing page, an Air-India International Constellation in flight

TOMORROW, Air-India celebrates 25 years of international service, since on June 8, 1948, a weekly Bombay-London flight was inaugurated via Cairo and Geneva with one of the airline's first Lockheed Constellations. This was a mere 16 years after the first commercial flight in India, made by J. R. D. Tata (now chairman of Air-India) on a mail service in a Puss Moth, and indicated what has been a major policy of the airline since: to provide the customer with the latest commercially viable equipment available. Air-India was one of the first to receive the Constellation, and many readers will doubtless have cause to remember how well both it and the Super Constellation served the airline.

This first international service came only a very few months after Indian independence and three months to the day after incorporation of what was then Air-India International, with a Government holding of 49 per cent and an option on acquiring a further 2 per cent. By November 1 that year the frequency had been increased to twice weekly, was up to thrice weekly a year later, and to four times a week a year after that, in 1950. The subsequent history of the route as far as Air-India is concerned has been one of steady expansion, with stops at such places as Rome, Paris, Prague, Dusseldorf, Zurich, Beirut, Damascus and Basra figuring in the timetables according to the commercial and political exigencies of the time.

The Constellation, says Air-India's present regional director in London, Mr Manek Dalal, played a very large part in the airline taking the lead on the India-UK route and had "a tremendous edge" over the Argonauts then used by BOAC. This eventually led to the traffic on the route being split between the two airlines about 65:35 in Air-India's favour.

Though not claiming to be one of the world's airline giants, Air-India nevertheless has a widely spread route network, and it was principally during the 1950s that the foundations for this were laid. After Bombay-London came services to Nairobi, Singapore, Hong Kong, Tokyo, Sydney, Moscow and eventually New York, all but the last mentioned being inaugurated before 1960. The fifties were also the melting pot for pooling agreements, then a new idea which Air-India helped pioneer with BOAC and Quantas in a tripartite agreement reached on April 1, 1960.

A reputation for innovation had already been gained by Air-India, which was one of the first to suggest and then put into practice the now universally accepted concept of mixed-configuration aircraft, and which had quickly responded to Pan American's Sleeperette with its own Slumberette in the first-class section of its Super Constellations on the London route in 1955. But the emergence of the North Atlantic as the prime world route, and the appearance of jet aircraft which could fly London-New York non-stop with a good load, called for a big step to be taken if Air-India was to continue to develop and thrive as an international airline. What was wanted were fifth-freedom rights on the North Atlantic to New York and, moreover, a minimum of a daily service.

The 1960 pool with BOAC was thus of crucial importance to the Indian carrier and was, says Manek Dalal, "a very happy partnership. Both sides were very understanding of the other's problems." It also, not suprisingly, signalled another burst of activity on Air-India's international front. The first Boeing 707 (a 420—the airline was first to operate Conway-powered 707s and was a champion of the engine at that time) had arrived in February of that year and two more had been delivered by the time the first Bombay-London service with the aircraft was flown in April. At the same time Super Constellation frequencies were gradually reduced on the route. By the beginning of July they had been withdrawn completely and there were then five 707 flights per week to London, with three continuing to New York.

The major transition to the jet age had been accomplished on the prime overseas routes, and in a remarkably short space of time. This is not to say that Air-India did not suffer from the same problems as other international carriers in 1961 and 1962—it did, in the main from the multitude of comparatively minor difficulties that naturally attend the introduction of a radically new type, principally on the ground. The airline nevertheless continued, unlike some, to show a profit (indeed, operating profit by 1963-64 was the best ever). Traffic on the UK route was at least sufficient in May 1961 to justify increasing the frequency to six times a week, with five extensions to New York.

One other event in 1961 is worthy of note. At the end of October, the first of the nine Super Constellations was delivered to the Indian Air Force. By June the following year the ninth had been sold to the air force (which is still flying the type) and Air-India became the world's first all-jet airline. There were at this stage six Conway 707s in the fleet.

With the new aircraft came new engineering problems, and with a characteristic desire for self-sufficiency Air-India set about building up its facilities, starting in 1963 with a jet engine overhaul plant and test house at Santa Cruz Airport, Bombay, where the airline is based. This has clearly allowed a large amount of potential foreign exchange expenditure to be saved over the years, and an

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extension to the overhaul plant has been added to cope with the JT9Ds of the airline's Boeing 747s and the JT8Ds of Indian Airlines' 737s. All the 707s and 747s are maintained at the Bombay engineering base, which includes a new hangar for the latter. A further hangar near the terminal building has been built for line maintenance, and an accessories shop constructed so that the airline can ultimately be completely self-sufficient in maintenance and overhaul of the 747s and their engines, instruments, electronics and communications systems. A sub-base is planned for Delhi and initial money has been allocated towards the cost.

Twenty years after the first international service from Bombay to London, when the frequency was once a week, Air-India decided that traffic on the route justified a twice-daily service. This in fact rose for a couple of years to 15 flights a week but subsequently reverted shortly before delivery of the first 747 in April 1971. The age of the wide bodies, and again the over-capacity cycle, had started (though perhaps paradoxically Air-India has managed to achieve higher load factors with the 747 in the fleet than with only the 707). After proving flights to New York with both the first and second aircraft, the inaugural service with the type to London was flown on May 24, and that to New York on May 26.

Like many other and bigger airlines, Air-India miscalculated traffic growth at the time the 747s were being introduced. This combined with soaring operating costs (nowhere is fuel more expensive than in India) to produce the first loss since the airline was nationalised in 1953. The over-capacity problem is by now a thoroughly familiar one—suffice it to say that Air-India suffered along with the rest, and even considered temporarily mothballing one of the 747s until economic conditions improved. This was not done in the event, and by June last year all of the airline's four aircraft were flying.

As had earlier happened with the 707s, problems on the ground were probably greater than in the air when the wide-bodied aircraft were introduced: "The ground equipment side," says Manek Dalal, "produced the most headaches—and ground-crew training." During the first month or two of operation inadequacies in galley design and other passenger amenities made their presence felt, though the problem of handling more than 300 people on board while maintaining previous standards was regarded as one of efficiency rather than design. Changes in some of the routines and procedures were subsequently made.

On the flight deck, arrangements were made as similar as possible to those on the 707s in order to achieve reduced familiarization time for the crews. Inertial navigation systems were installed in two of the airline's 707s some months before the jumbos arrived for the same reason.

Although the 747 had about one year of airline experience behind it by the time Air-India put it into service, engine development was not as well advanced as the airline might have hoped, and some problems were experienced, in particular with turbine seals and flight performance in connection with the water injection necessary for operating in and out of very hot airfields. The JT9D-7 was selected for the aircraft but, as this engine was still uncertificated at the time, the first two 747s were delivered with -3s—they were subsequently modified to -7 standard. In spite of the early problems Air-India's 747s turned in some of the best reliability figures for the first six months of operation and only one in-flight engine failure occurred during the first year.

"The 747 was a milestone," says Manek Dalal, following up with the oft-repeated words: "The biggest headache is to fill the damn thing." The vicious circle of higher operating costs and lower yields has to be fought by filling aeroplanes, but "to fill a 747 you need more stops, and more stops becomes uneconomic." All wage structures are rising, says Dalal, taking catering as a particular example, and a wage freeze does nothing to stop incremental rises in such things as insurance.

On the North Atlantic it has been an uphill struggle for Air-India, which suffers one disadvantage in that its name is not naturally and easily linked with the route. It has taken nine years or so to reach industry-average loads. The airline felt that one flight a day was the minimum for it to be able to operate successfully alongside US carriers on the route, whose philosophy tends, says Dalal, to be to spend more on getting better availability in order to earn more to spend on increased promotion.

Air-India's cargo rates are still very low, says Dalal, but the crux of the matter is passenger fares. They were stable until five years ago, but since then non-scheduled operators have shown 55 per cent growth rates to the Iata carriers' average 10 per cent or so. The chaotic fares situation of recent times has had an eroding rather than a dislocating effect, according to Dalal, and Air-India's answer, at least on the Atlantic and India-UK routes, has had to be to introduce a substantially reduced fare for Indian nationals.

It was largely because of the cheap service by BCAL on its Far East routes, which were hurting BOAC, that the British flag carrier asked for the BOAC/Air-India/Qantas pool to lapse in 1972 while it thought about capacity, charters and so on and waited for the British

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DHC-7: CANADA'S QSTOL

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gal, 5,964lit. Fuel can be supplied from any one tank to any other tank by using the pressure-refuelling manifold as a transfer line, but it cannot cross-feed any tank directly to any other engine. Each fuel tank has two booster pumps, a fuel-driven ejector pump and a standby electric pump. For starting, fuel is supplied by the engine-driven pump until the engine becomes self-sustaining and drives its own pumps; excess bypass fuel from the engine-driven pump then provides power for the main booster pump. To prevent fuel starvation during starting, the bypass supply to the main booster pump is closed. Since the fuel tanks are located above the engines, the engines will run without the booster pumps operating because of the head of pressure.

Dimensions: wing span, 93ft, 28·35m; wing area, 860sq ft, 79·9m²; aspect ratio, 10·05:1; overall length, 80ft 4in, 24·49m; height, 26ft 2in, 7·97m; wheel track, 23ft 6in, 7·16m; wheel base, 27ft 6in, 8·40m; propeller ground clearance, 5ft 3in, 1·60m.

Weights: max take-off, 41,000lb, 18,597kg; max landing, 39,000lb, 17,690kg; max zero-fuel, 35,500lb, 16,103kg; operating weight empty, 24,440lb, 11,086kg; max fuel, 10,230lb, 4,640kg.

Pressure refuelling and defuelling at a rate of 150 US gal, 125 Imp gal, 568lit per minute is provided through a connection point and control panel on the fuselage underside, aft of the rear pressure dome. This location permits refuelling with the gas generators of all engines running (the propellers being held stationary by brakes) for quick turnrounds at intermediate stops on short-haul routes. It is also the most convenient location for the hydrant refuelling that is planned for many Stol airfields to eliminate vehicles. Over-wing tank fillers are provided for gravity refuelling.

Powerplant

Development of the PT6 turboprop has kept in step with that of the DHC-7. The PT6 is, of course, a very well proven and widely used powerplant (Twin Otter, Turbo Beaver, King Air, Swearingen Merlin IIA, Pilatus Turbo Porter, Saunders ST-27, AIA Arava, Helio Stallion and several helicopters). More than 5,000 PT6s are in service in some 2,000 aircraft, flying in 86 countries. More than ten million flying hours have been recorded. In all, the PT6 powers more than 70 per cent of all light twin-turboprop aircraft in airline service.

The first PT6 ran in November 1959, and flight trials in the nose of a Beech 18 began in May 1961. Civil certification of the 578 s.h.p. PT6A-6 was granted late in 1963. The PT6 family of engines now comprises the PT6A commercial and T74 military turboprops; the PT6T commercial and T400 military coupled turboshafts; and the ST6 series of auxiliary power units, industrial and marine engines.

For the DHC-7, the PT6A-50 incorporates a two-stage free power turbine. In common with earlier PT6s, the gas generator has a screened, annular air inlet from a plenum chamber; a compressor with three axial stages and a final centrifugal stage; a double reverse-flow annular combustion chamber; and a single-stage turbine. The two-stage power turbine of the PT6A-50 drives the propeller shaft through a concentric, epicyclic reduction gearbox.

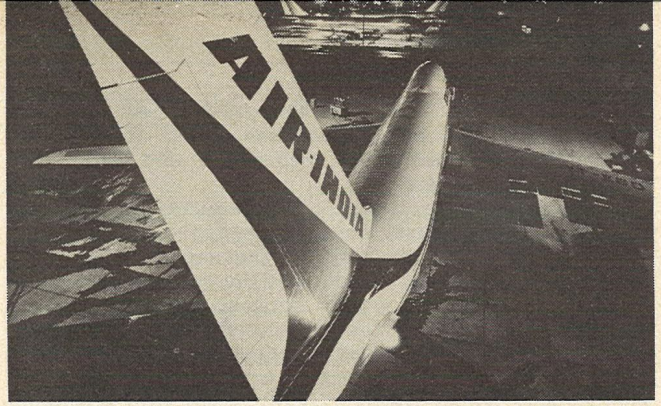
The first PT6 engine to go into full-scale production (in 1963) was the 580 s.h.p. PT6A-6. This was followed by the PT6A-20 which had improved performance. The 715 s.h.p. PT6A-27, in production since 1967, had its mass flow increased by 18 per cent over the PT6A-6 and -20. It featured a new compressor diffuser, which permitted increased compressor pressure ratio and reduced specific fuel consumption (s.f.c.). Cooled first-stage turbine blades were introduced in the PT6T-3 and T400 TwinPac helicopter powerplants, and in the ST6L-73 auxiliary power unit for the Lockheed TriStar—a feature that has been retained in the PT6A-50. These cooled vanes permit higher cycle temperatures and hence thermodynamic efficiency while maintaining metal temperatures well below earlier values, thereby improving s.f.c. With the introduction of cooled blades, additional cooling flow was added at the combustion liner wall and at the turbine disc and blade roots to limit thermal stresses.

It was necessary to design a new reduction gearbox for the PT6A-50 to match the low-speed (and hence low-noise) propeller for the DHC-7. The engine is flat-rated at 1,120 s.h.p. to 81°F, 27·2°C, but the gearbox can transmit higher powers for growth versions. As with previous PT6 gearboxes, that of the -50 consists of two planetary stages. The -50 gearbox has a reduction ratio of 22.74:1 from a maximum power-turbine speed of 30,017 r.p.m. This gives a 100 per cent propeller speed of 1,320 r.p.m. First production engines, however, will be restricted to a maximum propeller speed of 1,210 r.p.m. or 91·6 per cent—the additional speed may be used in developed engines. A new feature of the -50 gearbox is a 20kVA alternator drive, with an output speed of 15,866 r.p.m. at 100 per cent. Compared with a gas-generator drive, the power-turbine-driven alternator provides close frequency regulation in flight and engine-acceleration response that are unaffected by alternator load. The increased gearbox diameter and larger propeller loads require a new exhaust case for the -50. This features a two-port exhaust, venting over the wing to direct noise away from the ground.

Mounting the engines on the DHC-7 posed special problems because of the large (11ft 3in, 3·43m diameter) four-blade propellers. These difficulties were solved by adoption of a novel, lightweight, two-plane bed mounting in which low-rate vertical springs at both front and rear, combined with the long mounting base, provide good vibration isolation. High lateral stiffness, combined with low vertical stiffness at the front and rear mounting points, provides asymmetry for satisfactory whirl-flutter stability. Structural loads, which are most significant in the hard-landing case, are minimized by the long mounting base and by proper positioning of the suspension elastic centre with both bottomed and unbottomed isolation. The steady thrust loads are carried by the rear, lower mounts, which are duplicated, and the steady torque loads are absorbed by the rear, upper and lower mounts.

The Hamilton Standard Division of the United Aircraft Corporation has undertaken development and supply of the DHC-7 propellers. This is a new design of the simple and reliable counterweight type. Large-chord blades have solid, forged-aluminium spars covered by glass-fibre aerodynamic shells over foam cores. This construction has been evolved to reduce the weight penalty associated with achieving high thrust efficiency and very low noise level through slow rotational speed. In meeting the DHC requirement for a maximum noise signature of 95PNdB at 500ft, 152m, Hamilton Standard had two principal factors to consider. The most significant parameter, "rotational noise factor," defines noise caused primarily by rotation of the propeller, and features a distinctive tonal quality at a given r.p.m. The other parameter, "vortex noise factor," defines the noise attributable to the other sources such as lift coefficient and the ratio of blade area to disc area, and has a broad-band quality with no distinctive tones.

A study was performed to find the combination of diameter, r.p.m., number of blades, activity factor and integrated lift coefficient which would best satisfy the take-off and climb performance criteria while maintaining tip speeds within necessary values for acceptable noise levels. Diameter of a propeller is limited by the resultant heavier gearbox to provide a lower propeller speed, and the increases in aircraft structural weight to provide the necessary airframe clearance to support the higher loads. For a given diameter, blade activity factor can be traded-off against the number of blades to provide good take-off thrust and cruise efficiency, and to reduce blade loading. For the DHC-7, four blades were chosen in preference to three blades, because of the superior thrust efficiency of the former and the high weight penalty associated with the latter. More than one thousand glass-fibre blades of nine different types have been built for such aircraft as the Lockheed P-2 Neptune and P-3 Orion, Vtol aircraft and helicopters. In seven years of experience there have been no structural failures. ■



Above and below, the Air-India 747s go by the promotional name of "Palace in the sky"

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Government to make clear its position. A draft agreement was finally signed between the British and Indian carriers in April this year to pool UK-India and India-Hong Kong services, with both passengers and cargo covered. At the same time the two airlines expressed their hope of introducing lower fares on the routes to promote additional traffic.

To serve this new traffic, and also other routes to Australia and Japan, Air-India has expressed its intention of acquiring three more wide-bodied aircraft from 1974 or 1975. Hand in hand with the policy of buying the latest equipment goes that of achieving the greatest possible standardisation in the fleet. Thus it is most likely that the aircraft will be more 747s. An outlay of £43·5 million is envisaged for this purchase in the fifth five-year plan.

Although the Atlantic will continue to be the biggest market, thinks Dalal, and although it is mainly business traffic on the route paying full fare, overall yield is still going down, according to provisional 1972-73 results for Air-India—down 6 per cent compared with the previous year. With costs still relentlessly rising (fuel prices 30 per cent up) the airline nevertheless anticipates making an operating profit of about £2·6 million. Taking all other things into account, including £760,000 interest payable on the loan received for buying 747s, the net result for 1972-73 is expected to be a loss of £710,000 compared to £880,000 the previous year, although the aggregate loss represents only 1·6 per cent of total turnover during the period. Profitability is expected again next year.

An increasing proportion of revenue for the airline is being contributed by cargo and charter work (Air-India Charters Ltd, a non-Iata subsidiary, was set up in September 1971), and tourist traffic is likely to be the area receiving most attention in the next few years. This is not to say that AICL has not been a successful ploy in regaining ethnic traffic lured away by non-scheduled and sheduled operators who were consistently rebating Iata fares on Air-India routes. But India's Minister of Civil Aviation is also Minister of Tourism, and he aims to have doubled the present 400,000 or so tourists per year by 1978. "It is an increasingly broad spectrum of people who travel," he said recently. "We have got to get them [to India] at reasonable cost. This involves the whole problem of Iata fares . . . plus charter flights, which are I think a very effective way of bringing within the reach of a broader spectrum of potential tourists a country like India."

A long-haul airline such as Air-India with some high-yield routes has for long seemed, at least to BAC, a good target for Concorde sales. Air Marshal Chaturvedi, managing director of the airline, recently said there were no plans to buy the aircraft, yet other officials believe Air-India will buy Concorde, though not until 1980 or so. The major difficulty foreseen is financing, and it may well be that the airline will consider it more prudent not to overstretch itself on that score while it builds up load factors, admittedly in lower-yield areas, on its wide-body subsonic types. Repayments due on the four 747s were in 1972 around $100 million and, although the aircraft are amortized over 14-15 years, a longer cycle has been considered. Nevertheless it is not beyond the realms of possibility that a slim, delta Palace in the Sky will be carrying Air-India's colours across the Atlantic after another 25 years of international service.

CHARLES GILSON

REVENUE PASSENGER-KILOMETRES

Year	Revenue pax-km million	% change
1967–68	1,404·47	+17·9
1968–69	1,584·48	+12·8
1969–70	1,808·96	+14·2
1970–71	1,994·00	+10·2
1971–72	2,160·70	+ 8·36

CHARTER TONNE-KILOMETRES

Year	Charter tonne-km million	% change
1967–68	6·55	—
1968–69	4·75	−27·5
1969–70	5·17	+ 8·8
1970–71	4·67	− 9·5
1971–72 (a)*	7·85	+68·1
(b)†	8·10	

*(a) Excludes Air-India Charters Ltd.
†(b) Air-India Charters Ltd.

PASSENGERS CARRIED—OVERALL LOAD FACTOR

Year	Pax carried	% change	Overall load factor (%)
1967–68	285,459	+12·1	48·0
1968–69	331,051	+16·0	48·8
1969–70	402,609	+21·6	50·7
1970–71	487·121	+21·0	54·3
1971–72	442,395	− 9·7	52·1