Most DC-8s and 707s still in service are more than 25 years old. There are now several aircraft types with younger technology on the market which can replace them. Donal James analyses what maintenance costs operators can expect for the DC-8 & 707 and how fast they might rise.

Can airlines afford to maintain the DC-8 & 707?

The design of the first-generation jets, the 707 and DC-8, was not intended to provide an aircraft that would continue in operation for 30 years. However, a quantum leap in technology was implemented in their design to create an aircraft that has far exceeded its design and build criteria.

This article will analyse the DC-8's and 707's escalating maintenance costs; which may force their retirement.

The maintenance planning documents (MPD) published with the aircraft have provided the backbone for the various maintenance organisations and operators to use in their current production of maintenance schedules or programmes.

Each operator has differences in their maintenance schedule and has produced a programme for their own aircraft. This will result different maintenance costs between operators. There are also other variables, and where possible this analysis of 707 and DC-8 maintenance costs indicates the minimum and maximum figures available. The issue of commercial sensitivity in the publishing of actual costs against commercial costs also has to be considered.

Powerplants

The Pratt & Whitney (P&W) JT3D-3B and -7 engines that power the majority of 707 and DC-8 fleets are now well-established and mature engines. It is relativity easy to apply costs to the overhaul, restoration and repair of core units and their accessories.

There is also a considerable amount of material in the market for engines that is in either a serviceable, repaired, overhauled or new condition. The provision of spares therefore has a wide-ranging impact on the final cost of the actual engine refurbishment.

One interesting result of the diverse selection of spares for use in engine maintenance is the life achieved in terms of engine flight hours (EFH) and engine flight cycles (EFC) on-wing. The quality of spare parts used will have a direct effect on engine on-wing times.

The analysis of engine removal data indicates that short on-wing times are invariably due to single component failures (for example, turbine blade failure, cracked engine casing or high breather pressure due to a jammed carbon seal). The long on-wing engines are removed due to general wear and tear resulting in reduced exhaust gas temperature (EGT) margins and life expiry that can be predicted.

The case for using high quality engine parts is strong, since it will provide a basis of efficient planning and predictable cost.

The CFM56-2 engine retrofitted to the DC-8-60 series aircraft was a successful programme. The engine delivers the power and long on-wing times of the new generation of engines, with a major improvement in fuel consumption and operational improvements to the commercial viability of the aircraft. Due to the cost of these engines the majority of operators are using 'power by the hour' (PBH) contracts with the overhaul agencies to control their costs. This engine is also considered to be well-established and mature with long on-wing times and high reliability. The CFM56-2's overhaul and restoration costs are actually higher than those of the JT3D engine, which is a penalty for the newer technology and improved performance figures.

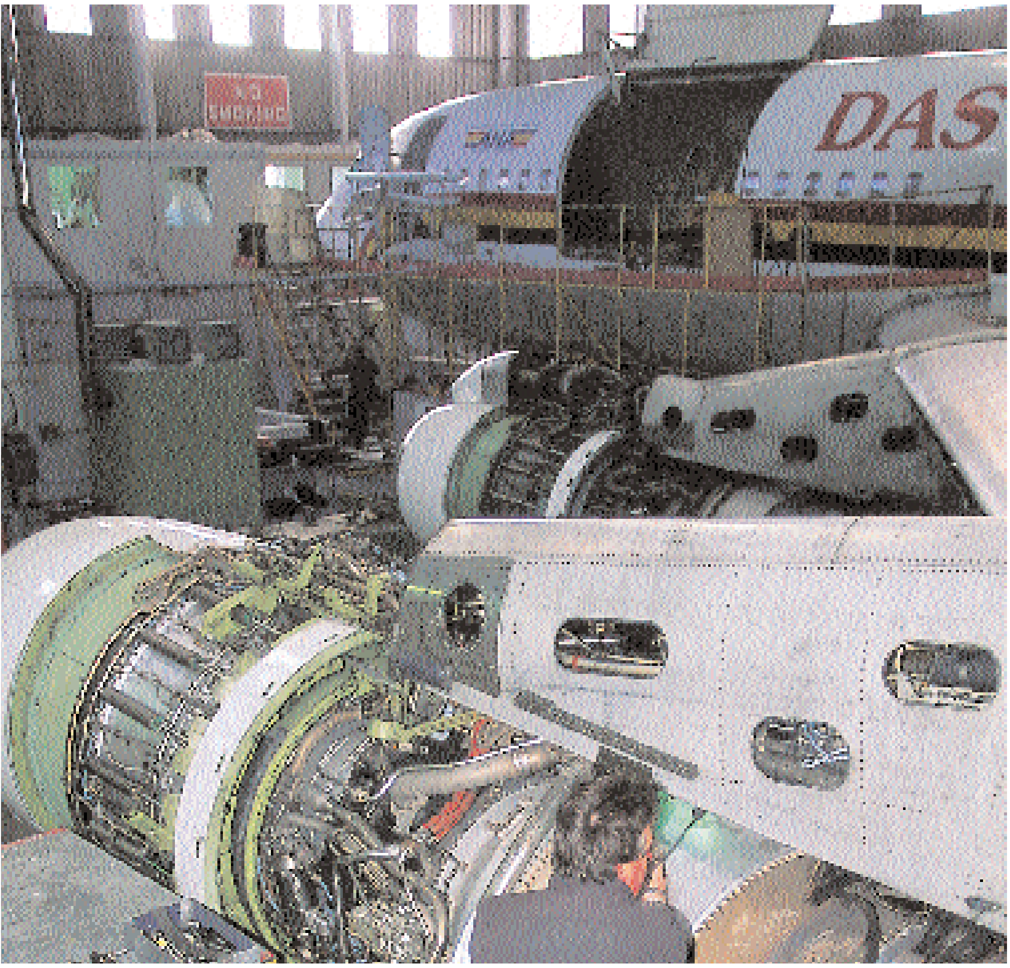
The requirement for extensive borescoping inspection on the CFM56-2 is also a maintenance burden and can introduce additional planning problems.

The advantage of the ability to borescope and use an efficient trend monitoring system on the engine is that off-wing maintenance can be predicted and planned with more certainty, compared with the JT3D.

The additional man-hours (MH) and provision of additionally skilled personnel adds to the cost of maintaining these engines.

707 & DC-8 LINE MAINTENANCE REQUIREMENTS

Maintenance task	Maintenance interval	MH consumed	Materials used $	Spares $/FH	Defects MH/FH
Transit check	Each flight	0.5			
Daily check	Each day	1.5	10		
Weekly check	7 days	2.5	200		
A check		30 days/150FH	15	300	
Avionics				40	0.25
Airframe structure					0.10
Airframe systems				10	0.10
Engine & systems				5	0.10
Wheels	150 cycles			11	
Brakes	450 cycles			107	
Total/FH		0.5MH/FH	$2.55/FH	173	0.55
Average utilisation 200 FH/month					



Maintenance costs per flight hour for the DC-8 & 707 are not excessive considering their age and level of technology. Parts are now becoming hard to acquire, however, and the market rates have doubled over the past five years in some cases. This trend could continue and so raise doubts over the aircraft's continued viability.

Rotables

The issue of spares used on the rest of the aircraft is more difficult to predict. There is a large market of spares available, with a variety of paperwork claiming serviceability ranging from 'tested' to 'overhauled'.

The price range for these items is unpredictable. An overhauled unit can cost up to 100% more than a repaired item. Due to the age of the core units, however, the use of off the shelf parts does not guarantee any greater reliability or improved meantime between removal (MTBR) figures.

A good example of this is the autopilot computer for the 707. An overhaul can cost in the region of $6,000–12,000, whereas the repair and test of the same item could cost $2,000–4,000. Due to the complexity of the design and the age of the components the unit will have no greater reliability whether it was overhauled or repaired, and as the warranty only usually applies to the actual work carried out by the last repair the operator will have no real redress on the supplier or overhaul agency.

This process applies to the majority of first-generation jet avionics used on the 707 and the DC-8. The way to improve this is for an airline to have its own pool of spares, repairing or overhauling these units and rotating them through its fleet. This may be more expensive in the short term, since there may be cheaper units on the open market. Experience has shown that an airline maintaining its own units and controlling the restoration through the various repair organisations will improve the reliability of the units.

There are companies which will undertake to maintain an operator's entire stock of units. Some are more specialised that others. Using these companies can produce major long-term cost savings and reliability improvements.

A specific example is the difficulty in maintaining the DC-8's 20KVA constant speed drive (CSD), universal joint and mechanical CSD disconnect. The reliability of the units has been poor and repairs are often uneconomic.

High Standard Aviation in Miami, Florida now offers specialised maintenance for these parts after seeing the problems experienced by operators. The company has provided a dramatic improvement in reliability and costs associated with these parts.

The alternative method of improving reliability and reducing cost is through the re-engineering of the system and replacement of the components with new state-of-the-art equipment and systems.

A good demonstration of this philosophy is the replacement of the cabin pressurising and conditioning system in the DC-8. In the early 1990s the cost of the cabin turbo compressors (CTCs) began to climb. This was due to a company seeing a niche market and buying up all the spares along with the manufacturing licenses.

National Air Services in Michigan, MK Airlines and AIA designed a new system that completely removed the four CTCs and the freon air conditioning system. A modern air source supply system and zonal airconditioning was introduced. The cost of system installation was recouped within a short time, due to the removal of the high-cost CTCs and freon airconditioning and installation of the new and reliable equipment along with the reduction of weight resulting in improved load carrying ability.

Several major DC-8 operators have elected to completely re-engineer the avionics and flight systems suite and have reaped the benefit of improved reliability and reduced cost for the investment.

With a low acquisition cost against the flexibility and return of these aircraft, it is always cost-effective to consider the introduction of new equipment to improve the operational availability of the aircraft.

As many of the aircraft are approaching an age of 30 years, and with the potential of several years of life remaining, it is advisable to invest in modern technology and replace parts and systems (using design engineering) where possible.

There are many companies that have the technology and are keen to apply their products to the ageing fleet. The fuel quantity indicating system (FQIS) on the DC-8 is complicated. It has electromechanical components, as well as the electronic components and ageing coaxial wiring that produce a variety of defects with regularity. There are several retrofit systems available that provide a quality system with capital costs that are more than supported by the reduction in the system maintenance costs.

Ian Sturrock, commercial director of A J Walter explains how the cost of many parts has escalated over the past few years. The surplus parts in the market have been used up. A shortage of units has materialised because operators were not repairing their unserviceable units, but were stockpiling or disposing of 'unserviceable' and unwanted stock.

The manufacturers of consumables and major parts for restoration of these units are demanding major increases in price from the overhaul agencies. These are being passed on to the operators in price hikes, often in the order of 100%. Pneumatic starter motors for both fleets now cost $18,000 plus, whereas five years ago they were less that half that price.

Line maintenance

The line maintenance elements for the two aircraft are similar, with all checks up to and including A checks. These are done by line personnel during technical or overnight stops.

Mechanics perform non-routine work generated by the flight deck crew technical log entries, non-routine maintenance and inspections, and the correction of deferred defects. The line environment should be adequately staffed to allow all inbound defects to be rectified or have the spares ordered and deferred. There should be enough manpower to allow routine inspections to be adequately actioned.

The cost of line maintenance is distorted by the intermittent use of engineering staff on aircraft turn-rounds and layovers/night stops. This necessitates having additional staff on duty to take care of the peak time, with consequential overstaffing at other times.

The table *(see page 44)* lays out the actual requirements for an aircraft, whether it is a 707 or a DC-8, but does not take into account the overhead cost of supporting a line operation.

The cost of line maintenance and A checks is equal to a cost of $238 per FH for both the DC-8 and 707. This is $175/FH for parts and the rest for labour.

B checks

The B check for the 707 and the DC-8 has an interval of between 500 and 1,000 flight hours (FH) or 90–120 days.

An aircraft that is on a relatively high utilisation of 7.5–12.5FH per day will therefore achieve an average utilisation of 750–1,250FH between B check routine work and inspections. A limited amount of CPCP and structural inspection work and a certain amount of modifications will be made.

The average cost of the B check for the 707 will be in the region of $120,000. This equates to a cost of $160 per FH (750-hour B check interval) to $96 per FH (1,250-hour B check interval).

The average cost of the B check fore the DC-8 will be in the region of $115,000, which will equate to a cost of $230 per FH (500FH B check interval) or to $115 per FH (1,000FH B check interval).

707 FREIGHTER B CHECKS

B check task	Maintenance interval	MH consumed	Materials used $	Rotable spares	Defects MH/FH
B1 routine	115 days/ 1,000FH				
Airframe		30	750		30
Engine		20	500		20
Avionics		15	150		
B1 & 2 inspection					
Airframe		25	1,200	25,000	250
Engine		20	750	15,500	150
Avionics		15	205	35,000	35
SBs & ADs		17			
B2 routine work	230 days/ 2,000FH				
Airframe		70	1,200		100
Engine		20	500		20
Avionics		15	150		
B1 totals		142	3,555	75,000	485
B2 totals		182	4,005	75,000	555

Total cost: B1 @ $60 per MH: $116,175, B2 @ $60 per MH: $123,225

DC-8 FREIGHTER B CHECKS

B check task	Maintenance interval	MH consumed	Materials used $	Rotable spares	Defects MH/FH
B routine work	115 days/ 750FH				
Airframe		60	850		75
Engine		20	500		20
Avionics		15	150		
B check inspection					
Airframe		25	1,200	20,000	250
Engine		20	750	15,500	150
Avionics		15	205	35,000	35
SBs & ADs		10			
B check totals		165	3,655	70,000	530

Total cost: labour @ $60/ per MH: $115,355

C checks

The C check is now usually set into eight equalised checks that eliminate the D check. The intervals for the DC-8 and 707 vary between 12–18 months and 2,500–4,000FH.

The majority of aircraft in both fleets have had the structural modification programme applied. The aircraft are also into the first and second repeat of the corrosion prevention and control programme (CPCP), so the corrosion issue is now under control.

The majority of fleets now have rotables on a condition-monitored or soft-time inspection interval. A hard time programme for components is considered prohibitive when compared to the perceived benefits of a soft-time programme. This leaves the landing gears as the main hard-time component. It has a maximum overhaul life of 10,000 cycles, 32,000 FH or 10 years. The overhaul cost of $160,000 then translates to a cost per FH of $5.33

A C check interval of 3,600FH results in an average cost for heavy maintenance of $150 (at $60 per MH) per FH for the DC-8 and $187 per FH for the 707.

707 & DC-8 FREIGHTER C CHECK MAINTENANCE REQUIREMENTS

Maintenance task	Maintenance interval	Routine & non-routine MH DC-8/707	Consumable materials DC-8/707	Rotable spares DC-8/707
C1	1 year/3,600FH	3,250	16,250	100,000/150,000
C2	2 years/7,200FH	3,350	16,750	100,000/150,000
C3	3 years/10,800FH	3,250	16,250	100,000/150,000
C4	4 years/14,400FH	3,600	18,000	100,000/150,000
C5	5 years/18,000FH	3,250	16,250	100,000/150,000
C6	6 years/21,600FH	3,350	16,750	100,000/150,000
C7	7 years/25,200FH	3,250	16,250	100,000/150,000
C8	8 years/28,800FH	3,900	19,500	100,000/150,000
ADs	NDT/visual	120/160		
CPCP	Annual average	2,160/3000	10,800	
SSID	Annual average	600/750	3,000	
Modifications		150/200	4,500	
Ageing inspection		300/650	1,500	
Average totals		6,730/7,910	34,725/47,500	100,000/150,000

Total: labour @ $60 per MH: $538,525-DC-8; $672,100-707

Landing gear: $160,000 every eight years

P&W JT3D MAINTENANCE

Maintenance task	Labour costs	Consumables	Rotables	Total $
Hot section inspections				50,000
Refurbishment				150,000–200,000
Overhaul	60,000	25,000		
LPC overhaul	18,000			
HPC overhaul	18,000			
HPT overhaul	8,000			
LPT overhaul	8,000			
Manifold overhaul			30,000 (pair)	
Combustion chambers overhaul	5,000			
Nozzle guide vanes			14,000	

SUMMARY OF DC-8 & 707 MAINTENANCE COSTS

Maintenance item	DC-8	707
Line & A checks	$238/FH	$238/FH
B Checks	$115-230/FH	$96-160/FH
C checks	$150/FH	$187/FH
Landing gear	$5.33/FH	$5.33/FH
Engine (JT3D)	$250/FH	$250/FH
Engine (CFM56-2)	$740/FH	

P&W JT3D

The cost of maintaining the engine is climbing all the time, as the pool of surplus units dries up and operators are forced to purchase new parts from P&W or Turbomarine.

New parts in the market are better quality and returning better lives in service. Examples of this are the first-stage turbine blades. Another example is the re-bladed nozzle guide vanes (NGVs). These are cheaper than the new parts, offer a comparable life but are superior to the repaired NGVs, which used to be very popular.

The investment of quality in an engine is demonstrated by an airline's reliability and engine health monitoring system. A major freight airline in the US achieved costs in the order of $34–40 per EFH on its own and its customer's engines through the application of quality labour and parts.

Fuel manifolds and diffuser casings are now becoming very expensive and difficult to find. Both parts are suffering from fatigue and proving difficult to overhaul as a result of age and accrued flight times.

Engine costs will continue to climb, especially as the manufacturing of new parts becomes the only means of supplying the operators. Many operators have engine costs in the order of $50–75 per EFH, equal to $200–300 per FH.

CFM56-2

This engine has benefits for the operator and is ideal for long-range work. The costs are more easily set out in $ per EFC, rather than EFH since the life of the engine is EFC-orientated. The average cost of the engine with a PBH programme is in the region of $900 per engine flight cycle.

Summary

Both aircraft have similar costs *(see table, this page)*. This is not surprising considering the technology and age of the aircraft. The DC-8 is more popular than the 707. This is explained by the DC-8's more robust airframe and the modification carried to the majority of the fleet by the re-engineering of the airframe to take the CFM56 and the hushkitting on the -62 and -63 models.

The 707 has its admirers and can be a reliable aircraft if well looked after. The Burbank hushkit will improve its life expectancy and the Omega JT8D-200 re-engining programme will also improve its prospects. Total costs for the 707 are $776-840 per FH. The JT3D-powered DC-8 has total costs of $758-873 per FH. The CFM56-powered aircraft have costs of $1,248-1,363/FH. AC