Basics of Aircraft Maintenance Reserve Development and Management

A Lessor's Perspective of Maintenance Reserve Theory and Best Practices

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Abstract

The importance of maintenance reserves to protecting asset value is a key consideration of lessors. In an ideal situation, the reserves plus the residual condition of select high cost maintenance events would essentially keep the economic condition of the aircraft whole.

Maintenance reserves serve as a mechanism to mitigate credit risk and therefore are generally imposed on weaker credit airlines. However, in the event a lessee negotiates to not pay maintenance reserves they may still be required to provide collateral security in the form of an end of lease financial adjustment or through a Letter of Credit (LOC). These reserves are, in turn, based on the industry norm for that aircraft type, or in the case of a new aircraft, based on manufacturers' recommendations.

Maintenance reserves are often the most contentious part of a lease negotiation; the lessor views reserves as a cost-covering exercise, while the lessee views it as a burden on their cash flow resources. Often undervalued as a discipline, an understanding of maintenance reserves is critical to gaining a perspective on the risk and rewards of aircraft leasing.

Basics of Aircraft Maintenance Reserve Development & Management

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1. INTRODUCTION

Most operating leases provide that the lessee is liable for the ongoing costs related to maintaining an aircraft to the required standard. In the event that an aircraft is forcibly repossessed due to a default by the airline, the aircraft may require expensive investment in outstanding maintenance work before it is in a condition to be re-leased or sold to another airline/investor. Therefore, a lessor's primary risk in relation to maintenance is one where the lessee fails to pay, in whole or in part, for the maintenance utility they consumed.

To mitigate maintenance exposure most lessors have independent credit departments to evaluate the creditworthiness of lessees. Evaluation of an operator's credit standing generally involves the establishment of some financial test, the failure to meet which would invoke an obligation to establish more stringent collateral security in the form of security deposits and payment of maintenance reserves.

Maintenance reserves are payments made by the lessee to the lessor to accrue for those scheduled major maintenance events that require significant aircraft grounding time and/or turn-around time for certain major component overhauls. Put another way, maintenance reserves are payments for maintenance utility[1] consumed and can be expressed as follows for a particular maintenance event:

Mx Reserves = Mx Utility Consumed OR Mx Reserves = Full-Life Mx Value – Mx Utility Remaining

A lease agreement will specify what maintenance events are to be covered through payment of reserves and for which the lessee may draw down against the accrued amounts. Areas of maintenance typically covered by reserves are as follows:

- Airframe Heavy Structural Inspections
- Landing Gear Overhauls
- Engine Performance Restoration
- Engine Life Limited Parts (LLPs)
- Auxiliary Power Unit (APU) Restoration

The contractual position relating to maintenance reserve is always a subject of intense negotiation. Many airlines have sufficient credit stature that their prominence in the marketplace means they can reject paying maintenance reserves. On the other hand, lessors will show less flexibility for weaker credit lessees and require these operators to pay maintenance reserves.

Maintenance reserve payments are calculated on flight hour, flight cycle, and/or calendar basis and are usually paid on a monthly basis in arrears. Accumulated reserves are reimbursed (subject to limitations) after major maintenance events are completed.

① see **Appendix A** for summary of Maintenance Utility

Therefore, at the time an aircraft is taken out of service for maintenance, the lessor should already have funds to cover the cost of outstanding maintenance. More importantly, in the event of default, maintenance reserve provides lessor with value protection throughout the lease.

In general, reserves become the property of the lessor immediately upon payment. Customarily, the lessee will cause the required maintenance to be completed and then claim reimbursement for the qualified portion of the work from the reserve account held by the lessor.

Repayment takes place only if payment into the reserve account is fully up to date, and only up to the amount held in the specific reserve account. Thus if a particular event is carried out, and the cost of that work exceeds the total in the specific reserve account, the excess cost is the responsibility of the lessee.

Funds generally cannot be transferred from other reserve accounts for the same aircraft to cover any shortfall incurred. So, for example, a lessee cannot siphon a fund used for engine maintenance and funnel those proceeds to subsidize the cost of airframe heavy check.

In the event a lessee negotiates to not pay maintenance reserves they may still be required to provide collateral security in the form of an End of Lease Financial Adjustment or through a Letter of Credit (LOC).

Under an End of Lease Financial Adjustment structure, if a certain maintenance event is returned at the end of a lease in a worse than stipulated condition, the lessee must make an end of lease payment to the lessor. Conversely, if a certain maintenance event is returned in a better than stipulated state, the lessor is obliged to pay the lessee. There are two types of end-of-lease payment structures:

- Mirror-In / Mirror-Out – A mirror adjustment can either be one-way, where the Lessee is required to pay an adjustment when a certain maintenance event is returned with less time remaining than at delivery, or a two-way mirror whereby lessor may have to pay the lessee if a certain maintenance event is returned in better condition than at delivery.
- Zero-Time or Full-Life – A payment whereby the lessor receives payment for time used since last overhaul or since new.

A maintenance Letter of Credit (LOC) is bank guarantee that lessee will return the asset to the lessor in the condition required by the lease. Often, LOC amounts are reconciled on periodic basis – typically annually or semi-annually – to reflect maintenance utility consumed and performed

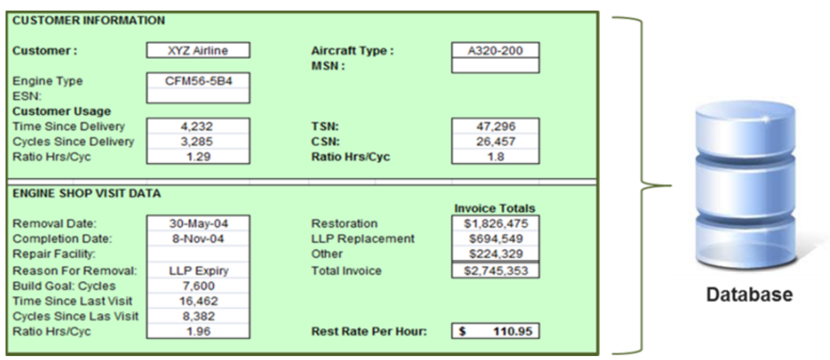
2. SOURCES OF MAINTENANCE DATA

Most lessors analyze cost data to come up with baseline maintenance reserve for each aircraft and engine model. Reserve rates (particularly engine rates) are often adjusted to account for key factors such as age, average flight length, and environment. Once sufficient reported cost data is available, baseline reserves are benchmarked to actual reported data to ensure consistent and unbiased cost metrics.

To develop baseline costs, lessors make use of internally available sources as well as industry sources. The three primary maintenance cost data sources available to lessors are derived from internally generated reserve claims, industry publications, and manufacturer published cost data.

i. Reserve claims – as a lessor accumulates sufficient maintenance reserve claims the degree of variability between baseline costs and actual costs diminishes. Many lessors develop costs reports that provide individual airline specific maintenance costs. In the example illustrated in Figure 1, information extracted from an engine performance restoration claim will yield a host of maintenance data (i.e. removal cause, time between performance restoration, flight leg, build goal, restoration and LLP costs, and the associated cost per flight-hour).

FIGURE 1- EXAMPLE ENGINE MAINTENANCE COST & INTERVAL DATA EXTRACTED FROM A RESERVE CLAIM REPORT



ii. Industry publications - the following industry publications provide detail analysis of both aircraft and engine types spread across numerous airlines, and are useful for establishing maintenance cost and performance interval benchmarks.

a. Aircraft Commerce
b. International Bureau of Aviation (IBA) – Maintenance Cost Journal
c. Aircraft Technology & Engineering Maintenance

iii. Manufacturer published cost data – The majority of aircraft and engine manufacturers publish maintenance cost handbooks as reference guides for establishing maintenance reserves. Airbus and Boeing, for example, publish annual handbooks that detail calculation methods used to benchmark Direct Maintenance Cost (DMCs) for a wide range of different airframe, engine, landing gear, and APU equipment. Additionally, most engine manufacturers publish similar handbooks aimed at providing both product and maintenance benchmark information for their engine models.

3. MAINTENANCE RESERVE ECONOMICS

The table below illustrates the equations used to compute reserve rates for each of the major maintenance events. Although each equation is identical in framework – that is, numerator equals cost and denominator equals performance interval – the variability in costs and performance intervals vary depending on the maintenance event. The computations of engine LLP rates, for example, exhibit virtually no variability given their cost and associated intervals are set by the engine OEMs. On the other extreme, engine & APU rates are subject to high degrees of variability in both event costs and on-condition performance intervals.

Application	Equation	Comments
Airframe Heavy Structural Inspection (HSI)	$\frac{\text{HSI Costs}}{\text{Fixed Mo Interval}}$	• Uncertainty in HSI costs, which can be difficult to predict if equipment is mature and/or aging.
Landing Gear Overhaul Costs	$\frac{\text{Overhaul Costs}}{\text{Overhaul Interval}}$	• Overhaul intervals are typically calendar based or cyclic based, whichever is more limiting.
Engine Performance Restoration (PR)	$\frac{\text{PR Costs}}{\text{MTBR}}$	• PR Costs & Mean-Time Between Removals (MTBR) is heavily dependent on the operation • Often difficult to quantify if equipment is in new or mature phase
Engine LLP Replacement	$\frac{\text{Catalog Costs}}{\text{Cyclic Limit}}$	• Predictable, with little to no uncertainty
APU Performance Restoration (PR)	$\frac{\text{PR Costs}}{\text{MTBR}}$	• Uncertainty in both costs and time on-wing • Often difficult to quantify if equipment is new

The greatest challenge of calculating maintenance reserves is attempting to predict the costs - and on-condition intervals in the case of engines & APUs - of maintenance events and spreading that cost out in a way that is fair to both lessor and lessee. In theory it sounds simple, however the uncertainty in predicting both costs and on-condition intervals can lead to all kinds of difficulties, particularly with new equipment that has no documented maintenance history. The following is an overview of the economic factors that influence each major maintenance event.

3.1 Airframe Maintenance Economics

Background

Depending on the aircraft type, airframe heavy structural inspections are scheduled every 6-12 years. Usually the aircraft is taken out of service for several weeks. During this check the exterior paint is often stripped and large parts of the outer paneling are removed, uncovering the airframe, supporting structure & wings for zonal and structural inspections. In addition many of the aircraft's internal components are functionally checked, repaired/overhauled, or exchanged.

The MPD document provides maintenance planning information necessary for operators to develop a customized maintenance program. The document lists all recommended scheduled maintenance tasks for every aircraft configuration. Scheduled maintenance tasks are categorized into three program groupings consisting of: a.) Systems & Powerplant, b.) Zonal Inspections, and c.) Structural Inspections

a) The Systems & Powerplant Program is developed to perform functional and operational checks on typical airplane systems i.e. flight controls, pneumatics, electrical power, etc.

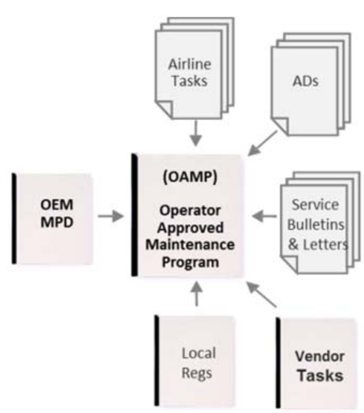
b) The purpose of the Zonal Inspection Program is to assess the general condition of attachment of all systems and structures items contained in each zone by use of defined zonal inspection tasks. The zonal inspection tasks include visual checks of electrical wiring, hydraulic tubing, water/waste plumbing, pneumatic ducting, components, fittings, brackets, etc.

c) The Structural Inspection Program is designed to provide timely detection and repair of structural damage during commercial operations. Detection of corrosion, stress corrosion, minor damage and fatigue cracking by visual and/or NDT procedures are considered.

It is the MPD that outlines the task requirements used to assess airframe maintenance reserves – see Figure 2. In general, the MPD routine maintenance tasks, and the rectification of any deficiencies resulting from performance of such tasks, forms the basis for the qualifying scope of work that is used to quantify airframe maintenance reserves. The lessor, thus must factor incremental costs resulting from non-routine maintenance into the airframe rate.

FIGURE 2- AIRFRAME MAINTENANCE RESERVE SOURCE DOCS

Airframe reserve rates are commonly derived from the routine maintenance tasks referenced in the Maintenance Planning Document (MPD) - tasks from other sources are generally excluded.



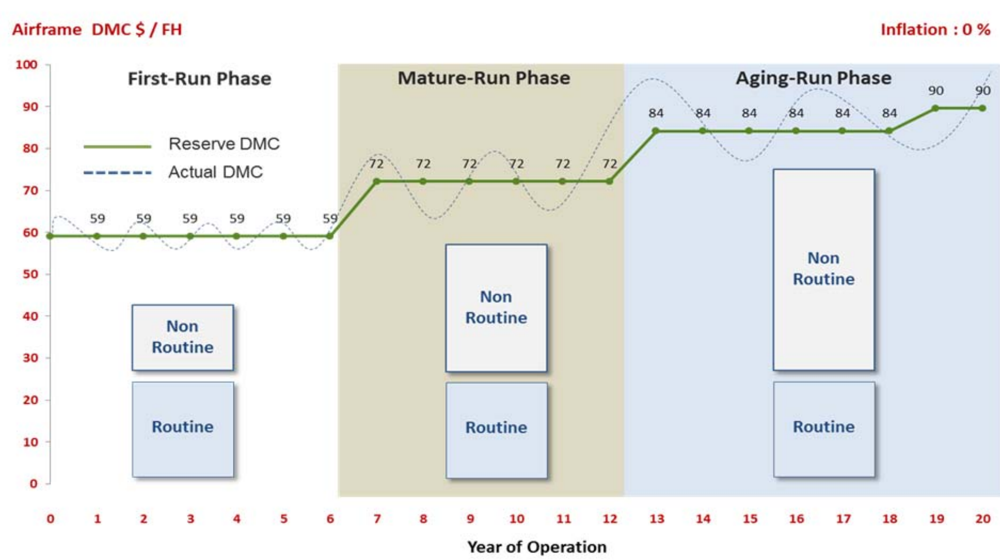
Maintenance Cost Drivers

Aging of aircraft - As an aircraft ages subsequent airframe heavy checks are expected to require higher levels of non-routine maintenance, which is defined to be the work required to rectify routine maintenance tasks. The non-routine ratio – sometimes referred to as the defect ratio - is the ratio of non-routine man-hours to routine man-hours, and is a measurement of the incremental time required to correct routine defects. For example, if an aircraft's heavy structural inspection requires 4,000 routine man-hours, in addition to 2,000 non-routine man-hours, the non-routine ratio for this check is 50%.

As an aircraft ages, the non-routine ratio can easily exceed 100%, which explains why successive maintenance checks tend to be more costly. Therefore, when developing airframe maintenance reserves it's important to adjust the rate to account for the particular phase within the airframe's maintenance cycle. The airframe's maintenance cycle can be broken into three phases consisting of: first-run, mature-run, and aging-run. Figure 3 highlights the changes in airframe Direct Maintenance Cost (DMC) of an A320 aircraft as it progresses through its maintenance cycle.

- First-Run is the initial operating years, often referred to as the honeymoon period and generally considered the first 4-6 years of in-service operation. The structure, systems, and components are new; and there is less non-routine maintenance and material scrap rate.
- Mature-Run begins after the newness phase and runs through the first maintenance cycle. This period typically falls between the first heavy maintenance visit and the second maintenance visit.
- Aging-Run begins after the end of the first maintenance cycle when the effects of airframe age result in higher non-routine maintenance costs. This period typically begins after the second heavy maintenance visit and continues to increase with time.

FIGURE 3 – EXAMPLE ADJUSTMENT OF AIRFRAME DIRECT MAINTENANCE COST (DMC) FOR AN A320 AIRCRAFT



3.1 Airframe Maintenance Economics

Typical Qualifying Work : Man-hours associated with scheduled grouping of MPD routine tasks and all non-routine man-hours generated by routine tasks, material costs related to the above tasks, basic cabin refurbishment, and rotable overhaul for time-controlled items. Some lessors include strip & paint into their standard reserves if these events occur at regularly scheduled heavy structural checks.

Typical Excluded Work : Work related to Service Bulletins (SBs), Service Letters (SLs), Airworthiness Directives (ADs), airline unique tasks, vendor tasks, local regulatory tasks, cabin reconfiguration costs, accidental damage repair. Packaging, duties, and shipping & handling fees are also generally excluded. Some lessors exclude tasks associated with the Systems Maintenance Program.

Example Airframe Reserve Estimations

- **A.** Airframe Heavy Structural Event : A320 C4 / 6-Year SI & C8 / 12-Year SI
- **B.** Inclusions: The labor and material cost of performing all MPD tasks affiliated with the Systems, Structural, and Zonal Maintenance Programs, and the rectification of any deficiencies resulting from performance of such tasks, stripping and painting, cost of cabin refurbishment and rotable overhaul costs for time-controlled items.
- **C.** Exclusions: Work related to Service Bulletins (SBs), Service Letters (SLs), Airworthiness Directives (ADs), airline tasks, vendor tasks, local regulatory tasks, cabin reconfiguration, accidental damage repair. Packaging, duties, and shipping & handling fees are also excluded.

Check	Check Tasks	MPD Interval	Check Phase	Check Costs $	Reserve Rates $ / Mo
C4 / 6-Yr SI	1C+2C+4C+6Yr SI	72 Months	First-Run	800,000 – 850,000	11,000 – 11,800
C4 / 6-Yr SI	1C+2C+4C+6Yr SI	72 Months	Mature-Run	920,000 – 970,000	12,700 – 13,400
C4 / 6-Yr SI	1C+2C+4C+6Yr SI	72 Months	Aging-Run	1,100,000 – 1,150,000	15,200 – 15,900
C8 / 12-Yr SI	C4 / 6-Yr SI + 8C+12-Yr SI	144 Months	First-Run	720,000 – 780,000	5,000 – 5,400
C8 / 12-Yr SI	C4 / 6-Yr SI + 8C+12-Yr SI	144 Months	Aging-Run	860,000 – 930,000	5,900 – 6,400

3.2 Landing Gear Maintenance Economics

Background

An aircraft landing gear shipset consist of a nose gear assembly plus two to four main gear assemblies, depending on the aircraft type. The main components of each gear assembly consist of the inner and outer cylinders, drag braces and struts, and various hydraulic actuation mechanisms that serve to lower and retract the gears.

Landing gear overhaul intervals are determined by the need to inspect, and if required, treat for corrosion. Overhaul intervals for landing gears are generally calendar & flight cycle limited, and for most models are in the region of 10-12 years and 18,000-20,000 flight cycles.

The timing of when the overhaul occurs is based on which of the performance intervals is more limiting. For example, a landing gear with overhaul intervals of 10 years and 20,000 flight cycles, which is operating 2,500 flight cycles per year will occasion its overhaul at the eight-year anniversary. Landing gears that are operating below 2,000 flight cycles per year will have their overhaul calendar-limited to 10 years.

Maintenance Cost Drivers

Factors driving Landing gear overhaul cost consist of:

- Size and complexity
- Number of modifications to incorporate
- Operational environment and maintenance practices
- Market penetration - number of MROs supporting the gear
- Cost of exchange fee

Labor required to overhaul a gear shipset is generally predictable since most of the workscope is routine. The majority of the total cost of an overhaul is material related ; bushings account for the biggest cost of parts and material, as do seals, bearings, and parts containing special alloy materials such as nickel, cadmium and chrome. Downtime for a narrowbody overhaul process is in the range of 30-40 days, while widebody gears are in the range of 50-60 days.

Few airlines have their own landing gear overhaul shops given that most do not have sufficient volumes to financially justify it, therefore most use third-party specialist overhaul facilities. These overhaul facilities typically carry spare gear inventory for multiple aircraft types, which they offer under either an exchange or loan program.

3.2 Landing Gear Maintenance Economics

Under a loan program, the overhaul specialist provides the airline with a designated spare gear, which is fitted to an aircraft while the airline's gear is overhauled. Upon completion of an overhaul, the spare set is removed and replaced with the original gear. The cost to the airline general reflects both the cost to overhaul the original gear plus a loan fee.

Under an exchange program, a spare gear is installed on an aircraft while the original gear is transferred to an overhaul facility. Once the airline's gear has been overhauled it then becomes a spare set, and subsequently an exchange unit. The cost to the airline general reflects both the cost to overhaul the original gear plus an exchange fee.

Typical Qualifying Work : Overhaul of a Landing Gear assembly in accordance with the Manufacturer's repair manual that restores such Landing Gear to a "zero time since overhaul" condition in accordance with the Manufacturer's repair manual and is performed in accordance with the Manufacturer's overhaul specifications and operating criteria (excluding any rotable components such as wheels, tires, brakes and consumable items). Most lessors include loan and/or exchange fees into their standard reserves.

Typical Excluded Work : Work related to Service Bulletins (SBs), Service Letters (SLs), Airworthiness Directives (ADs), exchange & handling fees, packaging and shipping charges. Repair, overhaul or replacement of thrust reversers and non-modular components, such as QEC, LRU or accessory units is not eligible for reimbursement from engine reserves.

Example Landing Gear Reserve Rate Estimations

A. Equipment : A320 Landing Gear
B. Overhaul Intervals : 120 Months & 20,000 FC, whichever is more limiting
C. Overhaul Cost : $420,000
D. Reserve Rate: US $21.00 per Cycle but not less than US $3,500 per Month

Operator	Utilization	Cyclic Limiter	Calendar Limiter	Overhaul Limiter	Reserve Rate
A	3,500 FH / 1,500 FC	160 Months	120 Months	120 Months	$3,500 / Month
B	3,500 FH / 2,000 FC	120 Months	120 Months	120 Months	$3,500 / Month
C	3,5000 FH / 2,500 FC	96 Months	120 Months	96 Months	$4,375 / Month
D	3,000 FH / 3,000 FC	80 Months	120 Months	80 Months	$5,250 / Month

3.3 Engine Maintenance Economics

Background

An engine removal is classified as a shop visit whenever the subsequent engine maintenance performed prior to reinstallation entails either: a) Separation of pairs of major mating engine flanges, or b) Removal/replacement of a disk, hub or spool. Engine shop maintenance includes two primary elements:

a) Performance Restoration: The core engine deteriorates as parts are damaged due to heat, erosion, and fatigue. As an engine is operated the Exhaust Gas Temperature (“EGT”) increases, inducing accelerated wear and cracking of the airfoils, which further decreases performance. Based on the engine materials and their properties, a critical EGT is established by the OEM, attainment of which necessitates a performance restoration shop visit. During a performance restoration, the core module is traditionally dismantled and airfoils (rotors & stators) are inspected, balanced, and repaired or replaced as necessary.

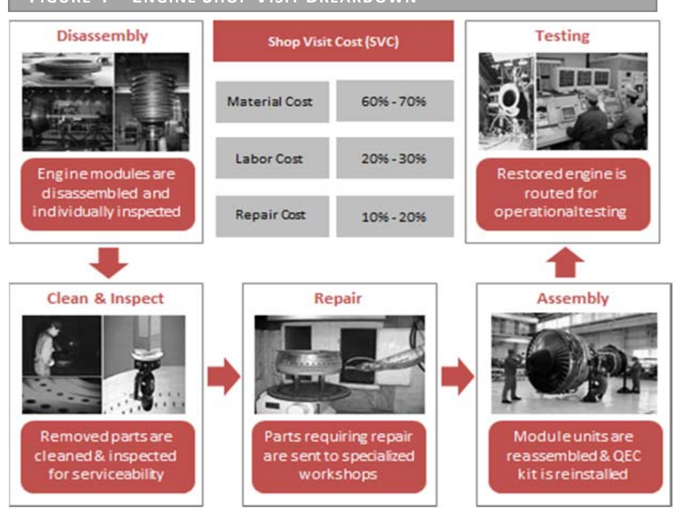
   The primary objective of the workscope is to restore the engines performance, and to build the engine to a standard that minimizes long-term engine direct maintenance cost, or cost per flying hour. This process, however, can be quite challenging given parts and modules have different rates of deterioration.

b) Life Limited Part Replacements: The rotating compressor and turbine hubs, shafts, or disks within the engine have a specifically defined operating life, at the end of which, the parts must be replaced and not used again.

The breakdown of an engine’s shop visit costs and maintenance process is detailed in Figure 4. The primary cost driver of engine shop maintenance is material cost; approximately 60% - 70% of the cost of an engine shop visit is due to replacement of material.

If life-limited parts (LLP) require replacement the material cost will increase further. Direct labor will account for approximately 20%-30% of total cost, while repairs will account for 10%-20%. In the aggregate, costs related to engine restoration and LLPs will make up approximately 70%-80% of total reservable maintenance costs.

FIGURE 4 – ENGINE SHOP VISIT BREAKDOWN



3.3.1 Engine Module Maintenance Economics

The biggest portion of material cost is attributable to airfoils – blades & guide vanes. Individual vane segments in the turbine modules can cost as much as $10,000, while turbine blades can cost as much as $8,000 each. A full shipset of High Pressure Turbine (HPT) blades can total between 60 – 80 blades and costs $400,000 - $700,000. And a full shipset of High Pressure Compressor Blades (HPC) can cost $150,000 - $300,000. Typically, the largest portion of parts repair cost is also associated with airfoils given that these parts require high tech equipment to make them serviceable again

Most repair shops will assess the life remaining on LLPs when an engine is inducted for maintenance and will manage time limited components to coincide with subsequent shop visits. Ideally, the repair shop will ensure that LLP stub-lives closely match the expected time on-wing from EGT margin erosion. So, for example, if an engine's LLP stub-life is 10,000 FC then the repair center will ensure that the engine has sufficient EGT margin to stay on-wing for 10,000 FC. The 10,000 FC would then be called the engine build standard.

An engine's Workscope Planning Guide (WPG) is a maintenance planning guide published by each engine manufacturer that details the suggested level of required maintenance on each module as well as a list of recommended Service Bulletins. Engine manufacturers generally specify three levels of workscopes consisting of minimum level, performance level, and full overhaul level.

i. Minimum Level Workscope – Typically applies to situations where a module has limited time since last overhaul. The key tasks accomplished with this workscope level are external inspections, and to some extent, minor repairs. It is not necessary to disassemble the module to meet the requirements of a minimum level workscope.

ii. Performance Level Workscope – Will normally require teardown of a module to expose the rotor assembly. Airfoils, guide vanes, seals, and shrouds are inspected and repaired or replaced as needed to restore the performance of the module. Cost-effective performance restoration requires determination of the items having the greatest potential for regaining both exhaust gas temperature (EGT) and Specific Fuel Consumption (SFC) margin.

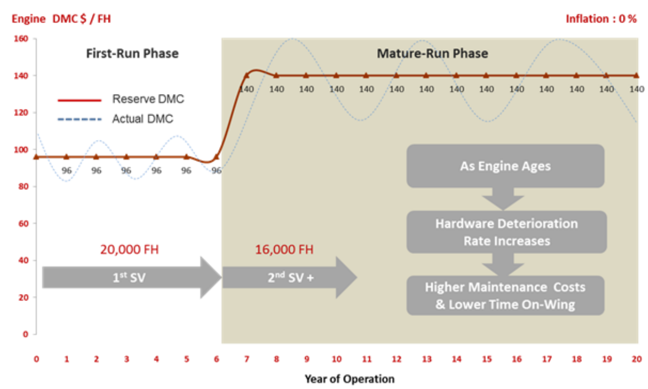
iii. Full Overhaul Workscope - Full overhaul applies to a module if its time / cycle status exceeds the recommended (soft-time) threshold, or if the condition of the hardware makes full overhaul necessary. The module is disassembled to piece-parts and every part in the module receives a full serviceability inspection and, if required, is replaced with new or repaired hardware.

3.3.1 Engine Module Maintenance Economics

Maintenance Cost Drivers

i. Age of Engine – Older engines generally cost more to maintain than newer engines. As an engine ages its average time to shop visit lessens - Figure 5. First-run engines will last considerably longer on-wing than mature engines. In fact, it is not uncommon to see first-run engines remaining on-wing 20%-30% longer than mature-run engines. As the engine ages a disproportionate amount of parts experience higher deterioration rates, higher scrap rates, and correspondingly higher engine maintenance cost.

FIGURE 5 – INFLUENCE OF AGE ON ENGINE DMC

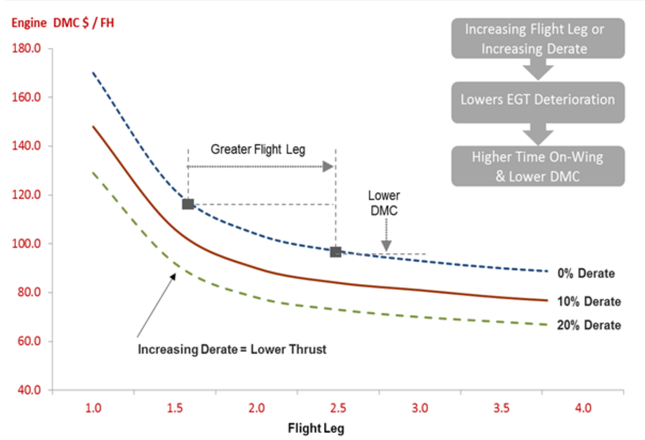


ii. Operation - To accurately forecast maintenance status it's important to consider the type of operation the aircraft will be exposed to. An aircraft's maintenance value will amortize based on the DMC associated with its specific operational profile. The same model aircraft operating at different profiles will experience different levels of DMC. The key operational factors influencing an engine's DMC are: 1.) Flight length, 2.) Engine derate, and 3.) Operating environment.

- Flight Length – The impact of lower flight length – Figure 6 - results in higher cyclic loads on an engine's parts & accessories with the consequence of higher non-routine maintenance.

  Smaller flight segments also force engines to spend a larger proportion of total flight time using take-off and climb power settings resulting in more rapid performance deterioration, which translates to higher DMC.

FIGURE 6 – INFLUENCE OF FLIGHT LEG & DERATE ON ENGINE DMC

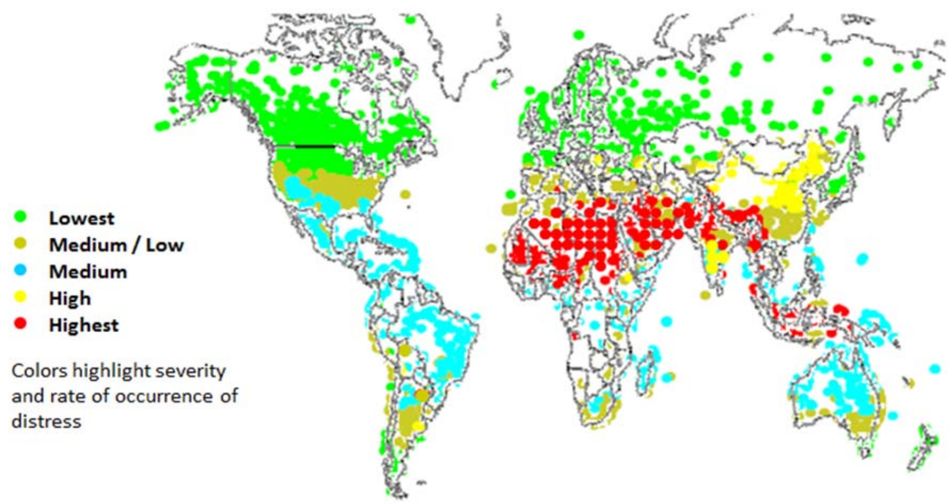


3.3.1 Engine Module Maintenance Economics

- Engine Derate – For a particular engine, take-off derate thrust is an approved takeoff thrust rating that is lower than the max rated takeoff thrust; operating an engine at a derate is similar to having a less powerful engine on the aircraft. A larger derate translates into lower take-off EGT, resulting in lower engine deterioration rate, longer on-wing life, and reduced DMC – see Figure 6.

- Environment – More caustic operating environments generally result in higher engine DMC – see Figure 7. Engines operating in dusty, sandy and erosive-corrosive environments are exposed to higher blade distress and thus greater performance deterioration. Particulate material due to air pollution, such as dust, sand or industry emissions can erode HPC blades and block HPT vane/blade cooling holes. Other environmental distress symptoms consist of hardware corrosion and oxidation.

FIGURE 7 – ENGINE ENVIRONMENTAL DISTRESS CHART



Typical Qualifying Work : The actual cost associated with a qualified performance restoration or permanent repair of on-condition parts in the basic engine during completed engine shop visits requiring off-wing teardown and/or disassembly. Engine performance restoration means, at a minimum, the accomplishment of a performance level workscope on the engine's hot sections.

Typical Excluded Work : Work related to Service Bulletins (SBs), Service Letters (SLs), Airworthiness Directives (ADs), exchange & handling fees, packaging and shipping charges. Repair, overhaul or replacement of thrust reversers and non-modular components, such as QEC, LRU or accessory units is not eligible for reimbursement from engine reserves.

3.3.1 Engine Module Maintenance Economics

Example Engine Reserve Rate Estimations

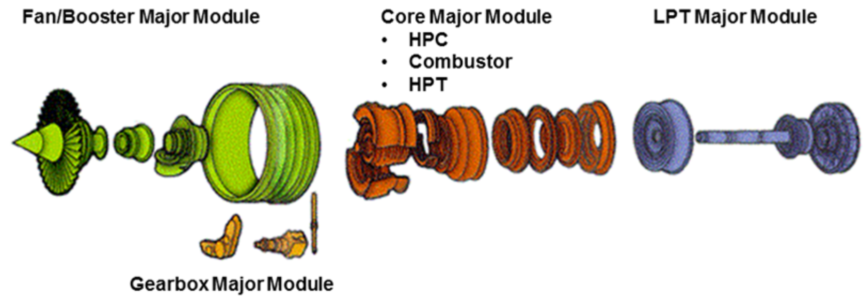
A. Engine model : CFM56-5B4/3 rated at 27,000 lbs

B. Operational : 10% Derate / Temperate Environment / 3,500 FH / Year

C. Qualified CFM56-5B4 engine performance restoration means, at a minimum, the accomplishment of a performance level workscope on the High Pressure Compressor (HPC), Combustor, and High Pressure Turbine (HPT) pursuant to the then current CFM Workscope Planning Guide and minimum performance level workscopes required on the Fan/Booster, Low Pressure Turbine (LPT) and Gearbox pursuant to the CFM Workscope Planning Guide.

D. The CFM56-5B engine modules - Figure 8 - refers to any of the six major modules of an engine, namely: 1.) the High Pressure Compressor ("HPC"), 2.) High Pressure Turbine ("HPT"), 3.) Combustor, 4.) Fan Booster/Low Pressure Compressor ("Fan Booster/LPC"), 5.) Low Pressure Turbine ("LPT") and 6.) Gearbox.

FIGURE 8 – CFM56-5B MODULAR CONSTRUCTION



	First-Run Maintenance Reserves Metrics			Mature-Run Maintenance Reserves Metrics		
FL	MTBPR - FH	PR Costs $	PR Rates $/FH	MTBPR - FH	PR Costs $	PR Rates $/FH
1.0	16,000 - 17,000	2.00M - 2.10M	115.00 – 125.00	8,500 – 9,500	2.20M - 2.30M	235.00 - 250.00
1.5	22,000 - 23,000	2.20M – 2.30M	100.00 – 110.00	12,750 – 14,250	2.25M - 2.35M	172.00 - 182.00
1.7	24,000 - 25,000	2.25M – 2.35M	93.00 – 100.00	14,000 – 16,000	2.30M - 2.40M	158.00 - 166.00
2.0	25,000 - 27,000	2.30M – 2.40M	88.00 – 95.00	16,000 – 18,000	2.35M - 2.45M	137.00 - 146.00
2.5	27,000 - 29,000	2.32M – 2.42M	80.00 – 85.00	18,000 - 20,000	2.37M - 2.47M	125.00 - 135.00
3.0	29,000 - 30,000	2.35M – 2.45M	78.00 – 82.00	20,000 - 21,000	2.40M - 2.50M	122.00 - 128.00
3.5	30,000 - 31,000	2.38M – 2.48M	75.00 – 80.00	21,000 - 22,000	2.45M - 2.55M	117.00 - 122.00
4.0	31,000 - 32,000	2.40M – 2.50M	73.00 – 78.00	22,000 - 23,000	2.50M - 2.60M	115.00 - 120.00

3.3.2 Engine LLP Maintenance Economics

Background

Within engine modules are certain parts that cannot be contained if they fail, and as such are governed by the number of flight cycles operated. These parts are known as critical Life-Limited Parts (LLP) and generally consist of disks, seals, spools, and shafts. The declared lives of LLPs are referenced in Chapter 5 of an engine's overhaul manual, and typically range between 15,000 - 30,000 cycles.

A complete set of LLPs will generally represent a high proportion (greater than 20%) of the overall cost of an engine. If the engine is operated over a long-range network, LLPs may never need to be replaced over the life of the engine. Over short-range routes however, LLPs may need to be replaced two or three times and, consequently, contribute a relatively high cost.

The term stub-life is used to represent the engines shortest life remaining of all LLPs installed in a specific engine. Not all stub-lives are consumed during operation, and quite often the range of cyclic life remaining on an individual LLP at the time of replacement can vary from 3 to 15 percent of total cyclic life.

Certain LLPs can have shorter lives imposed on them by Airworthiness Directives or other technical issues such as a decrease in fatigue characteristic. Additionally, some engine manufacturers certify ultimate lives at the time engine enters into service. Other manufacturers certify the lives as experience is accumulated. In these scenarios ultimate lives are reached after one or several life extensions.

Maintenance Cost Drivers : OEM LLP escalation rates, which typically average 4% - 6% per year.

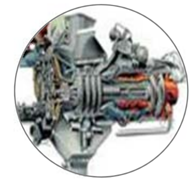
Typical Qualifying Work : Actual out-of-pocket materials cost without overhead or mark-up

Typical Excluded Work : Exchange fees, handling, packaging and shipping charges.

Example LLP Reserve Rate Estimation Based Off Current Life Limits & 10% Stub-Factor

LLP Description	Chpt. 5 - Current Life Limit (FC)	Chpt 5 - Ultimate Life Limit (FC)	LLP Cost - (US $)	LLP Cost Per FC ($/FC)	LLP Cost Per FC - 10% Stub
LLP 1	15,000	20,000	120,000	8.00	8.89
LLP 2	15,000	20,000	120,000	8.00	8.89
LLP 3	15,000	20,000	120,000	8.00	8.89
LLP 4	15,000	20,000	180,000	12.00	13.33
LLP 5	15,000	20,000	180,000	12.00	13.33
LLP 6	15,000	20,000	180,000	12.00	13.33
LLP 7	15,000	20,000	240,000	16.00	17.78
LLP 8	15,000	20,000	240,000	16.00	17.78
LLP 9	15,000	20,000	240,000	16.00	17.78
Totals :			**1,620,000**	**108.00**	**120.00**

3.4 APU Maintenance Economics



Background

The APU is a gas turbine generator that provides auxiliary electrical and pneumatic power to the aircraft. Today's APU have a modular construction for ease of maintenance. The main modules consist of the load compressor, power section and gearbox.

There are various parameters for measuring APU reliability but from a maintenance reserve perspective the most important is the Mean-Time Between Removal (MTBR), which is the average time between removals for all causes ; confirmed removals, unscheduled removals, FOD, and No Fault Found (NFF). MTBRs for APU will vary from manufacturer to manufacturer and model to model, however a representative range is on order of 5,000 – 7,000 APU FH for units operating on narrowbody aircraft and 7,000 – 9,000 APU FH for those on widebody aircraft.

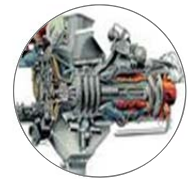
Similar to aircraft engines, APU maintenance costs and MTBRs are sensitive to the type of operation the unit is exposed to. APUs that operates high cycles will tend to have shorter removal intervals and incur lower shop visit costs whereas those operating lower cycles will remain on-wing longer and incur greater hardware deterioration and higher costs.

Major causes resulting from deterioration of rotating parts in the engine include high EGT, high oil consumption, metal in the system, and low pneumatic and/or electrical loads.

Workscopes performed at removal are either for repair or major refurbishment. In the vast majority of cases, APUs that reach their MTBR will require major refurbishment/restoration to be performed. A key objective of the shop visit workscope is to restore EGT margin and ensure that the APU can deliver nominal pneumatic and electrical loads.

The removal interval affects the material input level, which generally increases in proportion to the MTBR. Similar to engines, the cost drivers of APU shop visits are heavily skewed towards material repair & replacement costs, which make up approximately 70%-80% of total cost while labor will account for approximately 20%-30% of total shop visit cost.

3.5 APU Maintenance Economics

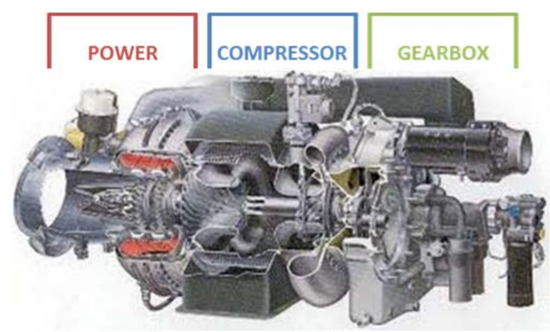


Typical Qualifying Work : Lessor will reimburse lessee from the APU Reserves for the actual cost of a completed performance refurbishment or overhaul of the APU. An APU performance restoration means, at a minimum, the accomplishment of a performance level workscope on the power section module.

Typical Excluded Work : Work related to Service Bulletins (SBs), Service Letters (SLs), Airworthiness Directives (ADs), and work performed for all other causes excluded, including material markup, outside vendor fees, handling fees, packaging and shipping charges. Repair, overhaul or replacement of APU accessories or line replaceable units is not eligible for reimbursement from APU reserves.

Example APU Reserve Rate Estimations

FIGURE 9 – GTCP 131-9A APU MODULAR CONSTRUCTION



A. APU model : GTCP 131-9A – Figure 9.
B. Qualified APU performance restoration means, a shop visit involving the complete disassembly, cleaning, inspection and reconditioning of an APU which restores the power section to zero time and with all work being performed in accordance with the highest standard specified in the Manufacturer's workscope planning guide and overhaul manual.
C. Average APU flight hours for this model is currently 5,500 – 6,500 APU FH, while average costs range for $220K - $240K, resulting in average restoration rates of $35 - $38 per APU FH.

3.5 Maintenance Reserve for Equipment with no Maintenance History

The preceding sections focused primarily on the estimation of maintenance reserves for existing aircraft. But how do we establish reserves for events with no maintenance history, or more importantly, develop fair assessments of both maintenance costs and on-condition intervals for new technology aircraft such as the 787 and A350. Both of these aircraft not only will have new generation engines but also will incorporate extensive use of composite materials in the fuselage and wing structures - from a maintenance perspective, composites are lighter and stronger than traditional aluminum alloys and have a far better resistance than aluminum to fatigue (or the formation of cracks) and they do not corrode, which should produce benefits when it comes to the number and frequency of inspections that have to be performed on the airframe.

The solution to the above will depend on how the contract addresses payment of maintenance reserves. If reserves are to be collected monthly in arrears than the most convenient methods for developing rates consists of either basing them on manufacturers' recommendations or using relative maintenance costs from competing alternatives. Figure 10 illustrates an example of the competing alternative method for projecting mature performance restoration costs for the Trent XWB-79 that is to be equipped on the A350-800.

Figure 10 – Example Calculation of Trent XWB-79 MRs

Engine :	PW 4077	GE90-76	Trent 877	Trent XWB-79
Rating (lbs)	79,000	81,000	77,200	79,000
Aircraft	777-200	777-200	777-200	A350-800
Avg Mature Shop Visit Cost ($M)	$5.8M - $6.4M	$5.6M - $6.2M	$5.8M - $6.4M	$6.0M - $6.4M
Avg Mature Time On-Wing (FH)	16,000 - 20,000	16,000 - 20,000	18,000 - 22,000	18,000 - 22,000
Avg Mature SV Rate ($ / FH)	300 - 330	280 - 320	275 - 295	280 - 310

Avg Stage Length :	8.0
Avg Derate :	10%
Environment :	Temperate

If reserves are to be collected at end of lease in the form of redelivery payments than a sensible method for establishing reserve rates is to agree on sourcing a maintenance event's expected cost and performance interval from reputable repair centers agreed to by both lessor and lessee.

Example Airframe Redelivery Rate Language Employing OEM Sourcing

"An amount equal to the number of months consumed on the Airframe since the last Airframe Heavy Structural Inspection (SI) Check multiplied by a cost per month calculated as follows: the quotient obtained by dividing (i) the expected cost of the next SI by (ii) the full allotment of months between SI on the Airframe as approved by the Maintenance Program.

The cost of the next SI will be established by the following method: "*The expected cost of the SI will be the average of the cost of such SI as performed by or on behalf of Lessee and the amounts quoted by three (3) reputable FAA/EASA maintenance facilities capable of performing such SI, one chosen by Lessor, one chosen by Lessee, and one mutually selected by Lessor and Lessee*."

4. MAINTENANCE RESERVE CONTRACT MANAGEMENT

4.1 Definitions & Interpretations

When drafting a legal document, it is common to have a list of commonly used technical terminologies that are referenced in the Definitions & Interpretations section of a lease document. Many of these technical terminologies relate directly to the use of, and management of, aircraft maintenance reserves. Therefore, it is important to avoid any ambiguity and define words exactly how they are intended to be understood. Most lease contracts include definitions of maintenance reserve events. The following example defines the maintenance reserve definitions associated with the A320 aircraft.

Example Maintenance Reserve Definitions – A320-200 / CFM56-5B4 Engines

i. "*4C/6 Year Check*" means the intermediate airframe structural, CPCP, and zonal inspection of the Aircraft (and resulting repairs), including a C Check, all MPD tasks having an interval of 6 years, and performed concurrently therewith such additional Flight Hour or Cycle controlled MPD structural and zonal inspections and including all lower level checks then falling due.

ii. "*8C/12 Year Check*" means the heavy airframe structural and zonal inspection of the Aircraft (and resulting repairs) including a C Check, all MPD tasks having an interval of twelve years, and performed concurrently therewith such additional Flight Hour or Cycle controlled MPD structural and zonal inspections and including all lower level checks then falling due.

iii. "*Engine Performance Restoration*" means, at a minimum, the accomplishment of a performance level workscope on the High Pressure Compressor (HPC), Combustor, and High Pressure Turbine (HPT) pursuant to the then current engine OEM Workscope Planning Guide and minimum performance level workscopes required on the Fan/Booster, Low Pressure Turbine (LPT) and Gearbox pursuant to the CFM Workscope Planning Guide.

iv. "*Engine Life Limited Parts*" means, those Parts, defined in the Engine Manufacturer's maintenance manual, or by the FAA or EASA or the Aviation Authority through Airworthiness Directives, that require replacement on a mandatory basis prior to or upon the expiration of the Engine Manufacturer's certified life for that Part.

v. "*APU Performance Restoration*" means, with respect to the APU, disassembly and rework of the power section, load impeller and gearbox modules according to the Manufacturer's then current performance restoration and full gas path overhaul criteria.

vi. "*Landing Gear Overhaul*" means an overhaul of a Landing Gear assembly in accordance with the Manufacturer's repair manual that restores such Landing Gear to a "zero time since overhaul" condition.

4.2 Maintenance Reserve Notional Accounts – Development & Management

Lessors establish notional accounts for each maintenance event to manage the accruals and disbursements of funds. Funds may not be transferred from other reserve accounts to cover excess incurred. After the work is performed the lessee pays the maintenance provider and then claims a reimbursement from the lessor out of the accumulated reserve account. Repayment takes place only if payment into the reserve account is fully up to date, and only up to the total value of the specific reserve account ; if the cost of work exceeds the total in the specific reserve account, the excess cost is the responsibility of the lessee. The following example defines the maintenance reserve notional accounts associated with the A320 aircraft – see Appendix B for example maintenance reserve ledger.

Example Maintenance Reserve Notional Accounts – A320-200 Aircraft

Lessor shall maintain the following notional accounts (each an **Account**) in respect of the Maintenance Reserves:

i. *Six Year / Twelve Year Check MR Accounts*, to which all Six & Twelve Year Check MR Payments will notionally be allocated and from which all payments by Lessor will notionally be deducted;

ii. *Engine #1 / #2 Maintenance MR Accounts*, to which all Engine #1 & #2 Restoration Shop Visit MR Payments will notionally be allocated and from which all payments by Lessor will notionally be deducted;

iii. *Engine #1 / #2 LLPs MR* Account, to which all Engine #1 & #2 LLP MR Payments will notionally be allocated and from which all payments by Lessor will notionally be deducted;

iv. *Landing Gear MR Account*, to which all Landing Gear MR Payments will notionally be allocated and from which all payments by Lessor will notionally be deducted;

v. *APU MR* Account, to which all APU MR Payments will notionally be allocated and from which all payments by Lessor will notionally be deducted.

Prior to a qualifying event, the workscope and estimated cost for each notional maintenance event shall be agreed by Lessor and Lessee, and both Lessor or Lessor's representative(s) shall be entitled to observe such work and shall be provided with copies of pertinent documents detailing the scope of work.

In the case of engine performance restoration events, it should highlighted that, "a qualifying performance level workscope seeks to: a.) Obtain the maximum time between shop visits with resultant lower cost per Engine Flight Hour and the greatest potential for regaining EGT margin, and b.) To plan the Life Limited Part stub-life such that engines are removed for LLP at Cycles Since Shop Visits that are consistent with recommended engine build goals."

4.3 Maintenance Reserve Coverage and Exposure

There are a number of performance indicators that serve to measure how a lessor is managing maintenance reserves. The indicators that are most commonly used are Maintenance Coverage and Maintenance Exposure.

Maintenance coverage is a cost-covering indicator, and a measure of how effectively the lessor is able to ensure that every dollar of maintenance consumed is covered through the contractual reserve rate. The essence of maintenance coverage is that in combination with the residual condition of the aircraft the lessor is expected to “remain whole”, that is coverage plus residual condition should equal 100%.

Figure 11 illustrates an example of Maintenance Coverage estimation for an A320 – under the column titled, “Mx Coverage”. Thus, overall coverage of 95.5% indicates that the lessor has $.955 in reserves for every dollar consumed by the lessee. It’s important to note that, despite there being a deficiency in coverage, this does not imply the lessor will incur out-of-pocket expenses given that most leases state that the lessor will only contribute its portion of the cost; if the lessee agreed to pay a below-market rate than it will be accountable for any shortfall. Bottom line is that a lessor will attempt to contribute its portion of the maintenance cost irrespective of whether there is a surplus or short-fall in the fund.

FIGURE 11 – EXAMPLE MAINTENANCE COVERAGE CALCULATION FOR A320 AIRCRAFT

A320 FAMILY - MAINTENANCE ECONOMICS

AIRCRAFT MSN / OPERATOR
MSN : 1234
Operator : XYZ

Notes :
Maintenance Coverage (%) = Contract DMC / Target DMC
Assumed APU Ratio = 0.35/APU FH per Aircraft FH

AIRCRAFT / ENGINE
Aircraft : A320-200
Engine : CFM56-5B4/3

OPERATIONAL PROFILE
Annual FH : 3,860
Flight Leg : 3.0
Eng Derate : 10%
Region : Temperate

EQUIPMENT PHASE
Airframe : First-Run
Engine : First-Run

A320-200 - CFM56-5B4/3 27,000 lbs - MAINTENANCE COVERAGE

			Target Maintenance Reserves				Contractual Maintenance Reserves				Mx
Mtx Event	Cost $	Coverage	$ / Mo	$ / FH	$ / FC	DMC $ / FH	$ / Mo	$ / FH	$ / FC	DMC $ / FH	Coverage
4C/6Y SI	810,000	Yes	11,250	35.00		35.00	11,000			34.20	97.7%
8C/12Y SI	875,520	Yes	6,080	18.90		18.90	6,000			18.70	98.9%
Gear Ovhl	435,000	Yes	3,625		21.75	11.27	3,250			10.10	89.6%
APU Rest	250,000	Yes		36.00		12.60		35.00		12.25	97.2%
Eng Rest	2,300,000	Yes		86.00		172.00		80.00		160.00	93.0%
Eng LLP	2,440,000	Yes			106.00	70.70			106.00	70.70	100.0%
Total :						**320.50**				**306.00**	**95.5%**

There are four forms under which maintenance coverage can be applied. These consist of: 1.) Cash reserves, 2.) Letters Of Credit (LOC), 3.) Maintenance service agreements (i.e. flight-hour agreement coverage), and 4.) Redelivery payments. If, for example, in lieu of cash reserves a lessor was able to obtain letters of credit than this should be construed as being equivalent to cash given the ease (liquidity) of monetizing a LOC. Similarly, events that are subject to maintenance service agreements are considered a form of maintenance coverage provided, however, there exits safe-guard contingencies in the form of assignability and recourse to funds. Lastly, redelivery payments should be accounted under maintenance coverage irrespective of the fact that the cost-covering occurs at the end of the lease term.

If maintenance reserves are either not collected, subject to a redelivery payment scheme, or are under-funded, than the lessor will be subject to maintenance exposure. In monetary terms, maintenance exposure equals the value of maintenance utility consumed less the value of maintenance reserves collected at a particular point in time.

Figure 12 below illustrates the projection of maintenance exposure for an A320 aircraft following an event of default at year four since entry into service; the unfunded maintenance exposure of the aircraft would total approximately $4.9M, and the lessor would likely have to fund this amount during subsequent lease(s).

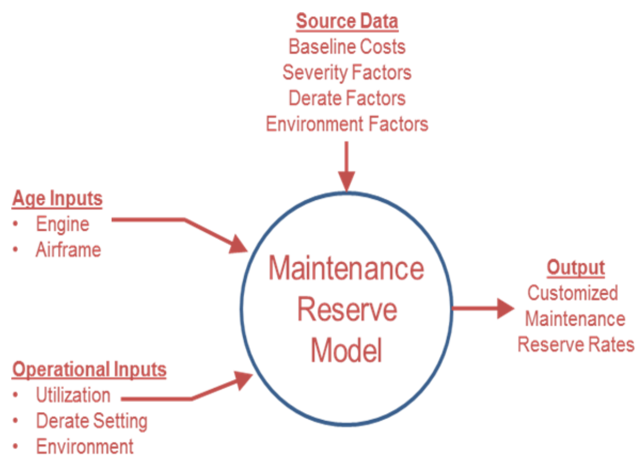
FIGURE 12 – EXAMPLE ESTIMATION OF MAINTENANCE EXPOSURE FOR AN A320 AIRCRAFT AFTER FOUR YEARS SINCE EIS

Maintenance Event	Full-life $ Cost	Residual $	(A) Consumed $	(B) Reserve $	(C=B-A) Exposure
4C / 6-Year SI	810,000	270,000	540,000	0	(540,000)
8C / 12-Year SI	875,520	583,680	291,840	0	(291,840)
Landing Gear Overhaul	435,000	261,000	174,000	0	(174,000)
Engine 1 Performance Rest	2,300,000	972,160	1,327,840	0	(1,327,840)
Engine 2 Performance Rest	2,300,000	972,160	1,327,840	0	(1,327,840)
Engine 1 LLP Replacement	2,440,000	1,894,453	545,547	0	(545,547)
Engine 2 LLP Replacement	2,440,000	1,894,453	545,547	0	(545,547)
APU Performance Rest	250,000	55,456	194,544	0	(194,544)
Totals :	**11,850,520**	**6,903,362**	**4,947,158**	**0**	**(4,947,158)**

4.4 Modeling of Maintenance Reserve Rates

A maintenance reserve model should incorporate baseline maintenance costs, along with those age-related and operational parameters, that are unique to an aircraft/engine type. As illustrated in Figure 13, the inputs to the model should include age-related factors for both the airframe and engines, and key operational parameters such as utilization; derate setting; and region of operation. For a specific aircraft/engine combination, the output of the model should quantify reserve rates that are unique to an airline's operation.

FIGURE 13 – MAINTENANCE RESERVE MODEL INPUTS



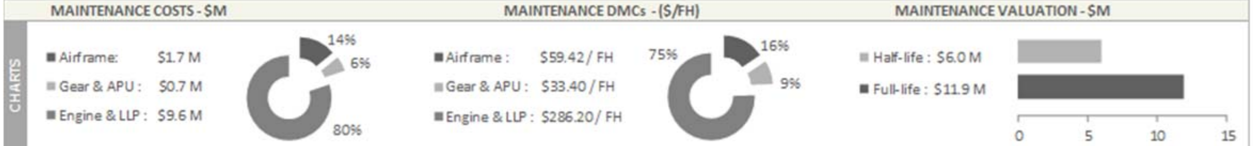
Done properly, reserve models will help us be consistent across transactions in how we view a particular aircraft type, they will help us to be consistent within transactions in how we weigh the impact of one feature against another, and finally, they will help us be consistent over time. Figure 14 illustrates an example of a maintenance reserve model incorporating key operational & age-related variables.

FIGURE 14 – EXAMPLE MAINTENANCE RESERVE MODEL FOR A320 AIRCRAFT EQUIPPED WITH CFM56-5B4/3 ENGINES

A320-200 - CFM56-5B4/3 27,000 lbs - MAINTENANCE RESERVES

EQUIPMENT INPUTS		OPERATIONAL PROFILE INPUTS				EQUIPMENT PHASE INPUTS	
AIRCRAFT	ENGINE	ANNUAL FH	FLIGHT LEG	DERATE	REGION	AIRFRAME	ENGINE
A320-200	CFM56-5B4/3	3,500	2.00	10%	Temperate	First-Run	First-Run

MAINTENANCE COSTS - $M | MAINTENANCE DMCs - ($/FH) | MAINTENANCE VALUATION - $M



MAINTENANCE EVENT	EVENT PHASE	UNIT COST $	EXTEND COST $	MAINTENANCE INTERVALS MO	MAINTENANCE INTERVALS FH	MAINTENANCE INTERVALS FC	MAINTENANCE RESERVES MONTHLY RATE	MAINTENANCE RESERVES UNIT RATE	DIRECT MAINTENANCE COST $ / FH	DIRECT MAINTENANCE COST $ / MONTH
FULL-LIFE VALUS										
Airframe 4C+6Y SI	First-Run	810,000	810,000	72			$11,250 / Mo	$38.57 / FH	38.57	11,250
Airframe 8C+12Y SI	First-Run	875,520	875,520	144			$6,080 / Mo	$20.85 / FH	20.85	6,080
Gear Ovhl		435,000	435,000	120		20,000	$3,625 / Mo	$12.40 / FH	12.40	3,625
APU Restoration		250,000	250,000		11,818			$38.50 / APU FH	21.00	6,125
Engine Rest (x 2)	First-Run	2,340,000	4,680,000		26,000	13,000		$90.00 / FH	90.00	26,250
Engine LLPs (x 2)		2,440,000	4,880,000			20,000		$106.10 / FC	53.10	15,488
FULL-LIFE TOTALS :			11,930,520						379.00	110,555

CFM56-5B4/3 - SEVERITY MATRIX	DERATE	ENGINE FLIGHT LEG							
ENGINE METRIC : DMC - $ / FH	10%	1.0	1.5	1.7	2.0	2.5	3.0	3.5	4.0
FIRST-RUN									
Temperate		$153.50	$109.80	$103.30	$90.00	$88.00	$86.00	$84.00	$82.00
Hot / Harsh		$171.90	$123.00	$115.70	$104.20	$98.90	$94.50	$91.70	$90.00
Erosive		$184.20	$131.80	$124.00	$111.60	$106.00	$101.30	$98.30	$96.50
MATURE									
Temperate		$234.50	$172.40	$158.60	$137.90	$130.30	$124.50	$120.80	$118.60
Hot / Harsh		$262.60	$193.10	$177.60	$154.40	$145.90	$139.40	$135.30	$132.80
Erosive		$281.40	$206.90	$190.30	$165.50	$156.40	$149.40	$145.00	$142.30
BLENDED									
Temperate		$186.50	$134.90	$125.80	$111.90	$105.80	$100.90	$97.90	$96.10
Hot / Harsh		$208.90	$151.10	$140.90	$125.30	$118.50	$113.00	$109.60	$107.60
Erosive		$223.80	$161.90	$151.00	$134.30	$127.00	$121.10	$117.50	$115.30

4.5 Maintenance Reserve Cash Flow Forecasting

Similar to a maintenance reserve model, an effective cash flow forecasting model should enable end-users to reconcile key operational parameters, for example utilization inputs, which dictate the frequency and timing of maintenance events. Additionally, the ideal model should allow for revisions/updates to both maintenance program inputs, such as engine mean-time between removals, and expected maintenance event cost inputs.

For transactions that include reserves, the goal of the model is to accurately forecast timing of maintenance events, monthly revenues & expenditures, and ending reserve balance. In contracts where no reserves are collected, the model should be capable of identifying the timing and amount of maximum exposure.

Example Maintenance MR Cash Flow Projection - The following is an example that illustrates forecasting of maintenance reserve cash flows for an A320 aircraft for two scenarios; a.) Twelve-year term where maintenance reserves have been appropriately established and collections equal total maintenance exposure, and b.) An event of default at year four where no reserves were collected followed by an 8-year lease where maintenance reserves have been appropriately established.

General Assumptions:

i. Separate reserves accounts set up for:
   - Airframe 4C / 6-Year SI & 8C / 12-Year SI Checks
   - Landing Gear Overhaul
   - Engine performance restoration shop visits & LLP replacements
   - APU performance restoration shop visit

ii. Payments, payable monthly in arrears, are calculated
   - On monthly basis for airframe & landing gear events,
   - On a flight hour basis for engine & APU performance restoration, and
   - On a flight cycle basis for engine LLPs

Contract Summary:

LEASE INFORMATION

OPERATOR		AIRCRAFT		LEASE		ANNUAL UTLIZATION	
Operator	XYZ	MSN	1234	Start	15-Jan-12	Forecast FH	3,860
Country	USA	Type	A320-200	Expiry	15-Jan-24	Forecast FC	1,285
Region	North America	DoM	15-Jan-12	Term	144	Forecast FL	3.00
		Engine	CFM56-5B4/3			APU Ratio	0.35

MAINTENANCE RESERVE SUMMARY

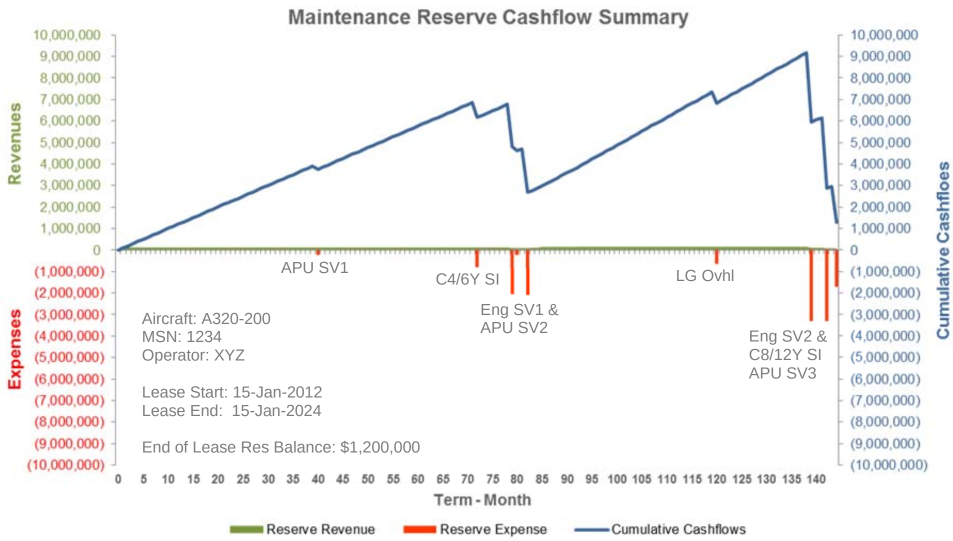
EQUIPMENT	EVENT	PHASE	COST	TARGET RATE		CONTRACT RATE	
Airframe	6YR / 4C	First-Run	$ 810,000	$ 11,250	/ MO	$ 11,000	/ MO
Airframe	6YR / 4C	Mature-Run	$ 931,500	$ 12,940	/ MO	$ 12,000	/ MO
Airframe	12YR / 8C	First-Run	$ 875,520	$ 6,080	/ MO	$ 6,000	/ MO
Landing Gear	Overhaul	First-Run	$ 435,000	$ 3,625	/ MO	$ 3,250	/ MO
APU	Restoration	First-Run	$ 250,000	$ 36.00	/ APU FH	$ 35.00	/ APU FH
Engine Modules	Restoration	First-Run	$ 2,300,000	$ 86.00	/ FH	$ 80.00	/ FH
Engine Modules	Restoration	Mature-Run	$ 2,450,000	$ 127.00	/ FH	$ 125.00	/ FH
Engine LLPs	Replace	First-Run	$ 2,440,000	$ 106.00	/ FC	$ 106.00	/ FC

MAINTENANCE EVENT FORECAST

EQUIPMENT	EVENT	DATE	INT - MO	INT - FH	INT - FC	COST	CONTRIBUTION
Airframe	6YR / 4C	Jan-18	72			$ 810,000	$ 792,000
Airframe	6YR / 4C	Jan-24	144			$ 931,680	$ 864,000
Airframe	12YR / 8C	Jan-24	144			$ 802,560	$ 864,000
Landing Gear	Overhaul	Jan-22	120			$ 435,000	$ 390,000
APU	Restoration 1	Nov-15	46			$ 250,000	$ 245,000
APU	Restoration 2	Mar-19	86			$ 250,000	$ 245,000
APU	Restoration 3	Jul-22	126			$ 250,000	$ 245,000
Eng Pos 1	Restoration 1	Aug-18	79	25,533	8,500	$ 2,300,000	$ 2,042,646
Eng Pos 1	Restoration 2	Aug-23	139	19,525	6,500	$ 2,450,000	$ 2,440,661
Eng Pos 2	Restoration 1	Nov-18	82	26,284	8,750	$ 2,300,000	$ 2,102,724
Eng Pos 2	Restoration 2	Nov-23	142	19,525	6,500	$ 2,450,000	$ 2,440,661
Eng Pos 1	LLP Replace 1	Aug-23	139		15,000	$ 1,090,000	$ 870,000
Eng Pos 2	LLP Replace 2	Nov-23	142		15,250	$ 1,090,000	$ 870,000
TOTALS :						$ 15,409,240	$ 14,411,693

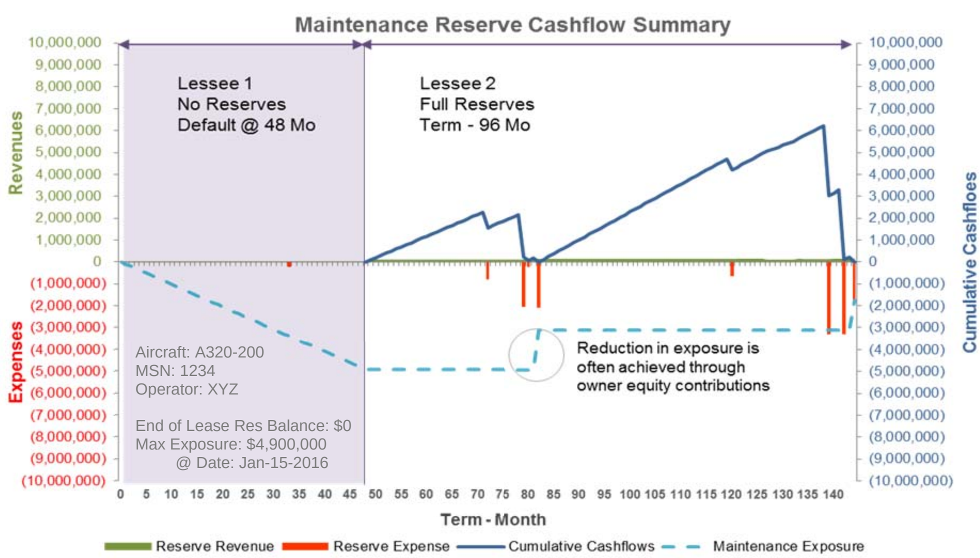
Scenario A:

- 12-Year lease term - maintenance reserves have been appropriately established and collections equal total maintenance exposure.
- Forecasted reserve balance at lease expiry equals $1.2M.



Scenario B:

- Lease term during which no maintenance reserves are collected and Lessee defaults at Year 4.
- Subsequent 8-year lease term during which maintenance reserves have been appropriately established with new Lessee and collections equal total maintenance exposure.
- Maximum exposure equals $4.9M in Year 4.



4.6 Maintenance Reserve Cost-Sharing

In the case of an aircraft that was previously operated by a lessee, the reserve balance at the end of the lease term will represent the lessor's pro-rata fund, which will be allocated towards future contributions with subsequent lessee(s). Whether the amount in each account balance is sufficient to pay for future expenses is immaterial, instead the lessor is bound to contribute its portion of the cost irrespective of whether they have a fund accumulated or not.

Figure 15 below illustrates the notional account balances for A320 aircraft where maintenance reserves have been appropriately established and collections equal total maintenance exposure during: a.) the time of redelivery by lessee to lessor, and b.) after one year of operation with new lessee.

FIGURE 15 – EXAMPLE STATUS OF MAINTENANCE RESERVE NOTIONAL ACCOUNT BALANCES FOLLOWING REDELIVERY OF AN A320

Mtx Event	Leasse A Balance Year 8	Lessor Balance Year 8	Lessee B Balance Year 8	Reserve Balance Year 8	Lessee B Year 1 Contribution	Reserve Balance Year 9
Airframe 4C/6Y	$312,000	$312,000	$0	$312,000	$156,000	$468,000
Airframe 8C/12Y	$624,000	$624,000	$0	$624,000	$78,000	$702,000
LG Overhaul	$336,000	$336,000	$0	$336,000	$42,000	$378,000
Eng 1 Perf Rest	$870,000	$870,000	$0	$870,000	$435,000	$1,305,000
Eng 2 Perf Rest	$870,000	$870,000	$0	$870,000	$435,000	$1,305,000
Eng 1 LLP	$1,000,000	$1,000,000	$0	$1,000,000	$125,000	$1,125,000
Eng 2 LLP	$1,000,000	$1,000,000	$0	$1,000,000	$125,000	$1,125,000
APU Perf Rest	$50,000	$50,000	$0	$50,000	$50,000	$100,000
Total	$5,062,000	$5,062,000	$0	$5,062,000	$1,446,000	$6,508,000

Status at Redelivery from Lessee "A"

Status at Delivery to Lessee "B"

Status after one year operation of Lessee "B"

At the time of a maintenance event the lessor will review a claim and estimate each constituent's financial contribution to the event's total cost. To estimate pro-rata contributions one must estimate the percentage share of a maintenance events performance interval consumed by both lessor and lessee, and multiply these percentages by the expected cost of the event.

Example Cost-Sharing Calculation - The example that follows outlines the steps taken to project lessor and lessee contributions to the aircraft's upcoming 8C/12-Year check based on the aircraft being delivered to new lessee at its 8th year anniversary from entry into service.

- Projected 8C/12-Year Check Cost = $1,800,000
- Lessor Pro-rata Share = 66.67% (96/144)
- Lessee Pro-rata Share = 33.33% (48/144)
- Projected Lessor Contribution = $1,200,000 (66.67% * $1,800,000)
- Projected Lessee Contribution = $600,000 (33.33% * $1,800,000)

4.7 Maintenance Inflation

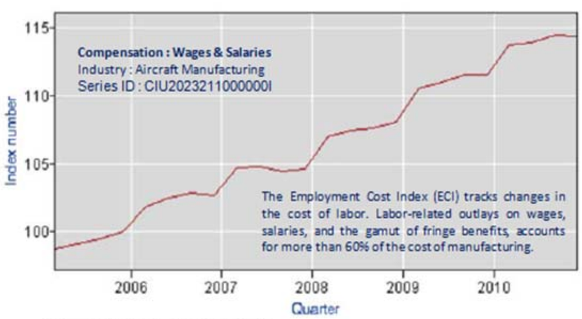
Escalation can be defined as changes in price levels driven by underlying economic conditions. The individual economy-driven factors affecting maintenance cost are mainly labor and material repair & replacement. Manufacturing wage rates increase over time because of overall changes in wages and prices throughout the economy, as well as changes in prevailing wages manufacturers must pay to retain skilled workers.

From a lessor's perspective, escalation is a "risk" that must be factored into a lease agreement. Complicating the issue, price escalation varies for different maintenance events such as airframe heavy checks, which are labor intensive, and engine maintenance, which is material intensive.

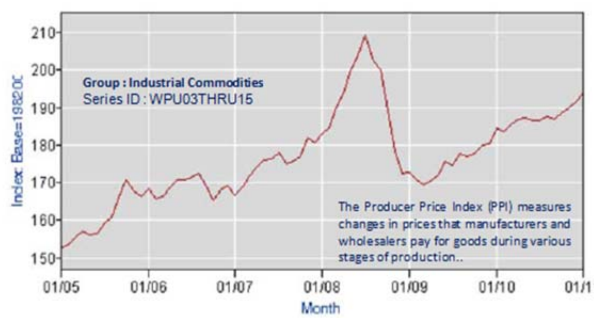
To measure and forecast changes to these cost inputs we need to factor the price escalations of key economic indices that correlate to them. These key indices are illustrated in Figure 16 and consist of: a.) Employment Cost Index (ECI) for aircraft manufacturing wages & salaries, and b.) Producer Price Index (PPI) for industrial commodities. The charts illustrate changes in these key indices during the period of 2006 – 2011.

If we assume a sensible weighting of 70% labor and 30% material we come up with an overall escalation rate averaging between 3% - 4% per year; a range that is generally consistent with many lease contracts. Engine LLPs are exceptions given these parts escalate in accordance with manufacturer's published escalation rates.

FIGURE 16 – MAINTENANCE INFLATION INDICES



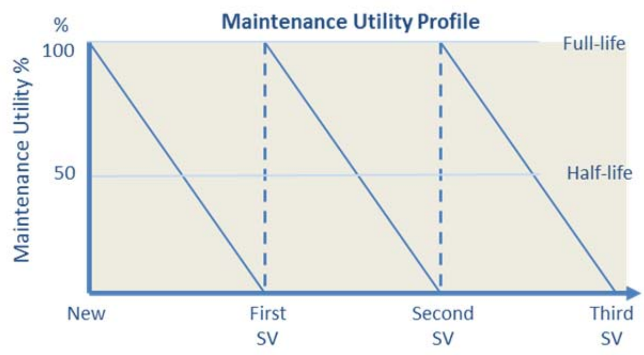
Year	Qtr1	Qtr2	Qtr3	Qtr4
2005	98.8	99.1	99.5	100.0
2006	101.9	102.5	102.9	102.7
2007	104.7	104.8	104.4	104.6
2008	107.0	107.4	107.6	108.1
2009	110.5	111.0	111.5	111.5
2010	113.7	113.9	114.5	114.4



Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	152.7	153.6	155.6	157.2	156.3	156.6	159.1	160.8	166.0	170.6	167.6	166.5
2006	168.3	165.7	166.3	168.8	170.6	170.6	171.3	172.4	169.2	165.4	168.0	168.9
2007	166.8	169.1	171.6	173.9	176.0	176.4	177.9	174.9	175.6	176.9	181.8	180.7
2008	182.8	184.6	190.2	193.8	200.0	204.0	209.5	202.4	200.1	189.3	178.4	172.3
2009	172.6	170.8	169.5	170.3	172.0	175.5	174.6	177.7	176.9	177.8	180.1(R)	180.4
2010	184.6	183.6	185.6	187.0	187.2	186.4	186.7	187.5	186.8	188.7(P)	189.7(P)	191.5(P)
2011	193.7(P)											

APPENDIX A - MAINTENANCE UTILITY

FIGURE 17 – MAINTENANCE UTILITY PROFILE



After a new aircraft enters into service, the airframe, engine, components, and major assemblies are subject to wear, corrosion, and fatigue which inevitably result in some deviation from its original condition. For a particular maintenance event the relationship between maintenance value, expressed in percentage terms and its operating age, expressed in performance intervals, can be illustrated from its maintenance utility curve – see Figure 17. As an event ages, maintenance will depreciate in accordance with its exposure to certain performance intervals, expressed as the number of calendar months, operating hours, flight cycles, or other performance intervals since new or since last shop visit.

The depreciation curve of a maintenance event follows a saw-tooth pattern, and the slope of the curve will be influenced by how each maintenance event's performance intervals are limited. In current regulatory usage, maintenance events can be categorized as either having a finite (hard-timed) limit or on-condition limit.

Hard-time limits are a measure of operating age whereby scheduled removal from service is mandated in order to prevent either critical failure or to comply with recommended scheduled tasks. For example, airframe structural checks are limited by calendar time and/or flight cycles to comply with recommended scheduled tasks, whereas engine life-limited parts are subject to safe life-limits (expressed in flight cycles) to prevent critical failure.

From a utility perspective, hard-time maintenance events have their corresponding values decline to zero and subsequently recapitalized to full value after each event, or in the case of an engine life-limited part, after replacement with a new part.

On-condition limits are framed through monitoring and analysis of key performance metrics to determine whether an item is in, and will remain in, a satisfactory condition or will require corrective maintenance. For example, engines are continuously trend-monitored to assess their overall health and condition; key performance indicators such as Exhaust Gas Temperatures (EGT), fuel flow, oil pressure, fan & compressor speed, and vibration are monitored for exceedance or probability of failure.

From a utility perspective, on-condition maintenance events rarely have their maintenance value fully exhausted during a shop visit and the workscope performed will often only partially restore the value it lost. The table below highlights each of the maintenance processes associated with their events.

APPENDIX B – EXAMPLE MAINTENANCE RESERVE NOTIONAL ACCOUNT LEDGER

Example maintenance reserve ledger – A320 aircraft:

Period Ending	Engine Pos 1 Restoration: Flight Hours Monthly	Flight Hours Total	Rate Per FH	Balance To Date	Actual Payment	Engine Pos 2 Restoration: Flight Hours Monthly	Flight Hours Total	Rate Per FH	Balance To Date	Actual Payment
31-Jan-12	250	250	$85.00	$21,250	$21,250	250	250	$85.00	$21,250	$21,250
28-Feb-12	250	500	$85.00	$42,500	$42,500	250	500	$85.00	$42,500	$42,500
31-Mar-12	250	750	$85.00	$63,750	$63,750	250	750	$85.00	$63,750	$63,750
30-Apr-12	250	1,000	$85.00	$85,000	$85,000	250	1,000	$85.00	$85,000	$85,000
31-May-12	250	1,250	$85.00	$106,250	$106,250	250	1,250	$85.00	$106,250	$106,250
30-Jun-12	250	1,500	$85.00	$127,500	$127,500	250	1,500	$85.00	$127,500	$127,500

Period Ending	Engine Pos 1 LLP Replacement: Flight Cycles Monthly	Flight Cycles Total	Rate Per FC	Balance To Date	Actual Payment	Engine Pos 2 LLP Replacement: Flight Cycles Monthly	Flight Cycles Total	Rate Per FC	Balance To Date	Actual Payment
31-Jan-12	125	125	$100.00	$12,500	$12,500	125	125	$100.00	$12,500	$12,500
28-Feb-12	125	250	$100.00	$25,000	$25,000	125	250	$100.00	$25,000	$25,000
31-Mar-12	125	375	$100.00	$37,500	$37,500	125	375	$100.00	$37,500	$37,500
30-Apr-12	125	500	$100.00	$50,000	$50,000	125	500	$100.00	$50,000	$50,000
31-May-12	125	625	$100.00	$62,500	$62,500	125	625	$100.00	$62,500	$62,500
30-Jun-12	125	750	$100.00	$75,000	$75,000	125	750	$100.00	$75,000	$75,000

Period Ending	Airframe - 4C / 6-Year SI: Calendar Months Monthly	Calendar Months Total	Rate Per Mon	Balance To Date	Actual Payment	Airframe - 8C / 12-Year SI: Calendar Months Monthly	Calendar Months Total	Rate Per Mon	Balance To Date	Actual Payment
31-Jan-12	1	1	11,500	11,500	11,500	1	1	6,000	6,000	6,000
28-Feb-12	1	2	11,500	23,000	23,000	1	2	6,000	12,000	12,000
31-Mar-12	1	3	11,500	34,500	34,500	1	3	6,000	18,000	18,000
30-Apr-12	1	4	11,500	46,000	46,000	1	4	6,000	24,000	24,000
31-May-12	1	5	11,500	57,500	57,500	1	5	6,000	30,000	30,000
30-Jun-12	1	6	11,500	69,000	69,000	1	6	6,000	36,000	36,000

Period Ending	Landing Gear Overaul: Calendar Months Monthly	Calendar Months Total	Rate Per Mon	Balance To Date	Actual Payment	APU Restoration: APU Flight Hours Monthly	APU Flight Hours Total	Rate Per APU FH	Balance To Date	Actual Payment
31-Jan-12	1	1	3,500	$3,500	$3,500	200	200	35.00	$7,000	$7,000
28-Feb-12	1	2	3,500	$7,000	$7,000	200	400	35.00	$14,000	$14,000
31-Mar-12	1	3	3,500	$10,500	$10,500	200	600	35.00	$21,000	$21,000
30-Apr-12	1	4	3,500	$14,000	$14,000	200	800	35.00	$28,000	$28,000
31-May-12	1	5	3,500	$17,500	$17,500	200	1,000	35.00	$35,000	$35,000
30-Jun-12	1	6	3,500	$21,000	$21,000	200	1,200	35.00	$42,000	$42,000

Period Ending	Total Ending Balance	Actual Ending Balance
31-Jan-12	$95,500	$95,500
28-Feb-12	$191,000	$191,000
31-Mar-12	$286,500	$286,500
30-Apr-12	$382,000	$382,000
31-May-12	$477,500	$477,500
30-Jun-12	$573,000	$573,000

APPENDIX C – EXAMPLE MAINTEANCE RESERVE LETTER OF INTENT LANGUAGE

Lessee shall pay maintenance reserves monthly in arrears for the Aircraft in the following amounts:

"Airframe Checks" - (a) US $11,250 per Month for the 4C/6-Year Structural Inspection per the Airbus MPD. Following completion of the first 4C.6-Year Structural Inspection, this amount will be increased to US $12,500 to account for aging of the airframe. (b) US $6,250 per Month for the 8C/12-Year Structural Inspection per the Airbus MPD. Following completion of the first 8C/12-Year Structural Inspection, this amount will be increased to US $7,000 to account for aging of the airframe.

"CFM56-5B/4 Engines"- (a) Engine Modules - Reserves for Performance Restoration shall be paid for each flight hour for each of the engines. The rate shall be established from the applicable matrix below based on the anticipated hour to cycle ratio and region of operation- the amounts below assume an average thrust de-rate of 10% and temperate operating environment.

From Delivery through the first Performance Restoration

Flight Leg	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Rate $ / FH	165	125	100	98	95	90	88

Following the first Performance Restoration

Flight Leg	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Rate $ / FH	240	190	145	142	139	136	134

(b) "Engine LLP's" – For each LLP within each Engine, the LLP catalogue price for such LLP divided by 90% of the then current cycle life limit for such LLP.

"Landing Gear" - US $20.00 / FC but not less than US $3,500 / Month for overhaul.

"APU" - US $38 per APU running hour for performance restoration.

The hours and cycles to calculate the reserve payments shall be provided to Lessor on or prior to the 10th day of each month for the prior month's utilization. The above amounts are quoted in January 20XX US dollars and shall be adjusted X% on January 1st of each year thereafter, with the exception of the engine LLPs, which shall be escalated in accordance to the then OEM LLP catalogue prices.

Adjustments to the maintenance reserve rates will be made if the maintenance program, engine thrust or derate, operating environment, and hour to cycle ratios or utilization vary from the original assumptions.

APPENDIX D – MAINTENANCE COSTS, INTERVALS & RESERVE RATES

1.0 Airframe Heavy Structural Inspection Costs, Intervals & Reserve Rates

- Assumes full workscope (systems, structures & zonal & material)

Aircraft	Check	Phase	Interval	Costs - 2010 $	Rates ($ / Mo)
A320-200	4C / 6Y SI	First-Run	72 Months	$750K - $850K	$10,400 - $11,800
A320-200	8C / 12Y SI	First-Run	144 Months	$850K - $900K	$5,500 - $5,900
A330-300	4C / 6Y SI	First-Run	72 Months	$1.4M - $1.6M	$19,500 - $22,200
A330-300	8C / 12 Y SI	First-Run	144 Months	$1.5M - $1.7M	$10,400 - $11,800
B737-800	C6-C8 Equivalent	First-Run	120 / 144 Mo	$1.3M - $1.5M	$9,000 - $12,500
B747-400	C4 / D-Check	Ageing	72 Months	$4.0M - $4.5M	$55,500 - $62,500
B757-200	S4C	Ageing	72 Months	$1.5M - $1.7M	$22,200 - $23,600
B767-300ER	S4C	Ageing	72 Months	$2.0M - $2.3M	$27,800 - $31,900
B777-300ER	C4 / SI	First-Run	96 Months	$2.5M - $2.8M	$26,000 - $29,100
E190	C4 / SI	First-Run	96 Months	$475K - $575K	$4,900 - $5,900
CRJ-700	HSI	First-Run	96 Months	$425K - $525K	$4,400 - $5,400

2.0 Landing Gear Overhaul Costs, Intervals & Reserve Rates

- Assumes cost for exchange unit plus removal/installation labor

Aircraft	Interval	Costs - 2010 $	Rates ($ / Mo)
A320 Family	10 YR / 20,000 FC	$380K - $450K	$3,200 - $3,500
A330 Family	10 YR	$875K - $925K	$7,300 – $7,700
B737NG Family	10 YR / 18,000 FC	$330K - $380K	$2,700 - $3,200
B757 Family	10 YR / 18,000 FC	$425K - $475K	$3,500 - $4,000
B767 Family	10 YR	$550K - $600K	$4,500 - $5,000
B747 Family	10 YR / 6,000 FC	$750K - $800K	$6,250 - $6,750
B777 Family	10 YR	$1.0M - $1.2M	$8,300 - $10,000
E190 Family	10 YR / 20,000 FC	$325K - $350K	$2,700 - $2,900
CRJ 700 Family	10 YR / 20,000 FC	$190K - $230K	$1,600 - $1,900

APPENDIX C – MAINTENANCE COSTS, INTERVALS & RESERVE RATES

3.0 Engine Performance Restoration Costs, Intervals & Reserve Rates

Engine	Thrust	Phase	FL	Time On-Wing (FC)	Costs 2010 $	Rate ($ / FH)
CFM56-5B6/P	23.500	First-Run	1.7	16.000 -17.000	$2.0M - $2.2M	$72- $80
CFM56-5B4/P	27,000	First-Run	2.0	11,500 -12,500	$2.0M - $2.2M	$86 - $96
CFM56-5B3/P	33,000	First-Run	2.0	7,500 – 8,500	$1.8M - $2.2M	$124 - $134
CFM56-7B24/P	24,000	First-Run	1.7	17,000 – 18,000	$2.0M - $2.3M	$70- $78
CFM56-7B26/P	26,300	First-Run	2.0	12,500 – 13,500	$1.8M - $2.2M	$78- $88
CFM56-7B27/P	27,300	First-Run	2.0	10,000 – 12,000	$2.0M - $2.2M	$86 - $96
V2524-A5	24,000	First-Run	1.7	15,000 – 16,000	$1.8M - $2.2M	$72 - $82
V2527-A5	27,000	First-Run	2.0	15,000-11,500	$1.8M - $2.2M	$95 - $105
V2533-A5	33,000	First-Run	2.0	6,500 – 7,500	$1.8M - $2.2M	$135 - $145
Trent 772	71,200	First-Run	6.0	3,500 – 4,000	$3.6M - $4.2M	$185 - $195
PW4068	68,000	First-Run	6.0	3,000 – 3,500	$3.2M - $3.6M	$180 -$190
PW4070	70,000	First-Run	6.0	2,750 – 3,250	$3.5M - $4.0M	$195 - $205
CF6-80E1A4	70,000	First-Run	6.0	3,000 – 3,500	$3.0M - $3.4M	$165 - $175
GE90-115B	115,00	First-Run	8.0	2,250 – 2,750	$4.4M - $4.8M	$250 - $260

4.0 APU Performance Restoration Costs, Intervals & Reserve Rates

Aircraft	Interval - APU FH	Costs - 2010 $	Rates ($ / APU FH)
A320 Family	5,000 – 7,000	$210K - $240K	$32 - $38
A330 Family	6,000 – 7,000	$350K - $375K	$40 - $45
B737NG Family	5,000 – 7,000	$210K - $240K	$32 - $38
B757 Family	4,000 – 6,000	$200K - $225K	$37 - $42
B767 Family	4,000 – 6,000	$200K - $225K	$37 - $42
B747 Family	8,000 – 9,000	$425K - $475K	$48 - $53
B777 Family	7,500 – 8,500	$425K - $475K	$50 - $55
E190 Family	5,000 – 7,000	$160K - $180K	$31 - $36
CRJ 700 Family	4,000 – 5,000	$130K - $160K	$30 - $35

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Shannon Ackert is currently Senior Vice President of Commercial Operations at **Jackson Square Aviation** where he has responsibility of the firm's commercial activities including technical services, contract development & negotiation, and asset selection & valuation. Mr. Ackert received his B.S. in Aeronautical Engineering from Embry-Riddle Aeronautical University and MBA from the University of San Francisco. Shannon started his career in aviation as a flight test engineer for McDonnell Douglas working on the MD-87/88 certification programs, and later worked for United Airlines as systems engineer in the airlines 757/767 engineering organization. After completing his MBA in 1999, Shannon joined GATX's aircraft leasing business unit as Director where he specialized in identifying and quantifying the expected risk and return of aircraft investments. Mr. Ackert has published numerous research reports with emphasis on aircraft maintenance economics, and is a frequent guest speaker at aviation conferences.