A320s with the highest number of accumulated FH & FC are approaching the aircraft's original design life limits of 60,000FH & 48,000FC. There are now several changes to the aircraft's MPD and a package of structural modifications, detailed in SBs, that allow the aircraft's life limits to be extended up to 120,000FH & 60,000FC.

A320 ageing & life extension modifications

The A320 was initially released with a design life of about 25 years, assuming an average flight time of 1.25 flight hours (FH) per flight cycle (FC). One issue, however, has been that the actual utilisation of aircraft in the fleet has been closer to 1.8-2.0 FH per FC.

As a result of this utilisation pattern, the aircraft's maintenance planning document (MPD) has been adjusted to account for the difference in the predicted stresses imposed on the airframe.

Another issue is that many aircraft in the fleet have exceeded their original design life limits.

The initial system and structural fatigue test results found in the design phase back in the 1980 have now had to be adjusted, as Airbus looks into the effects that flying for longer and higher have had on the aircraft. This analysis has been carried out through fleet sampling and testing to adjust the MPD accordingly. The net result is that adjustments to the aircraft's maintenance programme and structural modifications have therefore had to be introduced.

A320 fleet & utilisation

There are about 1,400 A319s, 3,400 A320s, and 890 A321 aircraft in service or parked. Of the available accumulated FH and FC data for the fleet, a summary *(see table, page 49)* has been produced to illustrate the more common rates of utilisation of the aircraft in service today.

The A320 fleet leaders that have accumulated more than 40,000FH, and have averaged close to 2.0 FH per FC, are airlines like Lufthansa, United Airlines and US Airways. These airlines' aircraft have stayed with them through most of their operating life.

A321 fleet leaders that have averaged over 2.0 FH per FC and accumulated more than 40,000FH, are with airlines like Lufthansa, US Airways, Alitalia, and Thomas Cook (Scandinavia).

Aircraft life limits

While the in-service FH:FC ratio has been monitored, Airbus has also had to evaluate the effects of aircraft approaching and exceeding their original design limits on maintenance planning.

Each aircraft's individual modification status, aircraft weight, and utilisation complicates the issue of life limits. In general, however, a basic guide for the operational life limit of A318, A319, A320 and A321 aircraft is 60,000FH and 48,000FC. These limits are 77,400FH and 18,000FC for the A319 Corporate Jet variant. These original limits are also known as the Limit of Validity (LOV) or Design Service Goal (DSG).

Some additional and revised inspection tasks have been added to the MPD to deal with aircraft that are approaching or have passed the original design limits. These revised and new MPD tasks are generated in one of five MPD source documents called the Airworthiness Limitation Section (ALS), and are required to ensure the continued and safe operation of the aircraft.

By revising and shortening the intervals of some tasks, and adding others to the MPD and maintenance programme, aircraft can have the LOV and DSG extended from 60,000FH to 80,000FH. This FH extension is offset, however, against a reduction in the FC limit from 48,000FH to 37,500FC.

The LOV and DSG limits can then be further extended to 120,000FH and 60,000FC, if required.

MPD & structural modifications

Two of these MPD modifications (currently under revision) are: 37734 (service bulletin (SB) A320-00-1198) 'A320 family lifetime extension – certify intermediate service goal (ISG)'; and 39020 (SB A320-02-1001) 'A320 family lifetime extension – certify extended service goal (ESG1)'.

The first modification 37734 ISG SB gives instructions that allow operation up to the extended LOV of 80,000FH or 37,500FC.

The second modification 39020 ESG1 gives instructions that allow operation up to the extended LOV of 120,000FH or 60,000FC.

An example of a change to the maintenance programme is the CMR task. This is the functional check of the protection of the airframe pressure relief safety valves.

The interval for this inspection for standard aircraft is 50,000FH. For post-modification (post-mod) 37734 ISG aircraft, the interval is shorter at 44,000FH, and for post-mod 39020 ESG1 aircraft, it is 36,000FH. This illustrates how tasks would be moved to different base checks in accordance with the aircraft's modification status, and how maintenance programmes would have to be adjusted before the aircraft reaches the DSG.

While shuffling inspection task intervals involves comprehensive monitoring by the maintenance planners, it does not have a big effect on the number of man-hours (MH) used in checks. Changes are easily absorbed into the standard base check cycle input arrangements without altering downtimes.

There are, however, eight major structural modification and strengthening SBs. These were released to customers to start the discussion process in late 2012, with continued development up to 2014. The SB numbers and price of the kits will officially be released at a later date.

This package of SBs outlines new procedures for extending the LOV and DSG FH and FC limits. These eight SBs provide alternative and additional content to the existing 37734 maintenance programme modifications, and importantly further develop modification 39020.

The SBs provide greater flexibility in

A320 FAMILY AGE & ACCUMULATED FH FLEET DISTRIBUTION

	A319 AIRCRAFT	AVERAGE AGE	AVERAGE FH:FC RATIO	A320 AIRCRAFT	AVERAGE AGE	AVERAGE FH:FC RATIO	A321 AIRCRAFT	AVERAGE AGE	AVERAGE FH:FC RATIO
20,000FH TO 29,000FH	344	11 YRS	1.60:1	408	12 YRS	1.80:1	91	11 YRS	1.86:1
30,000FH TO 39,000FH	235	13 YRS	1.60:1	383	15 YRS	1.85:1	116	13 YRS	1.67:1
40,000FH TO 49,000FH	160	15 YRS	1.90:1	291	16 YRS	1.80:1	120	15 YRS	2.00:1
50,000FH TO 59,000FH	53	16 YRS	2.40:1	121	19 YRS	1.86:1	4	17 YRS	2.34:1
60,000FH +	0	M/A	N/A	145	21 YRS	2.37:1	1	17 YRS	2.96:1

the extended trade-off of FH and FC in the extended LOV/DSG to suit operators' current fleet usage parameters. Details of the eight new strengthening SBs are now available to Airbus customers. As a guide, 800-1,000MH will be needed to incorporate them. This work has been carried out on trial aircraft by Airbus in partnership with high-FH customers.

With the extensive access requirements, these eight SBs would be best performed during a structural inspection check. They are most likely to be applied to aircraft during their second heavy structural check.

Examples of the structural strengthening are in the areas of the torsion box sections and on specific fuselage frames.

There are also six additional minor SBs, that use about 300MH. These are listed as optional for attention at areas of the aircraft structure, such as water service panels and emergency exit structure.

Aircraft owners and operators will therefore have to plan future life extensions in advance, and pre-order the modification kits for the eight structural SBs. They will also have to budget for the cost of the modification when planning to operate the aircraft beyond 80,000FH. This planning may start as early as reaching the 60,000FH mark.

There are also some specific aircraft component upgrade SBs that must to be carried out to allow the operators to fly beyond the DSG thresholds. Most of these are based around components for the landing gear and pneumatic systems.

In addition to the approval for life extension, close scrutiny is also required on aircraft fuselage repairs and the effect they have on the ageing airframe. Some lessors are already pre-empting the request for life extensions on their fleet and asking Airbus at point-of-repair issue for this to be taken into consideration. This could save about $5,000 per repair on repeat evaluation requests at a later date. Each operator choosing to extend the LOV of their aircraft will need to approach Airbus.

Knowing which DSG programme that each aircraft is operating with is an important consideration for lessors or operators that are sourcing ageing airframes. An aircraft's DSG status should match its planned years of remaining usage.

MPD development & tasks

The A320's MPD is a constantly changing document. It has to react to in-service fleet data with new inspection tasks for areas of common defect findings, or alter man-hour (MH) details given as a guide to budget against.

The MPD can be used to produce the maintenance requirements and a customised scheduled maintenance programme. The MPD also comprises maintenance tasks required by other documents like the maintenance review board (MRB) report, configuration maintenance and procedures (CMP) documents, airworthiness directives (ADs), SBs and the ALS.

Compliance with all of these source documents is required for continued airworthiness. All tasks listed in the MPD will have their source information listed next to the threshold and interval column.

The breakdown of the current MPD (Revision 39), released in July 2013, follows a standard format of a systems section, an auxiliary power unit (APU)/powerplant section; a structures section; and a zonal section.

The industry is anxiously awaiting Revision 40, because it has been a long time since revision 39. One of the points of interest will be the changes to the DSG procedures, some of which may result from adding maintenance inspections from the ALS section.

The ALS section

As described, the ALS has the revised and new MPD tasks that allow the extended LOV and DSG limits.

The ALS document (or Parts 1 to 5) was developed to control the threshold and intervals of ageing systems, components and structures by generating inspection and overhaul tasks. Many of the tasks that are listed correspond to, or are then entered within, the body of the MPD sections as a task number, and become part of that aircraft's maintenance programme.

The ALS parts 1 to 5 provide each mandatory replacement time or interval of specific components, structural inspections interval data, and related structural inspection procedures. This has become more important as the aircraft ages and accumulates a high number of FH and FC.

ALS Part 1

The first part of the ALS is the safe life (SL) airworthiness limitation items (ALIs).

The ALS part 1 focuses on the landing gear and gear support structure fatigue life. The fatigue lives for each of the gear and support structure components are displayed on detailed tables with aircraft model type versus landing cycle information, and component number.

Gears are one of the primary targets of investigation when the aircraft changes operator or owner. The traceability of all landing gear parts and components needs to be readily available and accurate in maintenance records.

The MPD itself has a task threshold for the overhaul of the gears. The ALS part 1 document, however, goes into the detail of each subsection of the gears' components' life limits.

In general the gears are changed every 10 years. Removal and installation uses about 330MH, and overhauls can cost in $150,000. It is important to carry out airframe side inspections (on the wing-to-gear attachment area) at the same time to clear the tasks in the MPD which require the gears to be removed for the inspection.

Part one of the ALS contains no MPD numbers. The ALS document has life limits, however, that will trigger the overhaul of the gear through using the equivalent MPD task number.

Two groups of adjustments to the A320's MPD and a group of eight structural modifications allow the aircraft's original design life limits to be extended from 60,000FH & 48,000FC up to 120,000FH & 60,000FC.

ALS Part 2

The second part of the ALS is the damage-tolerant ALIs. This section contains numerous structural inspection tasks on the fuselage, empennage, wing, pylon, and engine component structure.

These tasks are often classed as structurally significant inspection (SSI) tasks, and normally have extensive access requirements to locate damage to structural elements that could affect the aircraft's airworthiness. It is from this part of the ALS that many of the MPD structural inspections are generated. More than 800 MPD inspection tasks are generated via this section of the ALS, and are actually listed as MPD numbers.

The tasks range from general visual inspections (GVI) to special detailed inspections, which involve specialised non-destructive testing equipment. The intervals range from tasks which would fall into A check thresholds to high access heavy base check inputs.

ALS Part 3

The third part of the ALS is the certification maintenance requirements (CMRs). These are a mix of safety-related tasks.

CMR task intervals are based on statistical averages and reliability rates, and have FC, FH and calendar time intervals. Examples of CMR tasks are operational checks of key flight control systems, including electrical and hydraulic systems, alternate systems (often back-up systems) and general flight safety and passenger safety systems.

There are 42 CMR tasks listed in this section, ranging from: 90FH repeat interval inspection tasks for the operational check of the AC generation static inverter; to 60,000FH repeat intervals for the functional check of the brake accumulator system, which stores a charge of nitrogen in a cylinder to maintain limited reserve braking when hydraulic power is switched off.

These tasks do not have MPD numbers listed in the ALS section. They will, however, trigger MPD numbers where 'CMR' can be found referenced in the source column.

ALS Part 4

The fourth part of the ALS is the ageing systems maintenance (ASM) group of tasks.

Tasks generated in this section of the ALS allow operation of aircraft systems beyond their original design life limits. The section details components that are mandatory to replace, or on which repeat inspections must be performed to maintain the aircraft's airworthiness. The document looks at the preventative maintenance requirements within the relevant system's operational life, and how characteristics could change and be susceptible to ageing. This section covers the ram air turbine and actuator, gear retraction actuator cylinders, and air data modules.

Like part 1 of the ALS, part 4 contains no MPD numbers. The ALS document has life limits, however, that will trigger the overhaul or inspection of the required item via its MPD number.

ALS Part 5

The fifth part of the ALS is the fuel ALIs. These requirements comprise the critical design configuration control limitation (CDCCL) tasks. These are designed to prevent unsafe conditions within the fuel system as a result of maintenance actions, repairs or alterations that could create an ignition source within the fuel system.

This section lists modifications which are based on ADs and SBs. These focus on fuel-related systems, and also refer to instructions in the aircraft's maintenance manual (AMM).

ALS part 5 tasks appear in the MPD, or can be triggered by maintenance actions as a result of defects found during scheduled maintenance. This means the tasks can be triggered by regular time intervals or by the disturbance of the specific system during maintenance. For example, the operational check of the tank vapour seal and vent drain system will be required at its 6-year interval or triggered by disturbance via instructions in the aircraft maintenance manual (AMM) chapter 28-18-00-700. If the second option occurs, the mechanics on the floor will record the inspection on their paperwork for the check. This will then be logged by the maintenance planners for the aircraft records.

Summary

A320 modification programmes, which refer to DSG extension up to 120,000FH and 60,000FC, bring out the bigger question of the financial viability of maintaining the aircraft beyond the age of 30 to 40 years.

Aircraft nurtured enough to be utilised to these thresholds are most likely to have been fully owned by operators, and used for ad hoc work when needed. If still in good condition, the profit margins of an aircraft that only owes back maintenance costs and cash operating costs would be attractive. Maintaining a stock of older aircraft parts and certain components would be another issue.

As the new airframe strengthening process for life extension is still being finalised, along with the DSG threshold rules currently changing, this is an interesting area to watch from Airbus at the moment. Full details when available will be examined in the future.