

Extension lead

Stap Con Stapperer

Nearly 30 years after the A320 entered service, Airbus is preparing to publish maintenance tasks for the latest neo variant, while further optimising requirements for established models. **Ian Goold** reports

For redesigned parts on the A320neo (including powerplant and related systems), direct maintenance costs are 54% lower than for the A320ceo. This was achieved by both fewer tasks and longer intervals between inspections (*photo: Airbus*) A sthe first A320 twinjet is prepared for consignment to a museum after three decades of flight-testing, Airbus is about to publish maintenance-related tasks for the latest neo variant and for aircraft equipped with Sharklet wingtips, while continuing to optimise requirements for the whole single-aisle family. The European manufacturer is also developing a new fatigue monitoring programme, but has decided not to lengthen the type's 120,000 flight-hour (FH)/60,000 flight-cycle (FC) extended service goal (ESG).

Although there is no calendar-age limit for A320 revenue service, after more than a quarter-century of operation, the design is among the most in-demand narrowbody candidates as a source for spare parts.

Optimisation of A320 maintenance requirements saw more than 200 tasks (including all C check zonal work) reviewed during several systems and powerplant working-group meetings last year, Torsten Roeger, Manager Maintenance Programme A318/A319/A320/ A321, Airbus Customer Services. "For around 60%, an interval increase could be justified, [while for] around 10% the tasks have been deleted."

Under plans to refine light maintenance tasks, operators and maintenance-review board (MRB) authorities comprising the A320 industry steering committee (ISC) recently agreed to review typical A check requirements in an effort that could see inspection intervals increased from 750 FH and/or 750 FC and/or 120 day periods introduced eight years ago. The review will start in the second half of this year and is expected to be completed "by mid-2019", according to Roeger.

As well as recommending procedures for aircraft being flown in low or high utilisation regimes, Airbus offers customised solutions that allow operators to optimise maintenance programmes and/or planning (see box story, page 16). "The goal is to increase aircraft availability, improve cost-effectiveness, and reduce maintenance costs, while maintaining safety. Optimisation needs to be combined with tailored planning [and our] programmes have been designed to consider pre-packaged checks."

João Oliveira, Fleet Engineering, Maintenance Program Engineer at TAP M&E, says Airbus has simplified the maintenance-planning document (MPD) by "restricting source documents to MRB Report (MRBR), Airworthiness Limitation Section (ALS), ETOPS and, Configuration, Maintenance and Procedures (CMP) documents; removing other non-essential sources – AD/SBs and service-information leaflets (SILs); Vendor Recommendation Policy [revision]; and coordination and synchronisation between revisions of different source documents." (Airbus tells *MRO Management* that SIL documents are "about to be replaced by In Service Information (ISI).")

"The next MRBR change (Revision 22) will reflect results from evolution activities and cover requirements developed during A321 ESG development and A321neo certification," according to Roeger. Publication is planned for March 2017, with A321 ESG introduced in MPD Rev 43, MRBR Rev 22, ALS Part 2 Rev 6, and ALS Part 3 Rev 5. Last June's MRBR Rev 21 covered tasks for A320neos powered by CFM International Leap-1A engines and optimisation of the systems section, says Oliveira.

The last adjustment to A320 maintenance schedules was in December 2010, when C check intervals were extended from 6,000 FH and/or 4,500 FC and/or 20 months to 7,500 FH and/or 5,000 FC and/or 24 months. Similarly, A check timing was raised to 750 FH and/or 750 FC and/or 4 months from 600 FH and/or 750 FC and/or 100 days in March 2009. More than 12 years ago, in June 2004, A320 heavy check periods increased from 5 to 10 years and 10 to 12 years.

The manufacturer's philosophy is to move from 'hard' intervals to more-flexible concepts, with

operators grouping checks according to the type of operation. Two years ago, over 100 C check tasks saw intervals raised from 24 to 36 months (or FH/FC equivalent) or deleted.

A 2016 review permitted more operators to make the same extension to base-check intervals without significantly increasing the scope of A check events (tasks that do not achieve 36 months must be scheduled during A checks). Ahead of 6 year heavy checks, A320 Family structure-inspection requirements do not impose aircraft ground time longer than an overnight stop.

Now, an Airbus belief that the A320 Family maintenance programme will benefit from yet further optimisation has stimulated the upcoming review of light checks, although the manufacturer is cautious about the rate of such development. Asked about possible timing for an increase in 36 months (or equivalent FH/ FC) intervals, Roeger says that Airbus has focused on "achieving 36 months for typical base-check tasks. Then, we need to collect data from task performances at the increased interval. There are currently no plans for the next steps; this will be driven by in-service feedback."

In line with Airbus' move to synchronise revision of maintenance documents, the current A320 Family MPD (Rev 42) appeared in June 2016 alongside MRBR Rev 21 (and included ALS Part 2 Rev 5, Part 3 Rev 4, Part 4 Rev 4, and Part 5 Rev 3). TAP M&E's Oliveira says that SILs and SBs comprised "less than 10% of revised MPD tasks", while Lee Burgess, Head of Engineering at Monarch Aircraft Engineering Limited (MAEL), notes that last June's revisions to four out of five ALS Parts have been supplemented by several variations.

According to Oliveira, while most ALS changes had been triggered by the introduction of the A320neo, Part 2 has "suffered significant changes to incorporate new widespread fatigue damage (WFD) requirements and revised tasks for Sharklet-retrofitted aircraft." Also, ETOPS CMP documents were not changed before the current MPD revision. ►



TAP M&E claims to lead retrofitting of Sharklet wingtips, having completed five A320s and the only ACJ319 corporate jet modification. In early 2017, it was processing the first of four aircraft nose-to-tail installations.

Next, the MRO expects to install Sharklets on three more A320s for its parent fleet, according to Armando Macedo Ferreira, Marketing & Sales, Head of Airframe and Components Sales Office at TAP M&E. "We are negotiating with customers to continue with a nose-to-tail line during 2018."

Installing the new wingtips on in-service legacy aircraft requires wing structural reinforcement to accommodate increased loads, says Ferreira. Additionally, several avionics components – such as the performance database, spoiler/elevator computer, elevator/aileron computer, flight-augmentation computer, flight-control data computer, and fault-warning computer – must be upgraded to cope with different wing-lift capability.

"TAP M&E's Sharklet modification line can accommodate six to seven aircraft/year," says Ferreira, who claims the MRO has performed the retrofit both alone and simultaneously with a C check and painting without increasing the planned turnaround time.

Sample tasks introduced in the current MPD include inspections of the modified wing (see Table A, page 18). When A319s/A320s reach 42,000 FC or 84,000 FH, and thereafter at 10,400 FC/20,800 FH intervals, the ALS calls for detailed inspection of outer wing bottom skin stringers 4-8 and 11-13 (including drain holes) between Ribs 8 and 18. Likewise, the A320 MRB corrosion prevention and control programme (CPCP) specifies

TAP M&E has made Sharklet refitting a new speciality and hopes to set up a nose-to-tail line next year (photo: Airbus)



detailed checks of Sharklet wingtip Rib 27 lugs during 12 year heavy checks.

Airbus claims a large reduction in relevant powerplant and nacelle maintenance costs for the A320neo. The variant has introduced new Pratt & Whitney PW1100G and CFMI LEAP-1A engines and related systems and structures, for which Airbus has analysed and published dedicated maintenance requirements.

"Thanks to upstream cooperation with engine and nacelle manufacturers, a significant reduction of scheduled maintenance requirements – compared with current engines/nacelles – was achieved," Roeger says. "For redesigned parts (including powerplant and related system), direct maintenance costs are 54% lower than for the A320ceo, achieved by both fewer tasks and longer intervals between inspections."

Roeger provides several examples of this 'significant' pylon/engines/nacelles maintenance-task reduction. The 18 'structure calendar' tasks for the neo are five fewer than for the ceo, while the inspection interval for thrust reverser door-pivot and actuator fittings has doubled from 6 to 12 years. Considering fatigue-related maintenance items, intervals have doubled (from 7,500 FC) for forward and aft engine-mount fail-safe pins and bolts; airworthiness limitation item (ALI) tasks have fallen from 55 to 42.

Sample tasks introduced into the A320 MPD include checks of the outer wing rear spar, thrust reverser, and pylon reverser fittings (see Table B, page 18). For example, from 33,000 FC/66,000 FH (and thereafter at 17,000 FC/34,000 FH intervals), all neo aircraft must undergo ultrasonic inspection of the rear spar forward face at landing gear support Rib 5 and pintle and retraction-jack fitting-attachment points.

Similarly, on PW1100G-powered machines, detailed inspections of thrust reverser primary sliders and tracks are required at every 12 year check. On LEAP-1Aengined aircraft, MPD Rev 42 calls for general visual inspection of left- and right-hand pylon reverser fittings.

Airbus is also developing a fatigue monitoring programme (FMP) to 'completely replace' its established fatigue damage (FD) sampling policy. Although a deletion (as opposed to consolidation) of maintenance tasks happens very rarely, the genesis for this example arose several years ago from a review of A320 fatiguerelated items.

"For several tasks, it could be justified that sampling inspections are not required anymore and requirements were subsequently deleted" in MRBR Revs 13 and 14, according to the manufacturer. "The number of in-service aircraft and reported experience feedback" has enabled such simplification of fatigue-inspection requirements.









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Additionally, Airbus has taken account of A320 dynamic fatigue testing. For example, as a first step towards establishing 60,000 FC/120,000 FH ESG limits, it conducted 120,000 simulated flights during testing of major forward fuselage, centre fuselage and wings, rear fuselage, and engine-pylon structural specimens in Toulouse and Munich.

AJW believes the values of V2500A-1- and CFM56-5Apowered aircraft are significantly reduced as the airframe value is very small – the only significant worth is in the engines (*photo: MAEL*) The "new, much simpler" FMP follows a complex two-to-three-year exercise, with results presented to operators in 2016. "The ISC appreciated the efforts made," remarks Roeger. "FMP is based on monitoring specific structure locations (for example, complex structure, heavily loaded) with a calendar-based



interval matching heavy maintenance visits to be performed on a 100%-fleet concept."

The programme will offer "the possibility of escalation, based on actual inspection results on the related operator fleet when a certain confidence level is achieved". One consideration for Airbus is whether the industry will have confidence in the plan. Roeger says that operators "want confirmation the new policy is an improvement".

The new policy has been widely accepted by airworthiness authorities. Airbus has drawn up a list of "around 60" FMP tasks for the A320 Family, compared with more than 300 FD-sampling tasks. The next step is "to perform a trial exercise with selected operators to confirm the programme is an improvement in maintenance cost and burden for operators," according to Roeger.

Following the initial 120,000 FC fatigue testing that led to establishment of the A320 ESG, Airbus submitted the four full-scale test specimens to a further 60,000 simulated flights, up to a representative 180,000 FC. Roeger says that the tests "showed the need for several new inspections, the update of some figures, as well as the need of around 10 structural modifications to allow the operations above 48,000 FC/96,000 FH".

An example of new A320 Family inspections arising from the 180,000 FH tests is the need to check upper wing surfaces (see Table C, page 18). For A319/A320ceos attaining 51,700 FC (or 103,400 FH), and thereafter at 15,000 FC/30,000 FH intervals, a general visual inspection of the outer wing top skin is required between front and rear spars at rib and stringer attachments between Ribs 8 and 27.

As Airbus continues fatigue-monitoring development, it is keeping an eye on maturing airframes as more and more aircraft pass the original 48,000 FC and/or 60,000 FH design service goal (DSG) levels. The oldest A320 in service (MSN 0029) is more than 27 years old.

Since the first such event in 2014, more than 70 A320s and just over 60 A319 airliners have exceeded DSG parameters (measured in FC) and are being operated under ESG conditions, according to Roeger (see Table D, page 18). Airbus expected the first A321 to cross the DSG flight-cycle threshold in early 2017, about 18 months after the first A319 in mid-2015.

The most active A318 variants are not likely to get there until after 2020 (FH), or 2024 (FC), according to Roeger. The A320 Family FC fleet leader is MSN 0069, which by last October had logged more than 52,000 flights, while most time in the air has been clocked by MSN 0068 with almost 83,500 FH. ►

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The manufacturer has twice increased service goals, but decided recently not to pursue a third. It first introduced interim-service goal (ISG) thresholds of 37,000 FC/80,000 FH for high-time aircraft, which were seen as offering 3-5 years' additional revenue operation.

Following the ISG, an initial extended-service goal (ESG1) has provided clearance up to 60,000 FC and 120,000 FH, providing perhaps up to 10 years' extra revenue-earning use. Finally, Airbus conducted tests with a view to establishing possible ESG2 thresholds at 90,000 FC and/or 180,000 FH.

Roeger says that 338 A320s have received the ISG-related Modification 37734 (covered by SB 00-1198); of these, 27 have reached the ISG and have had ESG Modification 39020 (SB 02-1001) embodied. Mod 37734 did not "introduce any physical change on the aircraft structure", but was "a simple trade-off FH versus FC at ISG-fatigue damage – that is, the fatigue damage accumulated by the aircraft structure at the DSG is equivalent to that at the ISG."

Among the oldest A320s remaining active (with MSNs in the 0045-0096 range) are the remaining 15 examples from more than 30 built with four-wheel main landing gear bogies for service with Indian Airlines (now Air India). For these machines, the approved DSG extension has been limited to a maximum 45,000 FC – rather than 48,000 FC – and 63,500 FH at the "operator's request, to allow them to continue operating without the need of any additional maintenance action", says Roeger.

The extension represents, therefore, a straight exchange of additional flight time for fewer flight events. The lead such aircraft (MSN 0046) was already approaching retirement last year, with some 62,389 FH logged before November 2016, according to Airbus.

Last year, Airbus cited several EASA ADs associated with the ESG programme. Six ADs applied to all three A319/A320/A321 variants: 2013-0261 and -0310, and 2014-0081, -0166, -0177, and -0209. A319/A320 models were also covered by ADs 2014-0176 and proposed AD 14-144, while only A320s were required to comply with AD 2014-0169. Several other EASA ADs linked to ESG "development and related testing" were: 2013-0122, -0203, and -0226; 2014-0053, -0065, and -0069; 2015-0051, -0062, and -0084; and 2016-0015.

Roeger says that ESG1 approval provides "approximately an extra six years" operation, covering service until 2020 for the lead A320 airframe, and until 2021 and 2023 for the equivalent A319 and A321, respectively. Since the first A318 is not expected to reach DSG limits before 2020 (FH) or 2024 (FC), Airbus has not yet planned an A318 ESG.

The A321 ESG thresholds were approved last October, although the DSG FH value had been first reached (by MSN 0677) more than three years earlier in June 2013. To accommodate this, Roeger says that a dedicated (FH) extension was provided through SB 02-1003. The first A321 to reach DSG (FC) was expected to be MSN 1356 in January this year. ►



Airbus offers customised solutions that allow operators to optimise maintenance programmes and/or planning to increase aircraft availability, and reduce maintenance costs, while maintaining safety (photo: MAEL)



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With only operational limits to A320 airframe life, Roeger says that operators expect to fly aircraft until reaching ESG FC or FH thresholds (whichever occur first). The Air India A320 approaching its FH threshold late last year is an example of such aircraft that are then withdrawn from service, many for teardown for spares.

Aircraft being dismantled can be any of three distinct models, depending on build standard and upgrades over the life of the A320 up to the start of the A320neo. These include changes to main landing gear (pre-enhanced and enhanced), APU fit, engines (CFM56-5A/V2500A1, CFM56-5B/V2500A5), and avionics. The latter includes changes from CRT to LCD cockpit displays and upgraded flight-management guidance computer (FMGC), according to AJW Aviation Strategic Material and Asset Management Vice President Conrad Vandersluis. While many are currently "very early" examples, Vandersluis says there is " significantly more value in, say, a 12-year-old airframe than earlier-build aircraft".

Progressive engine upgrades that saw International Aero Engines V2500A-1 and CFMI CFM56-5A units replaced with V2500A-5 and CFM56-5B variants, respectively, provide an additional differentiator.

AJW believes the values of V2500A-1- and CFM56-5A-powered aircraft are "significantly reduced" as the airframe value is "very small". The only significant worth is "in the engines, which also depend on their limited-life part status". Nevertheless, if a suitable V2500A-1 was available "remaining operators would pay a reasonable value", according to Vandersluis, who says that the "only competitor for an A320 is another A320".

One maintenance consideration apparently independent of build-date is airframe corrosion, specifically of the rear spar, according to MAEL. "We have found the aircraft performs very well in terms of defects when below a certain age, typically six years – the only significant exception being rear spar corrosion, which doesn't seem to be age-related," says MAEL's Burgess.

Although the MRO sees more structural corrosion as A320/A321s age, the rear spar remains "an issue, even after initial rework". MAEL has noticed "no definite profile" in the timing of the corrosion becoming evident: "We have seen younger aircraft with extensive corrosion, and older ones with very little. It is an ongoing issue and something we have gained a lot of experience in rectifying."

MAEL long ago established a stand-alone A320 rear spar corrosion repair service. "We did our first line of pure rear spar inputs in June 2010 and completed well over 100 for easyJet, having previously completed the terminating SB on Monarch Airlines aircraft and for third-party customers. We have completed over 200," says Burgess.

"Most A321 Family inputs will have some form of rear spar inspection. We have seen cases where corrosion has reappeared after the terminating SB was performed," he adds.

Asked about A320 wing top skin condition, the MAEL executive reports corrosion around fasteners and spoiler-attachment brackets. "As aircraft get older, this can work its way between the top skin and the rear spar. Remedial work involves splitting of the skin to remove the corrosion. In the worst cases, top skin doubler reinforcement is required with an associated flight limitation," concludes Burgess.

CUSTOMISED A320 SUPPORT

While every A320 maintenance task has a flight-hour (FH) and/or flight-cycle (FC) and/or calendar-age parameter (whichever comes first), maintenance based on aircraft utilisation and fleet-maintenance planning "can be packaged with a flexible approach that best suits operational needs", says David Marty, Airbus' Head of Schedule Maintenance Services.

Airbus is offering customised support through its "AirPl@n'suite' of services", which is said to have been introduced "successfully" in the Middle East and Asia-Pacific regions. AirPl@n customers use "adapted scheduled maintenance intervals and packaging fitting their own operations."

The executive points out that, while current A320 A checks are limited to 750 FH, 750 FC, and/or four month intervals, the Airbus "optimised programme" can take the period to 1,000 FH, 1,000 FC, and/or six months "dependent upon reliable task reporting and low task finding rates". AirPl@n also offers a range of scheduled maintenance activities. Combining the accumulated know-how of 98 years as an aircraft manufacturer and maintenance service provider, OGMA has extensive experience in MRO Services from commercial to executive and defense aviation.

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Airframes

| Table A: Examples of relevant Airbus A320 maintenance tasks for Sharklet-equipped aircraft | | | | | |
|--|---|---------------------------|---------------------------|---|--|
| Task ref | Task description | Threshold | Interval | Applicability | |
| 572158-01-10 | Outer wing bottom skin stringer Rib 8-18 Detailed inspection of outer wing, bottom skin stringers (including drain holes), between Ribs 8 and 18, comprising modified stringers 4, 5, 6, 7, 8, 11, 12, and 13 | 42,000 FC or 84,000 FH | 10,400 FC or 20,800 FH | A319-(non-ACJ) or A320ceo modified wing | |
| 573102-01-1 | Wingtip Detailed inspection of wing tip, rib 27 lugs | 12 years | 12 years | Sharklet | |
| (source: Airbus maintenance-planning document – Revision 41 (June 2016)) | | | | | |

Table B: Examples of relevant Airbus A320neo maintenance

| Task ref | Task description | Threshold | Interval | Applicability |
|-------------|--|---------------------------|---------------------------|--------------------------------------|
| 572009-01-6 | Outer wing rear spar Special detailed inspection (US) of outer wing, rear spar forward face, at the attachment holes of gear support Rib 5, main landing gear forward pintle fitting and retraction jack fitting | 33,000 FC or 66,000 FH | 17,000 FC or 34,000 FH | A320neo (PW1100G and CFM LEAP-1A) |

(source: A320 Family MPD Revision 42 – ALI)

| 545329-01-1 | Pylon reverser fittings General visual inspection of pylon, reverser fittings, left-hand and right-hand | 7,500 FC or 15,000 FH | 7,500 FC or 15,000 FH | LEAP-1A | | |
|---|--|--------------------------|--------------------------|---------|--|--|
| (source: A320 Family MPD Revision 42 – MRB/CPC) | | | | | | |
| 783213-01-1 | Thrust reverser primary sliders and tracks Detailed inspection of thrust reverser, primary sliders, and tracks | 12 years | 12 years | PW1100G | | |
| (source: A320 Family MPD Revision 42 – MRB Fatigue) | | | | | | |

Table C: Example of relevant Airbus A320 maintenance tasks for older aircraft

| 572120-01-3 Outer wing top skin 51,70 General visual inspection of outer wing, top skin, upper surface at attachments to ribs and stringers between Ribs 8 and 27 from front spar to rear spar 51,70 | 00 FC or 15,000 FC or A319 400 FH 30,000 FH or A32 unmo | non-ACJ) Oceo dified wing |
|--|---|---------------------------------|

Table D: Airbus A320 Family fleet leaders

| | MSN | Age (calendar years) | Flight-hours (FH) | Flight-cycles (FC) | Average flight time (FH/FC)* |
|-------------|------|----------------------|-------------------|--------------------|---------------------------------|
| Oldest | 0029 | 27.82 | 46,881 | 25,025 | 1.87hr |
| Most hours | 0068 | 27.02 | 83,480 | 35,371 | 2.36hr |
| Most cycles | 0069 | 17.25 | 64,803 | 52,048 | 1.25hr |

(source: Airbus Commercial as at October 2016) *Average over life of aircraft to that date.