The A320 maintenance philosophy has evolved, resulting in a complex, multi-dimensional maintenance planning document (MPD). An exploration of the MPD's key changes, and the subsequent effect on the planning and grouping of tasks for A320 family aircraft, is explored here.

The A320 family's MPD analysed

The A320 family has now been in service for 28 years. During this period its maintenance planning document (MPD) has been revised more than 40 times. When it entered service, the A320 had a base check cycle pattern of eight checks, with the fourth and eighth checks including two large groups of structural inspections. The MPD and maintenance programme went through a fundamental change in 2005. The main changes were the adoption of a base check cycle of six checks and of individual task intervals, often with more than one interval criterion. The effect of these changes on the aircraft's maintenance and maintenance planning is examined here.

A320 family in service

There are about 6,300 passenger-configured aircraft in the A320 family aircraft in operation. The A319 accounts for just over 1,350 of these. The fleet has an average age of 11 years, and an average annual utilisation of 2,500 flight hours (FH), and 1,500 flight cycles (FC). This equates to an FH:FC ratio of 1.66:1.00, which translates to an average flight time of 100 minutes for every FC.

There are almost 4,000 A320s in operation. The average age of the aircraft is just over eight years. Average annual utilisation is 2,600FH and 1,400FC. Its average FH:FC ratio, therefore, is 1.86:1.00, equal to 90 minutes flight time per FC.

There are about 1,200 A321s in service, with an average age of just under seven years, an average utilisation of 2,350FH and 1,200FC. This results in an operating ratio of 1.95:1.00, or 117 minutes to every cycle completed.

For this feature, the A320's annual utilisation rate is assumed to be 2,600FH and 1,400FC as the industry average.

One MPD lists all maintenance tasks for four members of the A320 family: the A318, A319, A320 and A321. The MPD has 2,967 tasks listed, but not every task applies to every aircraft in the fleet. Some tasks, for example, apply to the A321, but not the A319.

"Structural tasks from the MPD will apply to each aircraft depending on its different physical dimensions," explains Peter Cooper, planning manager at Civil Aviation Services Ltd. "The variation in weight between types also leads to different task requirements."

While key variations in applicable MPD tasks among the four main types lies within the structural tasks, there are other differences. These will be highlighted throughout the analysis.

Maintenance programme

Generally speaking, airframe maintenance can be divided into line maintenance, A checks, and base check maintenance.

Base maintenance is associated with heavier checks that have tasks with longer intervals. Some tasks require deep access on the aircraft and extensive man-hours (MH) to perform, so the checks have longer downtimes. Base checks will address routine inspections arising from the MPD, alongside defect rectifications, refurbishments, modifications, airworthiness directive (AD), and service bulletin (SB) work.

Lighter tasks, for example, functional tests and system tasks, and those with shorter intervals are likely to be included in line maintenance or 'A' checks.

The A320 family's MPD is based on utilisation rates arising from typical A320 activity. The parameters for 'normal' A320 utilisation are 1,800-4,400FH, and 1,000-2,500FC per year. An operator that deviates from this expected utilisation has to consult its aviation authority to make appropriate and approved adjustments to its fleet's programme.

Line and base check patterns

As described, check requirements for the A320 family are mainly separated into line checks and base checks. These were formally referred to as 'A' and 'C' checks, although task groups and maintenance checks are no longer named this way in the MPD. Many airlines and maintenance organisations, however, still use the terminology for planning purposes.

"The A320's MPD is based on MSG 3 philosophy," says Timur Tyncherov, planning director at S7 Engineering. "The MPD contains tasks that are divided by usage or interval parameters, that is FH, FC, and calendar-timed tasks. These calendar tasks can be expressed in years (YE), months (MO), and days (DY)."

"While some operators still combine or group tasks into the former 'A' or 'C' in their MPDs, other operators prefer to use 'equalised' maintenance events," continues Tyncherov. "Equalised maintenance means that all tasks, maybe including some heavy inspections, are allotted among the small proportional checks without heavy checks, or 'semi-equalised' maintenance programmes, that involves a mix of letter checks and the equalised programme philosophy."

MPD format change

The A320 has undergone several major revisions to its programme. The biggest change was to its pattern of eight base checks in a cycle to the six checks in 2005. Its previous incarnation still

OLD A & BASE CHECK PATTERNS OF A320 FAMILY

Check name	Interval - FH/months	Task groups
A1	350FH/500FH	1A
A2	700FH/1,000FH	1A + 2A
A3	1,050FH/1,500FH	1A
A4	1,400FH/2,000FH	1A + 2A + 4A
C1	15	1C
C2	30	1C + 2C
C3	45	1C
C4 IMV	60	1C + 2C + 4C + S1
C5	75	1C
C6	90	1C + 2C
C7	105	1C
C8 HMV	120	1C + 2C + 4C + S1 + 8C + S2

involved A and C checks, alongside structural, system and zonal inspections *(see A320 family 1st & 2nd base airframe check cost analysis, Aircraft Commerce, issue 75 page 28)*.

The intervals of the original A and C or base checks changed several times. The original basic A check interval was 350FH, which was the interval for the group of 1A tasks. There were two further groups of A check tasks with intervals that were extensions of the basic 350FH: the 2A group of tasks with a 700FH interval, and the 4A group of tasks with a 1,400FH interval.

The A check cycle was, therefore, formed as a cycle of four block checks, with a 350FH interval between each A check. The fourth check, the A4 check, had an interval of 1,400FH.

The basic interval was later increased to 500FH, so the A4 check interval was, therefore, extended to 2,000FH.

In addition, the A320's MPD had a system of eight C checks and two structural checks.

The C check and C1 check intervals were 15 months at the first MPD revision released in 1988. There were groups of tasks with corresponding intervals that were multiples of 15MO. These four task groups were the 1C at 15MO, the 2C at 30MO, the 4C at 60MO, and the 8C at 120MO. These four task groups could be arranged into a series of eight block checks referred to as the C1 to C8 checks *(see table, this page)*. The C4 and C8 were the largest, with the C4 comprising the 1C, 2C and 4C tasks, while the C8 check included these three groups plus the 8C tasks. In contrast, the C1, C3 and C7 checks were lighter checks that comprised only the 1C tasks.

The two structural checks were formed with another two groups of tasks and were included in the maintenance check requirements. These were the S1 and S2 groups that originally had intervals of 4YE and 8YE. They were sometimes referred to as S1/4YE and S2/8YE tasks. These are structural tasks that require deep access.

The interval of the S1 tasks increased from four-and-a-half years (54MO) to five years (60MO), just as many of the earliest-built aircraft came due for their first C4 checks. The C4 check and S1 tasks were, therefore, conveniently combined to form a heavy base check, sometimes referred to as the C4/S1 check, at 60MO or five years.

The interval for the S2 tasks increased from eight-and-a-half years (102MO) to 10 years (120MO) at a time when many of the earliest-built aircraft came due for their first C8 check, as well as the S1 tasks coming due again. The C8 check was conveniently combined with the S1 and S2 tasks to form the eighth and heaviest check in the cycle. This came due at 120MO or 10 years.

The main intervals were increased in 2005. While the eight checks of the base check cycle were increased from 120MO to 144MO, the C check interval was increased from 15MO to 20MO. The 144MO for the eight checks allowed an average C check interval of 18MO.

Another element of the A320 family's maintenance programme is the sampling programme that affects the oldest fifth of each operator's fleet of A318s, A319s, A320s and A321s. Under the sampling programme, inspections are large structural items, and increase the routine MH required in the C8/S2 check. If there are findings on these oldest aircraft, all other aircraft in the fleet must be inspected.

The A320's MPD was revised every six to eight months as the aircraft went through service.

New MPD philosophy

A major change to the A320's MPD came in June 2004, which triggered the 28th revision of the MPD in January 2005. Whereas tasks had previously been grouped into specified checks because they had the same interval, each task was now treated individually and given multiple interval criteria. This means that tasks can be planned into check packages, according to an operator's usage parameters to maximise utilisation of task intervals. This avoids forcing operators into using task intervals inefficiently to conveniently group tasks into a single check. This also means, however, that combined groups of tasks, especially those with deep access, require excessive downtime.

Restructuring the MPD by giving tasks individual intervals has allowed operators to explore the advantages of equalised maintenance programmes, with the flexibility to arrange more frequent smaller check packages rather than large ones.

A320 MPD revision 41 is being explored for the purposes of this article. Overall revisions to the MPD include 171 deleted tasks, 339 new tasks, and 1,447 tasks with revisions. This is alongside the change in interval and structure to the A and C checks.

New A & base check pattern

In terms of letter checks, the latest version of the A320's MPD can be separated into light or 'A', and base or 'C' check patterns.

The basic interval for light or 'A' checks is 750FH, 750FC, or 4MO, whichever interval is reached first. Several groups of tasks have intervals that are multiples of this basic 'A' check interval.

The basic interval for the 'C' check is 7,500 FH, 5,000 FC or 24MO, whichever is reached first. There are several groups of tasks whose intervals are multiples of this basic 'C' check interval.

"There are about 200 tasks that have this C check interval, or multiples of it," describes Tyncherov. "There are also, however, a lot of tasks with an out-of-phase (OOP) interval, ones that fall between main task group intervals. The number of OOP tasks depends on individual aircraft utilisation."

"The terminology 'A check' is no longer used in the MPD, but is still used to generically describe small checks," outlines Cooper. "Most operators tend to follow the intervals of the tasks listed in the Zonal programme as the 'A' check interval, which is four months or 750FH or 750FC, whichever comes first (WCF). Other tasks that are standalone are often brought forward and included in this

A320 FAMILY ZONAL TASKS, CALENDAR INTERVAL TASK GROUPING & ACCESS - MPD REVISION 41

	Interval	A318 ONLY	A319 ONLY	A320 ONLY	A321 ONLY	APPLIC TO MORE THAN 1 TYPE	ENGINE TYPE	AIRCRAFT MOD STATUS	TOTAL TASKS	NOTES	DEEP ACCESS TASKS
LINE/A	400DY						1		1		
1A	4MO	3	1		2	10	2	2	20		
1A	4MO/750FH/750FC	1				2	1	2	6		
1A	6MO						1		1		
2A	8MO							1	1	A/C with entrance stairs	
4A	16MO						11		11	Tasks listed are total for all eng options combined	
5A	20MO						9	1	10		
1C	24MO	1		1	11	21	8	2	44	C check interval	Extensive wing and flap panel access
1C	24MO/7,500FH			1		2		2	5	C check tasks depending on FH reached	
A or bring forward	36MO						1		1		
2C	48MO					5	4	5	14	Every second C check interval Pylon access panels	
3C	72MO	3	1	1	7	14	3	6	35	Performed at 6-yr structural	Cargo & avionics bay access
3C	72MO/24,000FH	3	2	1	4	6	2	8	26	Structural check tasks depending on FH reached	Cargo & avionics bay access
6C	144MO	6	1		7	32		2	48	Performed at 12YE structural check	Interior furnishings, and wing tank access
Overall total									**223**		

grouping, even though the interval of these tasks is not fully used.

"There are four large groups of tasks in both the Systems and Zonal sections with intervals of 24MO, 48MO, 72MO and 144MO. The 1C group of 'C' or base check tasks can thus be considered as the 24MO items. For 2C it is 48MO, so long as there are no serious anticipations. The 3C consists of 72MO tasks, and the 6C is the 144MO tasks. Interestingly, in the Zonal section, the 72MO items have a dual interval of 72MO and 24,000FC, WCF," says Cooper.

Today's MPD for the A320 family, therefore, revolves around six main checks in a base check cycle. Because the basic C check interval is now 24MO, the sixth check comes due at 144MO, the same as the eighth check under the old eight-check cycle.

"The normal base check cycle resembles C1, C2, C3, C4, C5 and C6 checks, with the S1 or 6YE structural tasks, coinciding with the C3 check; and the S2 or 12YE heavy tasks coinciding with the C6 check," says Tyncherov. "These S1/6YE and S2/12YE tasks require deep access, and, therefore, force a long downtime to complete the check.

"The actual check pattern, however, depends on the airline. S7's utilisation, for example, leads to a high number of FH per month, so we perform a C check based on a 7,500FH interval every 18 months. Subsequently, its base check cycle is completed in a shorter calendar time, and is different to the standard system of six checks, with heavy visits at the third and sixth checks," continues Tyncherov.

"S7 plans A checks based on individual aircraft utilisation and the tasks due. Normally an A check visit occurs because the 750FH interval is reached. Our due list contains all tasks that are due on the date, plus all OOP tasks that are due on the interval before the next A check. An operator's main goal is to minimise maintenance between A checks."

Similarly, any OOP tasks that are due between two C checks will be performed during the former C check, even if the tasks have significant unused interval.

Other tasks incorporated into a C or base check may include routine component changes. "Hard time components have their own intervals based on OEM recommendations, and are often different from an aircraft's task intervals. Normally we try to change components with minimum remaining interval," says Tyncherov.

"Components that are maintained on a hard-time basis include pressurised items, like fire and oxygen bottles, escape slides and rafts, explosives, as well as landing gear, engines, auxiliary power unit (APU), and some flight control actuators," explains Cooper.

Many of the MPD tasks listed in the Zonal, System and Structural programmes no longer have intervals that conveniently group them into A or C task groups. Therefore, they are examined together with their intervals and deep access requirements to anticipate how they might be grouped into maintenance checks by an operator. This has been on the basis of an aircraft accumulating 2,600FH and 1,400FC per year.

Zonal tasks

There are 223 zonal tasks listed in the latest revision of the A320 MPD. Of these, 17 tasks relate purely to A318 aircraft, five to the A319, four tasks to the A320, and 31 to the A321 *(see table,*

A320 FAMILY SYSTEMS & POWERPLANT TASKS - MPD REVISION 41

	A318 ONLY	A319 ONLY	A320 ONLY	A321 ONLY	APPLIC TO MORE THAN 1 TYPE	ENGINE TYPE	AIRCRAFT MOD STATUS	TOTAL TASKS
Calendar interval tasks								
A/LINE		1	14	1	22	47	29	114
1C			3	2	39	6	52	102
2C		9			13	10	14	46
3C	1	3	2		45	13	36	100
4C		1			1	4	3	9
5C							4	4
6C				7	41		6	54
8C						2	1	3
10C (9C)					1		3	4
FH interval tasks								
A/LINE		1	3		12	39	41	96
1C	1	3	5	4	31	41	44	129
2C	3	5	7		13	7	33	68
3C	3	4	5	2	11		16	41
4C	1	3	4		23	4	21	56
5C		1	1	1	1	1	1	6
FC interval tasks								
A/LINE		4	2	2	22	28	24	82
C		9	6	1	51	10	44	121
MISC	3	4	3	4	17	44	27	102
Overall total								**1,137**

page 54). 92 tasks relate to more than one aircraft type, while 43 depend on the engine type on the aircraft. Lastly, 31 tasks depend on the aircraft's modification status (typically referred to as applicability or effectivity tasks).

Line Zonal tasks

Zonal task intervals are grouped relatively simply. The intervals include 400DY (one engine type specific task): 4MO, 6MO, 8MO, 16MO and 20MO (a total of 49 tasks). Given the light access nature of zonal tasks, they will be or could be carried out during line or 'A' checks at a multiple of the A check interval of 4MO and/or 750FH, WCF *(see table, page 54)*.

1C Zonal tasks

The next two sets of zonal tasks are 44 tasks with an interval of 24MO, and five tasks with an interval of 24MO, and 7,500FH, WCF *(see table, page 54)*. This is a C1 check interval, so these tasks would form part of the first base or 'C' check. They could be termed 1C Zonal tasks for ease of planning or grouping *(see table, page 54)*. Depending on the operator's utilisation, these could also be performed outside of the base check. Of these 49 tasks referenced in the MPD, 11 are A321-specific, while one is purely for the A320 type.

The Zonal task group has an interval of 36MO, but has only one engine-specific task. Since its interval falls 12 months between base checks, operators may either bring this task forward and perform it in every base check, or incorporate it into an A check. Since an A check interval can be four months, depending on utilisation, 36MO would equate to every ninth A check in the maintenance cycle.

2C Zonal tasks

The are 14 MPD tasks with an interval of 48MO, which could be regarded as the 2C Zonal tasks *(see table, page 54)*.

3C Zonal tasks

Subsequent Zonal tasks have an interval of 72MO, and could be regarded as the 3C tasks *(see table, page 54)*. There are 61 tasks with this interval, but 26 have an secondary interval of 24,000FH. These 61 tasks are also spread across aircraft types, so they do not all apply to every A320 family type.

Zonal tasks with 72MO intervals typically require access to cargo and avionics bay areas. They are, therefore, structural tasks that need more extensive access. As such, these coincide with the 6YE (72MO) structural tasks that form the C3 base check *(see table, page 54)*.

6C Zonal tasks

Lastly, there is a 144MO interval for zonal tasks. Obviously, much like the 72MO interval, this coincides with the second set of S2 or 12YE structural tasks. There are 48 zonal tasks with this interval parameter; 32 are applicable across the fleet and seven are only relevant to the A321. Two tasks depend on the mod-status of the aircraft. These 48 tasks could be regarded as 6C Zonal tasks *(see table, page 54)*.

System tasks

System tasks are divided into three types of interval: FH, FC and Calendar. The FH and Calendar intervals are the most used interval criteria for the large groups of tasks. There are a total of 1,137 system tasks referenced in the A320 MPD across the four types *(see table, this page)*. There are no sampling tasks included in the system tasks section of the MPD, so 'intervals' rather than 'thresholds' are referenced.

System tasks typically include functional assessments on the aircraft, such as pneumatic and avionic tests. These are, therefore, often tasks that only involve light access. Any tasks that are OOP with base check intervals are commonly grouped in with line or A check events.

There are a larger number of intervals

While the A320's MPD has seen a change to a base check programme of six checks, the biggest and most significant change is the large number of task intervals that have been introduced into the aircraft's maintenance programme. This has increased the complexity of maintenance planning.

in the System programme compared to the Zonal programme.

The grouping of tasks with FH and Calendar intervals into A and C check multiples is relatively straightforward compared to tasks with FC intervals. The grouping of tasks with FH and Calendar intervals is described below. The FC tasks are considered separately.

Light & A System tasks

Five different calendar intervals make up the lighter line checks that get performed at multiples of 750FH or 4MO. There is one task at 400DY, applicable only to aircraft with a specific modification status. 71 tasks have an interval of either 800FH or 12MO which could be regarded as 3A System tasks (six are A320-specific, while 36 depend on powerplant type), and 20 tasks spread across the family have an interval of 1MO.

There are six tasks that have multiple calendar intervals associated, at 13MO, 15MO, 16MO and 18MO. Four of these are mod-status related, or equipment or regulatory authority-dependent. One task is only relevant to the A320 series. Finally, 16 tasks arise at either 20MO or 4,500FC. These mostly concern engine inspections across the family, and remain light access and line-maintenance based. These five groups total 114 tasks that make up light and A checks *(see table, page 56)*.

There are also 96 System tasks with FH intervals that are shorter than the C check interval of 7,500FH *(see table, page 56)*. Only 12 relate to more than one aircraft type. These are OOP tasks, and will typically be incorporated into the A checks that occur in the two years before the first base check. These intervals are 1,000-5,600FH.

Adding the calendar and FH tasks together totals 210 tasks in the 24 months before the first base check event.

1C System tasks

There are 102 tasks with four calendar intervals between 24MO and 40MO that will all probably be grouped as 1C System tasks, and so come due at every base check *(see table, page 56)*.

The 102 tasks included in this group have a mixture of intervals that are 24MO and a combination of four different FH intervals of 6,500FH, 7,500FH, 7,700FH, 12,000FH, and one FC interval of 5,000FC. The remaining three intervals are 30MO, 36MO, and either 40MO or 6,000FH WCF. Of these 1C groups of tasks, 39 are applicable to more than one aircraft type, while most (52 tasks) are applicability tasks relating to the modification status of the aircraft in question.

Given the fact that these intervals mostly exceed the base check interval of 24MO, but do not reach the second base check interval of 48MO, it is a common concept to bring these tasks forward to the previous base check to avoid a heavy maintenance event between the C checks.

In addition to Calendar tasks, there are 129 FH-based tasks with intervals of 6,000-11,000FH. 31 tasks are relevant across the fleet, 41 are engine type-specific, and 44 depend on the modification status and equipment on board.

There are, therefore, 231 calendar and FH system tasks in the 1C group of tasks *(see table, page 56)*.

2C System tasks

46 tasks make up the '2C' group of system tasks with calendar intervals that will help to form every second base check for the aircraft. The tasks included in this group have a mixture of intervals that include 48MO and 7,500FH or 12,000FH; 50MO and 7,500FH; 60MO and 12,000FH or 22,000FH and 18,000FC; and 66MO *(see table page 56)*. 12 of these tasks are applicable across the fleet, while nine relate only to the A319. 10 tasks are applicability tasks, so they are dependent on individual aircraft factors. Some deep access tasks are involved here, with the removal of avionic bay floor panels.

There are also 68 FH tasks that combine to form the 2C group of System tasks. These have intervals of 12,000FH, 14,000FH, 14,800FH and 16,000FH. There are 112 calendar and FH tasks that make up the 2C group of tasks *(see table, page 56)*.

3C System tasks

The set of 3C calendar tasks coincides with the 6YE structural check and the 'C3' or third base check event for the A320. 100 tasks are referenced in the MPD that have intervals that either equal the 6YE/72MO threshold or have intervals that would be bought forward to match this check interval *(see table, page 56)*. Structural checks often involve an overall interior strip-out, including floor panels, galleys and lavatories and, therefore, are known as 'deep access'.

There are 41 tasks that are FH associated, which also fall into the 3C group. This equals 141 FH and calendar system tasks in the 3C group of tasks.

4C System tasks

For the 4C task group, only six calendar-based tasks are referenced. These are divided into applicability and engine-dependent tasks, and so are only relevant to specific aircraft across the family.

In terms of FH grouped tasks, 56 combine with this group. 23 are relevant across the A320 family, while eight tasks apply to either A318, A319 or A320 aircraft. The remainder are either engine-dependent or applicability tasks.

There is a total of 62 system tasks in this group of tasks *(see table, page 56)*.

A320 FAMILY STRUCTURAL TASKS - MPD REVISION 41

	Threshold focus on FC limits	Major struct insp repeat interval	A318 ONLY	A319 ONLY	A320 ONLY	A321 ONLY	APPLIC TO MORE THAN 1 TYPE	INCL ENGINE PYLON	EQUIP STATUS	TOTAL TASKS	NDT	DEEP ACCESS
A	Less than 12MO							1	4	5		
1C			9	6	6	4	6	7	5	43	NDT	
2C			5	7		1	5	40	10	68		GALLEY/LAV REM
3C/6YE			9	23	10	17	63	9	44	175		DEEP INTERNAL
4C			5	49	6	3		1	4	68		LANDING GEAR
5C			1	22	6	11	7	14	6	67		CARGO FLOOR
6C/12YE			32	27	15	23	88	19	49	253		SCUFF PLATES
2nd 12YE			20	15	15	40	75	11	38	214	NDT	AIR COND DUCTS, CABIN STRIP
2nd 12YE			7	14	12	1	4	0	1	39		DEEP INTERNAL
Mature & ageing tasks												
16,900FC-20,000FC		31,000FH-76,600FH, 6YE	2	5	11	9	3	1	6	37	NDT	
20,300FC-29,900FC		12,000FH-60,000FH	23	12	48	33	8	17	49	190		
30,000FC-40,000FC		49,400FH-88,100FH	22	25	96	43	18	7	54	265		
40,200FC-60,000FC		60,000FH-120,000FH	6	12	57	24	36	8	40	183		
Overall total											**1,607**	

5C System tasks

The 5C group of calendar tasks is also relatively small, with four applicability tasks.

There are also six FH-related system tasks that fall into this group, equalling 10 5C tasks in total *(see table, page 56)*.

6C System tasks

The 6C group of calendar interval system tasks is performed during a heavy structural check, and so requires deep access to complete. These 54 tasks have the 144MO interval; 41 of these are applicable to more than one aircraft type in the A320 family. Much like the 6YE structural check, the interior is removed from the aircraft to complete these system tasks. The cabin floor, galley and toilets, overhead compartments, ceiling panels and exterior wing panels have to be removed.

8C & 10C System tasks

The 8C and 10C tasks with longer intervals come due after the 6C group of tasks, and will not need to be included in base checks until the second base check cycle (the 'C7' to 'C12' base checks).

Calendar-based intervals for these include 240MO, of which there are four tasks. Assuming average utilisation for A320 operators, one can assume these four calendar tasks will form the 'C10' base check. These four tasks, however, may fall into a C9 base check depending on this utilisation. The 10th base check would occur at 240MO, 60,000FH or 30,000FC. If the FH or FC interval is reached ahead of the calendar time, then these tasks would be brought forward.

Lastly, there is a set of calendar tasks with an interval of 300MO or 25,000FC. Again, assuming average utilisation, it is most likely that the aircraft will reach 24,0000FC or an 8th base check at about 190 months, before reaching the 300MO interval. These three tasks are, therefore, likely to form an 8C group of tasks *(see table, page 56)*.

FC System tasks

In addition to Calendar and FH tasks in the system tasks section, there are 305 FC-led tasks. These are OOP tasks that will either fall into A or C checks. Those that require deep access will be brought forward to a base check. 121 of these will fall into different C check multiples; the remaining 82 tasks would be incorporated into various line and A checks.

The 121 C check tasks have a variety of intervals, and 17 have an interval of 5,000FC, combined with 24MO, 50MO, 60MO or 72MO, or 7,500 FH. Given the average annual utilisation of 2,600FH to 1,400FC, the 24MO would probably be reached first. These tasks would be grouped as 1C tasks.

Three tasks have parameters of 6,000FC or 72MO. Again, it would follow that 72MO would be reached first. Therefore, these would fall into the 3C group of tasks.

Structural tasks

Structural tasks are designed to assess airframe and fatigue damage, so many require deep access. As such, planners and operators will often incorporate these into base check events to manage aircraft downtime. Some tasks will, therefore, be brought forward, sometimes years or thousands of FH or FC ahead of schedule. Given the range of intervals given throughout the structural tasks section, flexibility is needed to adapt the grouping of these tasks in accordance with alterations to flight schedules and the number of FH and FC the aircraft accumulates. There is a total of 1,607 tasks mentioned as structural in the Airbus A320 MPD.

Only a small number of structural tasks fall prior to the first base check *(see table, this page)*. About five tasks are referenced in the MPD, although because these are engine- or modification-related, they may only be applicable on certain aircraft in the fleet. These will be incorporated into line checks during the first 12 months of operation.

The majority of the structural tasks are set at FC-driven intervals, with only a small number of calendar tasks.

1C Structural tasks

In terms of the 1C group of tasks, 43 have intervals that fall into this group. The intervals referenced are 48MO and less than or equal to 5,000FC *(see table, this page)*. Six of these tasks are applicable to one or more aircraft type.

2C Structural tasks

68 tasks can be grouped into the 2C set of tasks that will go on to form part of every second base check *(see table, page*

SUMMARY OF A320 FAMILY MAINTENANCE TASKS - REVISION 41

Task grouping	System tasks	Zonal tasks	Structural tasks	Total tasks
Line & A	292	2	5	299
1A		27		27
2A		1		1
4A		11		11
5A		10		10
1C	231	49	43	323
2C	114	14	68	196
3C & 6YE	141	61	175	377
4C	65		68	133
5C	10		67	77
6C & 12YE	54	48	253	355
8C	3			3
10C	4			4
Various C	121			121
12C/24YE			253	253
Ageing			675	675
Misc/VR tasks	102			102
Overall total	**1,137**	**223**	**1,607**	**2,967**

Base check task arrangement

Check name	Interval -months	Task groups
C1	24	1C
C2	48	1C + 2C
C3/6YE	72	1C + 3C + 6YE
C4	96	1C + 2C +4C
C5	120	1C + 5C
C6/12YE	144	1C + 2C + 3C + 6YE +6C + 12YE

58). The intervals for these tasks ranges from 5,300FC to 7,500FC, and combined with five years/60MO, WCF.

40 of these tasks are engine type-specific, and deep access tasks involve the removal of the galley and lavatory, alongside cargo floor panels for relevant types. Non-destructive testing (NDT) is commonly required to test structural integrity after panel removal.

3C Structural tasks

The 6YE, or S1, tasks form a large part of the third 'C3' base check, and mark the first structurally-focused set of tasks in the A320 base check cycle. As such, 175 tasks can be combined with the 3C system and zonal tasks *(see table, page 58)*. 59 of these tasks are aircraft type-dependent and only relevant to one of the A318, A319, A320 or A321 aircraft. 53 are engine type, modification status or equipment-dependent. The remaining 63 apply across the fleet.

4C Structural tasks

68 tasks coincide with the 4C group of tasks that will occur every fourth C or base check. These tasks mainly relate to overhaul of landing gear components.

5C Structural tasks

In terms of 5C tasks, there are 67 structurally-related items. Some of these require removal of cargo floor panels and are, therefore, deep access.

6C Structural tasks

Lastly, there are the 12YE items for the second heavy check in the base check cycle. There are 253 tasks in this group *(see table, page 58)*.

These refer to intensive interior removal, including, but not limited to, scuff plates, galleys, lavatories, interior and cargo floor panels, antennae, and engine and engine mounts.

Check cycle task groups

As previously mentioned, the former types of grouped tasks will combine to form significant base checks that involve heavy maintenance. The first six base checks, from C1 through to C6, form the first base check cycle.

The groups of 1C through to 10C reference tasks will be arranged into first to 10th base checks. It follows that the first two base check cycles for the A320 will be structured as block checks *(see table, this page)*.

The maximum number of MPD system, zonal and structural tasks for each main task group is summarised *(see table, this page)*. For line and possible A check task groupings, the maximum number is 299. The maximum number for 1A, 2A, 4A and 5A groups is 27, 1, 11 and 10 tasks *(see table, this page)*.

Similarly, the maximum number of MPD tasks in each main group includes: 323 for the 1C; 377 for the 3C/6YE; 355 for the 6C/12YE; 253 for the 12C/24YE, and 675 ageing tasks *(see table, this page)*.

In terms of maximum number of MPD tasks for each check, there are 323 for the C1, 700 for the 3C/6YE, and 1,251 for C6/12YE checks.

Industry ratios and factors

As routine inspections and tasks are completed throughout each base check cycle, unscheduled or non-routine items will arise that are not foreseen by operators or maintenance planners. Unavoidable elements, such as overall wear and tear of the aircraft, will give rise to non-routine rectifications. The proportion of these non-routine (N-R) findings will subsequently generate an N-R ratio that is in relation to the number of MHs required for routine tasks.

This N-R ratio will increase throughout a base check cycle, up to the first heavy maintenance check; in the case of the A320, this would be the 6YE structural check. After this has been completed, it would be expected that the N-R ratio would decrease slightly in comparison to the N-R ratio of the base check before the 6YE check. The N-R ratio would then increase gradually again until the C6/12YE maintenance event. As this is an extensive heavy maintenance visit, this would address many N-R items. "Generally, the N-R or defect ratio on the check following a heavy check is lower than the check before the heavy event," confirms Cooper.

Once this has been completed and the first base check cycle has passed, the cycle would repeat itself. For the second and third cycles, the N-R ratio will generally increase in stages, depending on how close the base check is to the next heavy

While there are almost 3,000 tasks in the MPD, there are large numbers that do not apply to an individual aircraft. This is either due to aircraft type, the engine installed on the aircraft, or the aircraft's modification status.

maintenance check. The N-R ratio at the start of each cycle will be higher than the first check of the previous cycle. The C7 check will, therefore, have a higher non-routine ratio than the C1 check, and the C15 check will have a higher ratio than the C7 check. This is due to aircraft age, which also has an influence on the N-R ratio. The N-R ratio will, therefore, increase over several base check cycles in a sawtooth profile.

"Average N-R ratio for a C check is 30-50%, but depends on aircraft age," explains Tyncherov. "It can be as high as 100% for structural checks that include the 6YE and 12YE items."

Given that an allowance is needed for non-routine items to be found during checks, planners have to apply realistic factors when providing quotations and downtime estimates to operators and other customers. In addition to anticipating N-R findings, there is also the well-acknowledged view that MH and access times that are referenced in MPDs do not often reflect actual time mechanics require to perform tasks. Therefore, a 'planning factor' is given to MH referenced in an MPD that aims to provide customers with an accurate as possible forecast of how many MH a task will actually use, and what the labour cost will actually be. It must be noted that this is an 'estimate', and, therefore, in no way guarantees the true cost of any scheduled maintenance event. It is still an important exercise to help manage customer expectations when aircraft are due substantial maintenance check packages.

An average correction factor of 2.5 can be used on the A320. "An experienced MRO can factor in up to 4.0 for MPD tasks," elaborates Cooper. "However, this can be much higher for start-up maintenance providers. It varies with the organisation."

Ageing and sampler tasks

An aircraft that completes its second base check cycle is typically regarded as 'mature', and one that is in its third cycle is regarded as an 'ageing' aircraft. As such, the aircraft will undergo more stringent structural checks to assess fatigue, which suggests larger, heavier base maintenance packages. Ageing tasks are typically ascribed an FC-based interval.

Once the A320 meets and exceeds 20,000FC, an increase in structural and deep access-focused tasks will be gradually introduced.

From 20,000FC onwards, there are 350 additional tasks in the MPD. These apply to all aircraft in the fleet, and the relevant tasks again depend on type, modification status, and engine fitted.

Tasks included in these checks include galley removal at 35,900FC, engine and antenna removal at 60,000FC, and a large number of NDT requirements that will all require varying levels of access.

To fully address and assess the affect that operational fatigue can have on the airframe, sampling tasks are a common requirement in an MPD. These are present in the A320 document and also take effect from 20,000FC onwards.

There are 279 tasks that are split into four groups, according to their initial thresholds. The first has an initial threshold of 20,000FC, and there are two tasks. The second group has an initial threshold of 30,000FC and includes 98 tasks. The third group of 56 tasks has initial thresholds of 302,00-46,000FC, and the fourth group of tasks has an initial threshold of 48,000FC.

Cosmetic maintenance

In addition to routine, regulatory, and operator requirements, overall cosmetic maintenance is addressed at certain periods during each base check cycle. As this is often not mandatory, and tends to be carried out at an operator's discretion, interior refurbishments, such as carpet or seat cushion replacement, generally take place while the aircraft is undergoing structural maintenance. This is because deep access tasks allow operators to save time to carry out these ad hoc tasks, and optimise the aircraft's downtime. "Seat covers are likely to be replaced on the second or third C check," highlights Tyncherov. "Carpets are replaced more often, while all other interior items are typically replaced on an on-condition basis."

"Galleys, toilets, PSUs, overhead bins and panels will typically be refurbished on the 6YE and 12YE checks," elaborates Cooper. "Also, interior refurbishment at some level will become a requirement if an aircraft has reached the end of lease."

Alongside interior refurbishment, stripping and repainting aircraft at various intervals is important to maintain aircraft appearance. "Five to six years is the normal interval for repainting the A320," continues Tyncherov. "This can also be carried out at the end of an operating lease or return to lessor," says Cooper. "Otherwise, operators tend to repaint on an on-condition basis."

Summary

The A320 has been operating since the late 1980s, and so the mature airframes are approaching end-of-life, also referred to as the limit of validity (LOV). While the A320neo is due to become a sure replacement for the family in time, operators are investigating whether to continue flying its predecessor a little longer. "10 of S7's A319s will reach LOV in the next few years," says Tyncherov. "We are examining if the LOV can be extended, and so are in negotiations with Airbus on the matter." AC