There are more than 4,300 737NGs in operation. While the oldest aircraft have yet to complete two base check cycles, base check data indicates that the 737NG has low and steady maintenance requirements. The aircraft does, however, have four large groups of tasks that will come due at an older age.

Assessing the 737NG's base maintenance requirements

There are more than 4,300 passenger-configured 737NGs in operation, with an age of up to 16 years. There are another 1,860 737NGs on firm order. The 737NG family is the second most numerous type in operation. It clearly has an important role as a short- and medium-haul workhorse in the global fleet. Its operating economics, including its maintenance costs, affect its long-term viability. The 737NG's base maintenance requirements and inputs over two base check cycles are examined.

The 737NG family was developed from the 737-300/-400/-500 family of Classic aircraft. It was designed to have lower airframe-related maintenance costs, using maintenance steering group 3 (MSG-3) principles, to make the aircraft more maintenance-friendly. The MSG-3 principles also included the corrosion prevention and control programme (CPCP) tasks as an element of structural tasks. This compares to the 737 Classics, which have CPCP tasks separate from the structural programme. As a result, the 737NG family has fewer maintenance tasks, and tasks that are easier to perform.

Fleet & operating profile

The 737NG fleet can be sub-divided into four main series: the -600, -700, -800 and -900. Each main series can further be sub-divided into several variants. The majority of the aircraft are passenger-configured, although there are 737-700Cs in convertible configuration. The -900 fleet is split between -900s and extended-range-capability -900ERs.

The -600 is a minority series, with only 53 in the fleet. About half are operated by SAS, mainly on typical short-haul operations.

There are more than 240 737-900s in operation, and 350 more aircraft on order. Main operators include United Airlines (previously Continental Airlines aircraft), Alaska Airlines, Lion Air and Turkish Airlines. These aircraft are used on medium-haul operations by most airlines. Turkish Airlines has an average flight cycle (FC) time of 3.60 flight hours (FH), and generates an average of 5,180FH per year with the aircraft.

The -700 and -800 account for most of the fleet. There are more than 1,050 -700s in operation, and the -800 has by far the largest fleet with more than 3,000 in service.

The 737-700 is operated by a large number of airlines, although Southwest has the largest fleet at 425 units.

Most 737-700s are operated at more than 1.50FH per FC, generating more than 3,000FH and 1,600FC per year. A few airlines operate the aircraft on relatively short cycles, and generate 2,000-2,560FC per year.

The -800 fleet accounts for almost 70% of all NGs in service. The largest fleets are operated by Ryanair (301 aircraft), American Airlines (221), United (130), Alaska (61), Delta (73), Norwegian (64), Air China (86), China Southern (96), Hainan Airlines (78), Xiamen Airlines (67) and GOL (82).

Most of the 737-700 and -800 fleets are operated at rates of utilisation of 2,900-3,500FH and 1,300-1,800FC per year. The average FH:FC ratio is about 1.9:1.0, although the average FH time for operators varies from 1.6FH to 2.2FH.

Some airlines, including GOL, Lion Air, Ryanair and SpiceJet, operate the -700 and -800 at 2,500-2,900FC per year, and at shorter cycles of 1.3-1.7FH.

The range of tasks, task groups and their associated intervals in the maintenance planning document (MPD) means the maintenance programmes for fleets operating at different rates of aircraft utilisation and FH:FC ratios will be arranged differently. There are a large number of FC tasks in the MPD, for example, and these will come due earlier for aircraft operating on short FH:FC ratios compared to long FH:FC ratios.

MPD development & tasks

Unlike the 737 Classics' MPD, the 737NG's MPD does not specify particular checks for each task. That is, there are no defined 'A', 'C' or 'D' checks. Instead, tasks are listed individually, and operators are free to plan maintenance checks and programmes in the pattern that suits them best.

"Operators can choose how they treat task cards when it comes to maintenance planning," says Sandra Everest, estimator at ATC Lasham. "An issue arises when a task has an interval that does not have the same frequency as the operator's base check. A task can be brought forward, can be treated as an out-of-phase (OOP) task and incorporated into an A check, or could be adapted by the operator and incorporated in one of its own tasks. The latter will be approved if the task is performed with the MPD interval."

MPD task intervals are specified in FH, FC, calendar time, a combination of FH and FC, a combination of FH and calendar time, and a combination of FC and calendar time. In the case of combined intervals, the interval that determines when a task is performed is the one that is reached first.

There is also a minority of tasks that involve replacing life-limited components. The life limit varies with each vendor.

There are overall a large number of different intervals, and this complicates base check planning.

"There are four main groups of tasks in the MPD," says Elvin Coskun, Boeing aircraft lead engineer, at Turkish Technic. "The first three main groups are the system, structural and zonal tasks. The system group of tasks has 677 airframe-related tasks, the structures programme has 753, and the zonal programme has 207. All tasks have an initial and repeat interval. The fourth group comprises the airworthiness limitation (AWL) tasks."

Freedom to group tasks means that, although some tasks have high intervals,

The majority of 737NGs are -700 and -800 aircraft. Most are operated at an average FC time of 1.7-2.3FH, and accumulate 1,300-1,800FC per year.

they can be grouped into line, or what may be generically termed 'A', checks, rather than including them in base checks, which some operators refer to as 'C' checks.

Deciding whether to include a task with a relatively high interval in a base check will partly depend on the type of task. Some tasks are visual (VCK), functional (FNC) or operational checks (OPC), and others are general visual inspections (GVI), the discarding and replacement of an easily accessible component (DIS), or service (SVC) tasks. Most tasks do not consume a large number of additional man-hours (MH) for access, removal and reinstallation, so it is possible for many operators to include such tasks in line or 'A' checks.

Other tasks with higher intervals require the removal and installation of items such as panels, carpets, flooring, galleys, lavatories, and other interior furnishings. A large number of MH can therefore be used to remove and install these items, in addition to performing the actual tasks. This also uses a lot of aircraft downtime. There are several tasks in the MPD that require the removal of many interior items, such as panels and furnishings. Many operators therefore include these tasks in base or 'C' checks, where a traditional block check maintenance programme is used.

It also makes sense for maintenance planners to group tasks that require access to the same areas of the aircraft in the same check.

Some airlines have opted for an equalised maintenance programme, under which the airline operates a programme of 'A' checks at a regular interval. Groups of high interval tasks are then split into approximate equal portions, with each portion being included in a cycle of 'A' checks. The advantages are that there are no or few larger base checks that require a long downtime. Instead, maintenance is arranged into more frequent, but smaller, work packages.

An example is Turkish Airlines. "We currently operate a block base check system. Our base check interval is 7,500FH, 4,000FC and 730 days, whichever interval is reached first," says Coskun. "The base or C check is once every 24 months for most of our fleet. There is no cycle or pattern of checks, so they are not numbered. Some operators have big checks at the sixth or eighth check. We are now, however, looking at equalising the base checks into equalised A checks with a 1,000FH interval."

A large number of tasks in the MPD have calendar intervals that are a multiple of two years, while many tasks with FH intervals are a multiple of several thousand FH. For this reason a base check interval with two criteria of 24 months or two years and about 6,000FH is used by several operators. Some airlines have an FH interval of 7,500FH.

System tasks

The system programme has tasks specified in all six different interval criteria: FH, FC, calendar time, FH/FC, FH/calendar, and FC/calendar. The initial and repeat intervals in the system programme are equal for all tasks.

These groups of tasks are summarised *(see table, page 44)*. The three groups of tasks with combination intervals are listed as one group.

The important issues are each interval. If there are tasks within each interval group that require deep access, these should be included in base checks. Tasks with intervals of less than 6,000FH and 24 months, and the equivalent number of FC accumulated in the same period, will generally be included in line and A checks. Tasks with higher intervals than this are generally included in base checks, although some could be planned into lighter checks. Not all tasks have intervals that are convenient multiples of 6,000FH. They may have to be brought forward, and so would lose some interval utilisation. Relatively few tasks in the system programme require deep access.

FH tasks

There are 254, mainly lighter, tasks with intervals of 6,000FH to 48,000FH *(see table, page 44)*. They include a large number of OPC, FNC, VCK, GVI and DIS inspections.

There are 37 tasks with a 6,000FH interval, and 93 with an interval of 7,500FH. Tasks at 7,500FH were escalated from 6,000FH in 2010. Some were only escalated to 6,500FH and 7,000FH, and 37 of the tasks were left at 6,000FH.

Many of the tasks between 6,000FH and 30,000FH are FNC, OPC, VCK, GVI and SVC tasks. They therefore involve little deep access, as is typical of system programme tasks.

FC tasks

The 54 tasks with higher intervals from 1,600FC to 75,000FC *(see table, page 44)* may be grouped at multiples of the base check interval.

Calendar tasks

There are 94 tasks with intervals of two to 12 years *(see table page 44)*. Most of these tasks have easy or light access requirements, although there are three with a 10-year interval that involve an inspection in the centre wing fuel tank, and a few more that involve associated wire bundle inspections. Some door inspections take place every two years.

Combination interval tasks

The fourth main group is tasks with combination or dual interval criteria. There are 62 tasks with intervals that are the equivalent of two years or more, the highest being 14 tasks with a 12-

737NG SYSTEM PROGRAMME MPD TASKS

Initial interval	Repeat interval	Number of MPD tasks	Deep access tasks	Light access tasks
50-5,000FH	50-5,000FH	94	2 engine tasks	
6,000-7,000FH	6,000-7,000FH	43		
7,500FH	7,500FH	93		
8,000-9,000FH	8,000-9,000FH	26		
10,000/11,000FH	10,000/11,000FH	8		
12,000FH	12,000FH	16		
12,500/13,000FH	12,500/13,000FH	11		
15,000FH	15,000FH	11		
16,000FH	16,000FH	7		
18,000/20,000FH	18,000/20,000FH	3		
22,400/22,500FH	22,400/22,500FH	2		
25,000FH	25,000FH	24		
30,000FH	30,000FH	8		
40,000FH	40,000FH	1		
48,000FH	48,000FH	1		
50-1,000FC	50-1,000FC	12		
1,600-3,000FC	1,600-3,000FC	14		
4,000FC	4,000FC	17		
5,000FC	5,000FC	7		
6,000FC	6,000FC	1		
10,000FC	10,000FC	1		
12,000/12,500FC	12,000/12,500FC	3		
15,000FC	15,000FC	1		
25,000FC	25,000FC	7		
2 DAYS-18 MO	2 DAYS-18 MO	21		
24/30/36 MO	24/30/36 MO	53		Door inspections
48/60 MO	48/60 MO	4		
72/84 MO	72/84 MO	13		
96 MO	96 MO	3		
120 MO	120 MO	12	Access to fuel tanks	Wire bundles fuel tanks
144 MO	144 MO	9		
90DY/560FC - 36 MO/12,000FH	90DY/560FC - 36 MO/12,000FH	23		
24 MO/4,000FC	24 MO/4,000FC	2		
24 MO/4,800FC	24 MO/4,800FC	4		
24/30 MO/5,500FC	24/30 MO/5,500FC	5		
24 MO/6,400FH	24 MO/6,400FH	1		
7,500FH/6,000FC	7,500FH/6,000FC	4		
72 MO/18,000FC	72 MO/18,000FC	24	Removal of interior items	
72 MO/21,600FC	72 MO/21,600FC	3	Access to flt control cables	
96 MO/36,000FC	96 MO/36,000FC	2	Removal of fuselage panels	
120 MO/18,000FC	120 MO/18,000FC	1		
120 MO/21,000FC	120 MO/21,000FC	2		
144 MO/36,000FC	144 MO/36,000FC	14	Removal of access panels, galleys & lavatories	
Life limited/NOTE/ Vendor	Life limited/ Vendor	57		

year/36,000FC interval *(see table, this page)*.

The highest FH/FC tasks have an interval of 7,500FH and 6,000FC. Tasks with a 4,000FH/2,000FC and lower intervals will be included in line maintenance by most operators.

The highest FH/calendar tasks have an interval of 8,000FH and 36 months. The calendar interval is likely to be reached first or close to 36 months in the case of most operators. The same applies to all other FH/calendar tasks.

There are 14 different FC/calendar intervals. The highest is 36,000FC and 12 years. The 12-year calendar interval will be reached first by most aircraft.

A large number of tasks require deep access in this category. The first is the 24 inspections with a 6-year/18,000FC interval. These all require the removal of a lot of fuselage and cargo compartment panels, and the cargo loading system.

There are also a small number of deep access tasks at eight- and 10-year intervals. Another 10 tasks at the 12-year/36,000FC interval require removal of access panels, galleys and lavatories.

Note & VEN REC tasks

There are 56 tasks that concern the replacement of certain rotable components, such as batteries and oxygen bottles. In many cases the task is performed when the component expires, or when recommended by the vendor.

Structural tasks

The structural tasks in the 737NG's MPD have intervals specified in FC, calendar time, and a combination of calendar time and FC. There are also a few tasks with a NOTE interval. Many of these have an interval determined by limits of the total number of FH and FC an aircraft has accumulated.

Tasks in the structures programme have high intervals; many require light or deep access. Tasks in the structures programme cover landing gear, doors, fuselage, stabilisers, engine nacelles, and the wings. The fuselage (ATA Chapter 53) accounts for most of the tasks.

"The 737NG includes the CPCP inspections as an integral part of the tasks in the structures programme," explains Coskun. "Most of the tasks that have integrated CPCP inspections are six-, eight- and 10-year tasks. The areas of the aircraft with tasks that include CPCP inspections are doors, fuselage, nacelles, engine pylons, stabilisers, and wings."

"There are 152 tasks that include CPCP inspections with six- and eight-year initial intervals. These are the majority of the tasks in the structures programme that include CPCP inspections," explains Nico Hemmer, director of AMRO at

737NG STRUCTURES PROGRAMME MPD TASKS

Initial interval	Repeat interval	Number of MPD tasks	Deep access tasks	Light access tasks
18,000FC	18,000FC	2		
34,000FC	34,000FC	4	Fuselage inspections	
36,000FC	36,000FC	2	Fuselage inspection	
50,000FC	4,000FC	32		Internal fuselage
50,000FC	6,000FC	6		
50,000FC	8,000/9,000FC	27	Panels & blankets	Fuselage skin panels
50,000FC	12,000FC	4	Interiors, panels	Internal fuselage
50,000FC	14,000FC	1		Horizontal stabiliser
50,000FC	15,000/16,000/ 17,000FC	4		Internal fuselage
50,000FC	18,000FC	45		Internal fuselage
50,000FC	22,000/24,000FC	47		Internal fuselage
50,000FC	30,000/33,000FC	2		Internal fuselage
50,000FC	36,000/40,000FC	81		Internal fuselage
56,000FC	1,600FC	1	Horiz stabiliser	
56,000FC	3,000/3,550/4,000FC	20	Horiz stabiliser	
56,000FC	5,000/6,000FC	7	Engine pylons & horiz stabiliser	
56,000FC	8,000/9,000FC	24	Engine pylons, wings & horizontal stabiliser	
56,000FC	10,000/11,000FC	4	Horiz stabiliser, wings	
56,000FC	12,000/13,000/14,000FC	9	Horiz stabiliser, wings	
56,000FC	15,000FC	4	Horiz stabiliser	
56,000FC	18,000FC	70	Engine pylons, wings & horizontal stabiliser	
56,000FC	21,000/22,600FC	2	Horiz stabiliser, wings	
56,000FC	24,000FC	18	Horiz stabiliser	
56,000FC	27,000/28,000FC	2	Horiz stabiliser, wings	
56,000FC	30,000FC	1	Horiz stabiliser	
56,000FC	34,000/36,000FC	48	Engine pylons, wings & horizontal stabiliser	
56,000FC	75,000FC	2	Engine pylons	
5-YEAR	5-YEAR	2	Removal of winglets	
6-YEAR	6-YEAR	4		
8-YEAR	3-YEAR	1		
8-YEAR	4-YEAR	4		
8-YEAR	6-YEAR	2	Removal of panels, insulation blankets, galleys & lavatories	
3,000 DY	3,000 DY	3	Removal of interior items	
9-YEAR	3-YEAR	3		
10-YEAR	5-YEAR	2		
10-YEAR	10-YEAR	7	Removal of panels & insulation blankets	
12-YEAR	12-YEAR	2	Removal of dry area floor boards	
20-YEAR	8-YEAR	1	Fuselage inspection	
24 MO/4,000FC	24 MO/4,000FC	18	Removal of galleys & lavatories	
30 MO/9,000FC	30 MO/9,000FC	2		
36 MO/9,000FC	36 MO/9,000FC	6		
1,500 DY/8,000FC	1,500DY 8,000FC	1		
72 MO/18,000FC	72 MO/18,000FC	39		Engine pylons
96 MO/24,000FC	96 MO/24,000FC	7	Removal of cargo panels, galleys, lavatories & blankets	Cargo door cutout
96 MO/18,000FC	96 MO/18,000FC	16		
96 MO/24,000FC	96 MO/24,000FC	3	Fuselage task	
120 MO/36,000FC	120 MO/36,000FC	15	Removal of floor panels & insulation blankets	Internal wing
144 MO/36,000FC	96 MO/24,000FC	38	Removal of panels, interior items & insulation blankets	Internal doors
144 MO/36,000FC	120 MO/30,000FC	4	Removal of floor panels	
NOTE	NOTE	3		
FLS Gp1 - FH/FC	FLS Gp1 FH/FC	27	Internal wings	
FLS Gp2 - FH/FC	FLS Gp2 FH/FC	72	Internal wings	Internal wings

Fokker Services.

The high intervals mean the structures tasks are likely to be included in base checks. Due to long downtimes it would be difficult to include them in line or A checks.

FC tasks

There are 469 FC tasks. A small number have initial intervals of 18,000FC, 34,000FC and 36,000FC *(see table, this page)*. Some have a few deep access tasks in relation to the fuselage and horizontal stabiliser.

There are two large groups of tasks with high initial intervals of 50,000FC and 56,000FC, added to the MPD in 2010. These two groups have 461 tasks, so the structural programme has almost tripled since their inclusion.

Many of these tasks are intended to find damage, wear and cracks. The planner and mechanic can refer to a damage tolerance rating (DTR) document that provides a diagram and more detail of how damage is found. The description of the task in the MPD is cross-referenced to the DTR, of which further details can be found in Section 9 of the MPD.

Many tasks in these two groups are cross-referenced to the DTR document.

Boeing has not yet estimated the man-hours (MH) needed to perform these tasks, and is only likely to do so once a few aircraft have been sampled.

The first 249 tasks have an initial interval of 50,000FC. There are 14 sub-groups, with different repeat intervals of between 4,000FC and 40,000FC *(see table, this page)*.

Many of these tasks are inspections for various internal and external fuselage structures, and require light access in terms of removal of panels and interior items. Many of the tasks also involve non-destructive tests (NDT).

A complication is that many of these tasks have short repeat intervals that start at 4,000FC, and go up to, and beyond, 14,000FC, equal to another nine or 10 years' operation after the tasks were first performed.

Many operators accumulating 1,600FC per year may see this group of tasks as a retirement watershed.

The issue is different for aircraft operating at 2,500-2,900FC per year, whose tasks will come due when the aircraft is 17-20 years. This means they will probably have to be performed, and then repeated at intervals of one to 14 years. The tasks with the lower repeat intervals will have to be performed regularly, so operators utilising aircraft at high FC annual rates will have to accept higher airframe-related maintenance costs after 17 years.

Everest explains that there may be an alternative means of compliance (AMOC)

The 737NG's MPD has to be carefully examined for tasks that use a lot of man-hours for removal and reinstallation of interior items, or require deep access, since these items determine which base checks are the heaviest.

for some of these tasks. Rather than repeating inspections at increased frequencies, it may be possible to replace the components or structural items related to some of the tasks, which would eliminate the need to perform them. Everest warns that some of these inspections may still have to be made.

A second group of 212 tasks has an initial interval of 56,000FC, and repeat intervals of 1,600FC and 36,000FC, although there are also two tasks that have a repeat interval of 75,000FC *(see table, page 46)*. There may also be AMOC for these tasks after the initial inspections have been made at 56,000FC.

Many of these tasks involve inspections to structures in the horizontal stabiliser, wing spars, engine pylons, and flap fittings and carriages.

Most airlines operating at 1,600FC per year will reach the initial 56,000FC interval at an age of 35 years. These tasks are also likely to force a retirement.

The tasks will first come due at 19-22 years for aircraft operating at higher rates of 2,500-2,900FC per year. These may also be performed to keep the aircraft operational. Many operators with high annual rates of FC utilisation may decide to combine these two groups and perform them together.

Calendar tasks

The third large group of tasks comprises 31 inspections with calendar intervals. Initial intervals are at five to 20 years *(see table, page 46)*. Some of these tasks include CPCP inspections.

Some require deep access. There are, for example, two inspections that involve removing the galleys, lavatories, floor boards, sidewall panels, and insulation blankets in the surrounding 'wet floor' area. They first come due at eight years, and are repeated every six years. "The MPD indicates that 3MH are needed for the actual inspections for these two tasks, but it can require 500MH to remove and reinstall all the associated interior items to gain the required access. These access MH are similar to those used for the 737 Classic, although the 737NG is a bit more efficient because of its design," says John Drysdale, marketing executive at Transaero Engineering Limited, Shannon.

There are also two tasks that require the removal of the floor boards in the remaining 'dry floor' area at a 12-year interval. According to the MPD, the actual inspections require only 4.50MH, but use several hundred MH for the removal and reinstallation to gain access.

FC/calendar tasks

The fourth main group of tasks is 149 inspections with FC/calendar interval criteria. There are 11 different intervals *(see table, page 46)*. In all cases the calendar intervals will be reached before the full FC intervals for aircraft operating at 1,600FC per year. Most of these tasks come due at an even number of years, from two to 12 years.

NOTE & FLS tasks

A fifth group of 102 tasks has a NOTE in the MPD for determining their interval.

Three tasks have initial intervals of 27,000-56,000FC. The other 99 are 'flight-length sensitive (FLS)' tasks, and 78 of them need either deep or light access. The interval for FLS tasks is a combination of FH and FC, and is determined by referring to one of two charts in section 9 of the MPD. There are 27 tasks that have their intervals determined by figure 1, and 72 that have their interval determined by figure 2.

Both charts have a maximum limit of a total FH and FC accumulated by the aircraft, by which the tasks have to be performed.

Figure 1 has absolute maximum limits of 75,000FC and 100,000FH. The chart, however, only allows a maximum limit of 75,000FC for a corresponding total of up to 45,000FH. Between a total of 45,000FH and 100,000FH, the upper FC limit decreases linearly to 30,000FC. The upper FH limit remains at 100,000FH for total accumulated FC between zero and less than 30,000.

The limits of the chart mean that aircraft operating at 1.9FH per FC will reach their maximum allowed FH and FC limits at 80,000-82,000FH and 42,000FC. This will be equal to 27 years.

Aircraft operating at a shorter FC time of 1.1FHFC will reach their FH and FC limits earlier, at about 64,000FH and 59,000FC. This will be equal to 21 years.

Figure 2 has absolute maximum limits of 56,000FC and 75,000FH. The chart, however, only allows a maximum limit of 56,000FC for up to 33,000FH. From 33,000FH to 75,000FH, the upper FC limit decreases linearly to 22,000FC. The upper FH limit remains at 75,000FH for total accumulated FC between zero and 22,000.

The limits of figure 2 mean that aircraft operating at 1.9FH per FC will reach their FH and FC limits at 62,000FH and 33,000FC. This is equal to 20 years of operation.

Aircraft operating at a shorter FC time of 1.1FHFC will reach their FH and FC limits at 47,000FH and 43,000FC, equal to 14-17 years' operation.

For aircraft operating at short average cycles of 1.1-1.3FC and at 2,500-2,800FC per year, the tasks with initial intervals of 50,000FC and 56,000FC, and Group 1 and 2 FLS tasks, will all come due after 14-22 years of operation. Where possible, it would make sense to combine all of these tasks and perform a large structural workpackage.

Zonal tasks

The zonal programme's tasks are specified in FC, calendar time, and a

737NG ZONAL PROGRAMME MPD TASKS

Initial interval	Repeat interval	Number of MPD tasks	Deep access tasks	Light access tasks
2,000FC	2,000FC	6		
4,000FC	4,000FC	2		
6 MO	6 MO	2		
12 MO	12 MO	2		
120 MO	120 MO	2		
90 DY/560FC - 18 MO/4,000FC	90 DY/560FC - 18 MO/4,000FC	33	Fuselage & doors	
24 MO/4,800FC	24 MO/4,800FC	16	Keel beam & stabilisers	
24 MO/5,500FC	24 MO/5,500FC	29	Deep wing inspections	
30 MO/5,500FC	30 MO/5,500FC	70	Air conditioning bay	Internal fuselage
30 MO/9,000FC	30MO/9,000FC	6		Internal fuselage
60 MO/13,000FC	60 MO/13,000FC	5	Removal of floor panels & cargo loading system	
72 MO/21,600FC	72 MO/21,600FC	6		
96 MO/18,000FC	96 MO/18,000FC	8		
96 MO/24,000FC	96 MO/24,000FC	3		
96 MO/36,000FC	96 MO/36,000FC	3	Deep fuselage	
120 MO/36,000FC	120 MO/36,000FC	8	Removal of seats & panels	
144 MO/36,000FC	144MO/36,000FC	6	Removal of panels	Internal fuselage

combination of the two. There are 207 tasks, and all affect the same areas of the aircraft as the structural programme.

FC tasks

There are two FC intervals of 2,000FC and 4,000FC, which have a small number of tasks *(see table, this page)*.

Calendar tasks

There are three calendar intervals of six months, one year and 10 years *(see table, this page)*. Only the two 10-year tasks would be included in base checks.

FC/calendar tasks

The majority of zonal programme tasks have FC/calendar intervals. There are 16 different intervals. The first five have calendar intervals of up to 18 months, so these tasks should be included in line checks.

The other 11 task intervals have calendar limits of two to 12 years. The associated FC limits of these intervals are 4,800-36,000FC *(see table, this page)*.

There are a total of 157 tasks in these 11 groups. The FC limits are high enough for the calendar limits to be reached before the FC limits in the case of aircraft operating at 1.9FH per FC, and accumulating about 1,600FC per year. Most calendar intervals are convenient multiples of two years, and so coincide with typical base check intervals.

There are a large number of deep access tasks in this group of FC/calendar tasks. These include internal fuselage and stabiliser structural inspections, deep internal wing inspections, and removal of the fuselage skin at the wing-body fairing. There are also some internal fuselage inspections that require lighter access.

There are a small number of other deep access tasks with the higher intervals of four, six, eight, 10 and 12 years *(see table, page this)*.

Additional tasks

In addition to the three main groups of system, structure and zonal programme tasks, there are additional tasks specified in section 9 of the MPD.

"There are two groups of tasks in section 9: airworthiness limitation items (AWLs) and certification maintenance requirement (CMR) tasks," says Everest.

A CMR task is a periodic task, which is established during the aircraft's design certification as an operating limitation. "The task is intended to detect safety-significant latent, or hidden, failures that would result in a hazardous or catastrophic condition," explains Drysdale.

There are 11 CMR tasks. Four have an interval of 4,000FH/2,000FC, two have a 24-month interval, and another four have intervals of 4,500-20,000FH. There are also three with a NOTE interval.

"An example of a CMR task is the inspection of the centre wing spar vapour web for cracking," says Drysdale.

Some AWLs do not have conventional intervals, and instead are triggered by maintenance actions known as critical design configuration control limitation (CDCCLs) that occur as a result of non-routines arising from the routine tasks. CDCCLs can also be triggered by a component change, or an OPC or FNC. CDCCL tasks are performed when indicated in the aircraft maintenance manual (AMM). An example is checking of chaffing in wiring bundles over the centre fuel tank when any inspections are made in the area.

There are also 10 routine AWLs, with intervals of one, six and 10 years; and 6,500-22,500FH. It is important to note that some of the AWL routine tasks are structurally significant item (SSI) tasks.

Major ADs & SBs

Unlike the 737 Classics, the 737NG has been relatively free of major airworthiness directives (ADs) and service bulletins (SBs). These are ADs and SBs that involve major inspections and terminating action, so they would incur a large number of MH and high cost of parts and materials. They may also need an extensive check downtime, or deep access and replacement of interior items.

One AD that affects several aircraft types involves inspecting the damage caused along fuselage scribe (scratch or damage) lines. These are caused when the aircraft has been stripped of its paint and sealant along the lap joints, lap joint and any skin repairs, and decal installations.

"The AD requires the use of special optical equipment to check for damage along the fuselage lap joint," explains Everest. "The initial interval for such an inspection depends on the zone of the aircraft, and the repeat interval depends on how deep the last inspection was and what damage was found.

"One of the major ADs that is unique to the 737NG, relates to problems with the aircraft's elevators," says Everest. "This resulted in AD 2010-17-19 being issued, which has now been superseded by AD 2013-06-05, and applies to all 737NGs." The AD requires replacement of the elevator tab control mechanisms, with new ones that have modified attachment lugs. The compliance deadline for most 737NG is within 60 months of release of the 2013 AD, that is, by June 2018. The estimated cost of modifying the aircraft is 95MH, and $80,000 in parts and materials .

A recent AD issued against the 737NG is number 2013-19-04 from November 2013. This was issued following a report of cracks being found in the skin at body station 540, and just below stringer S-22L, at the lower fuselage, near the forward bulkhead of the main gear well. The purpose of this AD is to detect a crack in the skin, which would result in a rapid decompression of the cabin. This requires a high frequency eddy current test in the area around the eight fasteners securing body station 540.

Base cycle arrangement

As described, there are a large number of different intervals for each group of tasks in the four main programmes in the

There are a large number of tasks and task intervals that require the removal of interior items. These should be grouped together as much as possible to minimise repetition of maintenance action. The refurbishment of the aircraft's interior should be planned to coincide with these tasks.

MPD. In addition, each operator will add their own tasks, or edit MPD tasks to include some of their own tasks. "We also have are our service quality task card (SQTC) programme," says Coskun. "This is to improve cabin quality and fulfil company procedures. These are non-mandatory cards."

The variety of task intervals means there are many ways to group tasks and organise base check programmes. A common system is for a base check interval of 6,000FH, 4,000FC and 24 months. Most aircraft have annual rates of utilisation of 3,000FH, and operate at 1.9FH per FC. Some airlines would therefore reach the 6,000FH and 24-month limits at about the same time, and so conveniently allow a base check every two years.

A large number of operators have annual utilisations higher than 3,000FH, and close to 4,000FH. A 6,000FH base check interval would therefore be once every 21 months.

A large number of tasks at 6,000FH were escalated to 7,500FH, meaning more airlines could adhere to a 7,500FH and 24-month base check interval. This, however, would mean that the 43 system programme tasks with intervals of 6,000-7,000FH would have to be left out of base checks, and treated as OOP tasks that are added to A checks.

"Programmes do vary between operators, but a 7,500FH, 5,500FC and 30-month base check interval is now used by quite a lot of them," says Drysdale. "A maintenance review board report has revised a number of tasks at the 7,500FH interval to 15,000FH, so it is possible that in 2014 a standard base check interval could go to 15,000FH, 6,600FC and 30 months."

The large number of task groups at calendar intervals and FC/calendar intervals that are multiples of 24 months means that so far it has been easiest to have a base check interval based on a two-year interval. Moreover, the main groups of tasks that have intervals of multiples of two years are structural inspections that require deep access, and so have the largest MH requirements and longest check downtimes.

"A lot of operators have base check cycles of six checks, which is a 12-year interval," says Everest. "A heavy check is performed at the sixth check, the C6 check, at 12 years. This is because a large number of tasks, many of them with deep access requirements, come due at six- and 12-year intervals. These require the removal of a lot of interior items and panels *(see tables, pages 44 & 46)*.

"Under a programme with a 24-month base check interval, the biggest checks are the six-, eight-, and 12-year checks," says Everest. "The large number of deep access tasks at six- and eight-year intervals means there would be two consecutive heavy checks. The most significant deep access tasks with an initial eight-year interval are two that require the removal of floor and sidewall panels, insulation blankets, galleys and lavatories for inspection of the floor beams in the areas around the galleys and lavatories; the so-called 'wet floor' area. This is because leakage and spillage around the galleys and lavatories can lead to corrosion."

These inspections have a six-year repeat interval. "These two tasks use 500-650MH for removal and inspection of all the interior items," estimates Everest. There are also many deep access tasks with a 12-year interval. For these two reasons, many operators bring these eight-year tasks forward to coincide with those that have an initial six-year interval. This way the repeat interval of six years coincides with the 12-year tasks and the sixth base check.

There are other deep access tasks with both an initial and repeat interval of eight years. Although interval utilisation is lost, it is overall more efficient to bring eight-year tasks forward in line with the third check at the six-year tasks.

There are also some 10-year tasks that require deep access.

"The 12-year check on the 737NG can be regarded as similar to a D check on a 737 Classic," says Everest. "This is not only because there are a lot of 12-year tasks, many that require deep access, but also because the six-year tasks are repeated. Aligning these tasks at these various intervals reduces the duplication of deep access tasks, which use a lot of MH for removal and installation."

Hemmer confirms that most operators have so far maintained a calendar interval of 24 months for their base checks, and that the third, sixth and ninth base checks are the heaviest.

Besides calendar tasks, the majority of FH and calendar tasks will come due at intervals close to multiples of two years.

Whichever FH, FC and calendar intervals are used as a base check interval, it is inevitable that some task groups will have poor interval utilisation.

Given that the oldest aircraft were built and entered service in 1997, no aircraft will have completed two cycles of base checks. They will have reached their ninth base checks, the third heavy check. The second base check cycle will be completed after about 24 years, although typical check interval utilisation means this is actually likely to be about 21 years.

Aircraft about 11 years and older will have completed their first cycle of six base checks.

The aircraft that have accumulated the highest number of cycles are 737-700s operated by GOL and Southwest. These have accumulated 35,000-40,000FC, and most have been operated at FC times of less than 1.5FH. These aircraft have had average annual utilisations of 2,200-3,200FC. They will therefore reach the group of 50,000FCs in three to seven years.

The current intervals of tasks in the 737NG's MPD means that the most optimal base check interval is 6,000FH and 24 months. Base checks can conform to a cycle of six checks, with the third and the sixth being the two heaviest in the cycle.

The same aircraft will, however, be close to reaching the FH and FC limits of the FLS Group 2 tasks.

Base check inputs

There are several elements of base check inputs, including: routine inspections; non-routine defects that subsequently arise; interior cleaning; interior refurbishment; the incorporation of engineering orders (EOs), ADs and SBs; the removal of heavy components; and stripping and repainting.

The MH and materials for these elements are examined for the 12 base checks in the first two base check cycles, each with six checks. This is on the basis of a 24-month interval, and aircraft operating at 1.9FH per FC.

The 50,000FC, 56,000FC and two groups of FLS tasks are not included in any of the checks, because they will all come due after the second base check cycle has been completed.

The base check inputs are examined over two cycles of six checks, with a 24-month base check interval. This would therefore be a full interval of 24 years, although interval utilisation means this would actually be 21 years.

Routine inspections

An airline's routine inspections start with the MPD/AMM tasks, and include the items that will (or are likely to) be included in the base checks, and lesser checks and some OOP tasks. The MH used for aircraft preparation can also be considered part of routine maintenance.

Routine inspections for the 737NG use fewer MH than the 737 Classics. "In our experience the 737NG uses about half the MH for routine inspections compared to the 737-400," says Coskun. "The main reason is that the NG has fewer tasks, and it has easier access. The MSG-3 philosophy used in the aircraft's design means its maintenance tasks are structured differently to those of an aircraft designed with MSG-2. An example is that certain OPC and FNC tests can be performed on components and systems in situ, rather than having to remove them from the aircraft. The MSG-3 philosophy also allows problems to be caught early with testing and condition monitoring, so there is a lot more preventative maintenance."

Routine MH used for the C checks in the first base check cycle can start at 600-700MH for the C1 check. The actual size of the check will vary according to actual tasks included and other factors, such as labour efficiency. The C2 check is usually a little larger, but the C3 check is the first heavy input. The C3 check may require about 1,300MH *(see table, page 54)*.

The C4 check, which may have a lot of eight-year tasks that were not necessarily brought forward to a six-year interval, will also be a large work package, and have a routine MH requirement of 1,700MH.

The C5 check will have some 10-year tasks, although these will be small as a group compared to heavy six- and eight-year tasks. The check will therefore be smaller, and so is likely to require about 1,100MH *(see table, page 54)*.

The C6 check, at 12 years, will be the first very large check, with not only the 12-year tasks coming due for the first time, but also the six- and eight-year tasks being repeated for the first time. The labour used for routine inspections will therefore be high at 3,000-3,300MH *(see table, page 54)*.

The six checks of the first base check cycle will therefore use a total of 8,500MH *(see table, page 54)*.

The labour used for routine inspections in the second base check cycle will be a little higher. This is first because a small number of tasks come due for the first time, but more importantly, more tasks are hitting their repeat intervals. In some cases the repeat intervals are shorter than the initial intervals. The MH used for each of the six checks in the second cycle can be about 10% higher than they were in the first cycle *(see table, page 54)*.

Non-routine rectifications

Routine inspections lead to non-routine defects and repairs. In many cases, the 737NG has a lower routine: non-routine ratio than the 737 Classic.

"Non-routine rectifications are mainly required because of the deterioration of the aircraft's systems and their related reliability," says Coskun.

Drysdale comments that on early C checks the non-routine ratio can be quite low, and rises slowly as the aircraft goes through more checks. "When the aircraft reaches its first heavy top base check, the C6 check that includes structural inspections, then the routine to non-routine ratio reaches 1:1," says Drysdale. "This will drop in the subsequent early checks of the second base check cycle, since these will have few or no structural inspections. The ratio will gradually ramp up again as the aircraft progresses through the six checks of the cycle.

"The main causes of non-routine rectifications are mainly the structural tasks, particularly in the wet areas of the aircraft," continues Drysdale. "Corrosion is one of the biggest issues. General wear of cabin items also creates a large amount of non-routine items. There is also underfloor deterioration, and wear of the sidewall and ceiling panels, and corrosion affects tie-down tracks which can be extensive to repair. Fuselage frames can also suffer damage, and luggage-loading systems usually get heavy wear.

"Galleys suffer minor damage, while lavatories can consume heavy MH due to poor maintenance, leaks and corrosion," explains Drysdale. "Sidewalls and overhead bins account for minor wear, but fuselage frames in the vicinity of overhead bins are prone to damage."

Everest explains that the 737NG's non-routine ratio during the first two base checks is generally 5-10% lower than the 737 Classic *(see Assessing the 737 Classic's ageing maintenance, Aircraft Commerce, June/July 2013, page 36)*. The non-routine ratio for the C1 check will therefore be up to 20% *(see table, page 54)*, although it could be as low as 5%. The non-routine ratio will then creep up to 45% by the C3 check, the first heavy check at six years, and continue to rise to 70-80% by the C6 check at 12 years; the first large structural check at the end of the first base check cycle. This will therefore generate about 125MH of non-routine labour in the C1 check. This will rise to 575MH in the C3 check, and 2,300-2,650MH in the C6 check *(see table, page 54)*. The total non-routine MH for the six checks of the first base check cycle will be about 4,600MH.

Everest estimates that overall non-routine ratios in the second base check cycle will be about 10% higher than in the first base check cycle. The ratio will therefore be 25-30% in the C7 check, and 45% in the C9 check. Everest estimates that it could reach about 85% in the C12 check, although this has yet to be reached for the oldest aircraft. Drysdale, however, says it could be as high as 100%.

The number of MH for non-routine rectifications will therefore be about 200MH in the C7 check, and 600-650MH in the C9 check. Broad estimates that non-routine labour could reach 3,000-3,500MH in the C12 check. The total labour for non-routine rectifications could thus reach 5,600-6,000MH for the six checks of the second base check cycle.

Routine & non-routine

These two elements account for the majority of labour MH used to complete a check. The sub-total for routine inspections and non-routine rectifications in the six checks of the first cycle will be 13,500-14,000MH. The sub-total for routine and non-routine in the second base check cycle will therefore be 15,000-15,500MH *(see table, page 54)*.

There are several additional elements to the main inputs of routine inspections and non-routine rectifications.

The cost of materials and parts for these two elements also has to be considered. These costs for routine inspections will remain fairly predictable through the life of the aircraft, since they will be specified in the AMM. These will mainly be consumables (non-aircraft parts) and expendable parts. This will be at a relatively low rate of $10-20 per MH for routine inspections. This may increase gradually as the aircraft gets older because of deeper tasks that involve a higher percentage of structural inspections coming due.

Non-routine rectifications will not only use consumables and expendables, but these are generally consumed at a higher rate per MH than they are for routine inspections. Non-routine rectifications will also use repairables, structural parts and interior furnishings.

They will therefor have a higher cost of total materials per MH, which can be $40-80 per MH.

The overall cost of total materials and parts used for the routine and non-routine elements of base checks will therefore gradually increase through each base check cycle as the portion of non-routine MH increases. This will start at about $20 per MH for the C1 check, and increase to $28 and $32 per MH for the heavier C3 and C6 checks.

The higher portion of non-routine MH in the second base check cycle will see the rate of total materials and cost of parts vary from $23 to $35 per MH.

Total materials and parts for the number of MH used in the first two base check cycles will therefore be about $360,000 and $450,000.

Interior cleaning & refurbishment

Interior cleaning and on-condition or 'as-is' interior repairs and refurbishment are performed at every C check. Deeper cleaning will be required on heavier checks due to removal of more interior items, and some deeper inspections.

This will also include the dry-cleaning

SUMMARY OF MH & MATERIAL INPUTS FOR TWO BASE CHECK CYCLES - PASSENGER-CONFIGURED 737NG

Check	Routine MH	Defect ratio	Non-routine MH	Sub-total MH	Interior clean MH	Interior refurb MH	ADs, SBs & EOs MH	Heavy comp change MH	Strip & paint MH	Total MH	Total material costs-$
C1	620	0.20	125	745	110	50	350	170		1,425	39,100
C2	670	0.35	235	905	110	50	350	170		1,585	45,000
C3	1,270	0.45	575	1,845	200	400	350	170	1,200	4,165	210,000
C4	1,670	0.50	835	2,505	110	500	350	170		3,635	135,000
C5	1,075	0.55	590	1,665	110	150	350	500		2,775	78,000
C6/D1	3,250	0.70	2,275	5,525	200	500	350	170	1,200	7,950	382,000
Total 1st base cycle	**8,555**		**4,630**	**13,185**	**840**	**1,350**	**2,100**	**1,350**	**2,400**	**21,525**	**887,500**
C7	700	0.30	210	910	110	50	350	170		1,590	46,000
C8	750	0.40	300	1,050	110	50	350	170		1,730	52,000
C9	1,350	0.45	610	1,960	200	400	350	170		4,280	235,000
C10	1,750	0.55	965	2,715	110	500	350	500		4,175	149,000
C11	1,150	0.50	575	1,725	110	150	350	170		2,505	83,500
C12/D2	3,500	0.85	2,975	6,475	200	500	350	170		8,895	477,000
Total 2nd base cycle	**9,200**		**5,630**	**14,830**	**840**	**1,350**	**2,100**	**1,350**		**23,170**	**1,040,000**

and replacement of seat covers, and the cleaning of carpets. These items will be performed at each base check, as well as during A checks.

An allowance of 110MH for the four lighter checks and 200MH for the two heavier checks in the base check cycle should be made *(see table, this page)*.

Interior cleaning will have a cost of material and parts that is equal to a low rate of consumables and expendables of that used for routine inspections. This will be about $5 per MH.

There will also be the refurbishment of the interior at longer intervals and major checks. The major interior items that require refurbishment are galleys, lavatories, sidewall and ceiling panels, bulkheads and cabin dividers, floor panels and non-textile floor (NTF) material, passenger service units (PSUs), and insulation blankets.

As described, several tasks that are mainly in the system and structural programmes require the removal of these items for access to perform deep inspections. It makes sense to align the refurbishment of these items with the base checks when they get removed. Most of these have six-, eight- 10- and 12-year intervals. Some operators may bring some of these tasks forward to optimise their maintenance planning. Andrius Norkevicus, head of engineering and planning, at FL Technics explains that five main tasks influence interior refurbishment. “The first of these is a task with an initial interval of eight years and 24,000FC. These are the door cutout inspections that require the removal of galleys and lavatories,” says Norkevicus. These have a repeat interval of six years, so may be brought forward to initially be performed at six years to simplify planning.

“The second main item is the aft passenger compartment inspection initially at 12 years, and thereafter at eight years,” says Norkevicus. This requires removal of major interior items.

Similar to this is the third main task of the forward passenger compartment inspection, with an initial and repeat interval of 12 and eight years. This requires the removal of interior items and insulation blankets in the forward half of the passenger compartment.

The fourth main task is the inspection of the passenger compartment floor structure in the wet-floor area. This also requires the removal of most interior items in the area of the galleys and lavatories. This has initial and repeat intervals of eight and six years.

The fifth main item is the inspection of the passenger compartment floor structure in the dry-floor area. This requires the removal of most of the floor structure in the dry area of the cabin, with initial and repeat intervals of 12 years.

While airlines with owned aircraft can optimise maintenance planning by aligning interior refurbishment with these and other tasks, Everest explains that interior refurbishment is often needed when end-of-lease checks are being performed. This may be at times not optimal to maintenance intervals.

An allowance of 50-100MH should be made for lighter checks. The labour used for the refurbishment of interior items should be about 400-500MH for the C3, C4 and C6 checks *(see table, this page)*. Similar allowances should be made for both base check cycles, although labour requirements may be higher in the second. Alternatively, labour requirements may be lower but cost of materials and parts higher if some interior items are replaced.

The cost of interior refurbishment will be relatively high, since a lot of repairables and interior furnishing items can be used. This is especially the case in the heavier checks where most of the interior refurbishment is performed. The checks with lighter interior refurbishment workscopes may have associated costs of parts at $3,000-9,000. The larger C3, C4 and C6 checks will each have related costs of parts of about $40,000-50,000. The cost of materials, parts and interior furnishing items is $150,000-175,000 for each base check cycle.

EOs, ADs & SBs

A second major additional element to base checks is completion of EOs, ADs and SBs. These can have smaller MH requirements, or be major ones that consume a large amount of labour, materials and parts.

Everest recommends an allowance of 250-450MH for each base check *(see table, this page)*, since there are no major ADs, SBs or EOs that have so far affected the 737NG.

Materials and parts for this element will be similar to non-routine rectifications. An average rate of $50 per MH has been used, giving a total cost of about $105,000 for the six checks of the base check cycle.

Heavy component changes

The only three heavy components that require changing on the 737NG are the

Analysis reveals that the 737NG has so far had low and steady inputs for base checks. There have so far been no major ADs or SBs, or any heavy structural problems. There are, however, four large groups of tasks that will come due at 20-35 years of age.

engines, the auxiliary power unit (APU) and the landing gear. Engine removal intervals do not necessarily coincide with the C checks, but are anywhere from five to 12 years. Everest estimates that 130MH are needed required to remove and re-install both engines.

The APU uses 20MH for removal and installation of a replacement unit.

Landing gear removal and the installation of a new unit use about 330MH. The landing gear overhaul interval is 10 years.

Thrust reversers require only 15MH for the removal of the shipset and replacement with a pair of serviceable items, but this labour is already included in the access MH in the routine portion of the check.

There are also changes of rotable components, some of which are specified as NOTE and VEN REC tasks in the system programme.

Overall, 170MH should be allowed for the removal and installation of rotable and heavy components for most heavy checks. An allowance of 500MH should be made for the C5 and C10 checks, which have the removal and installation of landing gear.

While the cost of rotable components is considered as a separate element to airframe maintenance, some allowance for the replacement of LLPs, in particular safety-related components, should be made. This is especially the case for the heavier checks, when more are likely to be replaced. A budget of $140,000 for the first base check cycle, and $195,000 for the second base check cycle is used.

Stripping & repainting

Stripping and repainting will also be performed at an interval decided by each operator, typically once every six years, considering the average time a paint scheme lasts. An allowance of 1,200MH should be made to strip and repaint an aircraft the size of the 737NG, and the cost of consumables and paint used will be about $30,000.

Total inputs

Besides the MH for routine inspections and non-routine rectifications, the four main groups of additional items will add about 7,000MH to the six checks in the base check cycle *(see table, page 55)*.

The total labour used for the first base check cycle will therefore be 21,000-22,000MH. This will be used over an actual interval of 10-11 years because of typical interval utilisations, even though the MPD interval is 12 years. This will therefore be equal to an MH consumption of 0.61-0.67MH per FH over the full cycle interval.

The total cost of all materials and parts used for all elements of the check will be about $890,000 for the first base check cycle *(see table, page 55)*.

The second base check cycle is expected to use 23,000-24,000MH over a similar interval. Labour use will therefore increase to 0.68-0.71MH per FH.

The MH for the full cycle are only about 2,000MH more than the first base check cycle. While this may seem small, the 737NG has so far proved to be a trouble-free aircraft in maintenance terms. The 737NG has not, for example, had a large amount of additional maintenance tasks added, as did the 737 Classic with the CPCP.

Unlike the 737 Classic, therefore, the 737NG should only expect a small increase in labour inputs in the second base check cycle compared to the first. This is due to a higher rate of non-routine defects in the second base check cycle. No 737NGs, however, have yet completed a full second base check cycle, so it is not yet clear exactly how much the aircraft's maintenance requirements will increase.

The cost of all materials and parts used in the second base check will be about $1.05 million *(see table, page 55)*.

One element of labour and material inputs not considered here, however, is four groups of tasks from the structural programme: the tasks with initial intervals of 50,000FC and 56,000FC; and the two groups of FLS tasks. For most aircraft operating at 1.9FH per FC, and accumulating 1,300-1,800FC per year the 50,000FC, 56,000FC and Group 1 FLS tasks will all come due at 27-35 years. This will therefore follow the second base check cycle.

The Group 2 FLS tasks, however, will come due at 33,000FC or 20 years of age, coinciding with the C8, C9 or C10 check for many aircraft. The oldest 737NG in service will therefore these tasks carried out in 2016, and after. There are 72 of these tasks, all involving deep inspections in the wings. These will clearly add to the labour and material inputs described.

For aircraft operating shorter average FC times and accumulating 2,500-2,900FC per year, all four groups of tasks will be due at 14-21 years, during the second base check cycle.

As described, it makes sense to combine them all in a heavy maintenance check. So far data are not available to estimate what labour and material inputs will be required to include these tasks in a check such as the C8 or C9 check.

The labour inputs for the 737NG compare to total labour consumption of 27,500MH and 42,000MH in the first and second base check cycles for the 737 Classic *(see Assessing the 737 Classic's ageing maintenance, Aircraft Commerce, June/July 2013, page 36)*. Moreover, this labour consumption is over a shorter interval of 20,500FH, given a typical 85% utilisation of actual base check interval. The 737 Classics' labour rate is therefore equal to 1.34MH per FH in the first base check cycle, and 2.05MH per FH in the second.