The 737 Classic has a complex maintenance programme on account of CPCP tasks with a wide range of initial and repeat inspection intervals. These CPCP tasks also add to the aircraft's base maintenance requirements. The aircraft's ageing base maintenance requirements, taking major ADs into consideration, are assessed.

Assessing the 737 Classic's ageing maintenance

Almost 2,000 737-300/-400/-500s were built from1984 to 2000. More than 1,350 are still in active passenger and freight airline service, 200 are parked, and others are in military and government service.

While large numbers of the 737-300/-400/-500 family (737CL) have been displaced by the 737NG and A320 families through attractive lease rates, the 737CL has competitive operating costs when offered at attractive lease rentals, although one major issue is maintenance costs, in particular base maintenance.

Most of the 737CL's base maintenance check tasks are determined in flight hour (FH) intervals. A small number of corrosion prevention and control programme (CPCP) tasks need a lot of labour man-hours (MH), and have intervals designated in calendar time.

The 737CL's current maintenance planning document (MPD) allows a C check interval of 4,000FH. The MPD has a full base cycle interval of 24,000FH, at the sixth C check and D check. There are two groups of C check tasks at multiples of four and eight times the basic C check interval. The operator can perform them together at the eighth check, or early at the D check. The first option results in the eighth base check tasks being out of phase with the D check, while the second zeroes all base check tasks at the D check.

These intervals mean that the oldest 737CLs will have been through four complete base check cycles, and most will be in their second, third or fourth base check cycles. In terms of overall operating costs, it is important to consider the 737CL's base maintenance labour and materials requirements, and how they rise with age and successive base check cycles.

Fleet profile

The 737CL fleet is sub-divided by the three series of the family (the -300, -400 and -500), and by accumulated FH, and so by base check cycle.

The D check at the sixth base check gives the cycle a maximum MPD interval of 24,000FH.

The actual likely MPD interval achieved between successive C checks by most operators is 85%; equal to 3,400FH. Average, annual rates of aircraft utilisation across the passenger-configured fleet are 2,400FH. These have tended to be higher for older aircraft in the fleet, and lower for the younger ones. C checks will therefore be performed once every 16-17 months on this basis, but can fall to 14-15 months, depending on scheduling constraints. Base check cycles and the sixth C check/D check will therefore be performed once every 20,000FH; equal to eight to nine years of operation.

Aircraft in the fleet can therefore be grouped according to accumulated FH. Aircraft still in their first base check cycles will have accumulated up to 20,000FH. Most aircraft in their second base check cycles will have completed 20,000-40,000FH, while third base check cycles will be 40,000-60,000FH, and fourth base check cycles will be 60,000-80,000FH.

There are 575 active passenger-configured 737-300s in operation *(see table, page 38)*, large numbers of them with Southwest Airlines, USAirways, Air China, Lufthansa and Norwegian Airlines. Few others, however, are still with their original operators, and most of the rest are operated by second users.

Most of these are aircraft are in their second, third and fourth base check cycles *(see table, page 38)*. Only about 20 are in the first and fifth base check cycles.

There are also 122 freighter-configured 737-300s, sub-divided between four freighter variants: the -300F, -300BDSF, -300SF and -300QC. The -300QC is a factory-built Quick Change (QC) variant, while the other three are full freighters. Most freighters are in their second, third and fourth base check cycles.

There are 356 active passenger-configured 737-400s *(see table, page 38)*. The largest fleets operated by original carriers are with British Airways, Turkish Airlines, Alaska Airlines, USAirways, Japan Transocean Air, Malaysian Airlines, Thai International and Qantas. Many of the remaining aircraft are with smaller airlines and second users. A higher proportion of the -400 fleet is with original users. Virtually all -400s are in their second, third and fourth base check cycles *(see table, page 38)*.

There are also 30 active freighter-configured 737-400s: the -400F, -400BDSF and -400SF pure freighter variants; and the -400C combi variant.

Another 274 active passenger-configured 737-500s are in operation. Most are in their second, third and fourth base check cycles *(see table, page 38)*. Larger fleets are operated by ANA Wings, Lufthansa, United Airlines, SAS and Southwest Airlines.

There are 1,360 active -300, -400 and -500 series passenger- and freighter-configured aircraft. In terms of total accumulated FH and base check cycles, there are 1,100 aircraft in their second and third base check cycles *(see table this*

737 CLASSIC ACTIVE FLEET SUMMARY

Age range	737 -300	737 -400	737 -500	737 -300F	737 -300QC	737 -300BDSF	737 -300SF	737 -400F	737 -400C	737 -400BDSF	737 -400SF	TOTAL
Up to 20,000FH	3	7	6	2	9							**27**
20,000FH to 40,000F	161	116	123	3	13	1	14	3	1	4	6	**445**
40,000FH to 60,000FH	272	182	117	17	15		35	1	2	1	7	**649**
60,000FH to 80,000FH	122	51	26	6	1		6		4		1	**217**
80,000FH plus	17											**17**
Total	**575**	**356**	**272**	**28**	**38**	**1**	**55**	**4**	**7**	**5**	**14**	**1,355**

page), and 220 in their fourth. Another 135 737-300s and 64 -400s are parked.

MPD development & tasks

The 737CL's MPD can be arranged into five task groups: line check tasks; A check tasks; C and base check tasks; CPCP tasks; and out-of-phase (OOP) and additional tasks.

The line check tasks are performed at flight cycle, daily and weekly intervals. Some tasks with a 40FH interval can be scheduled as required in line checks. There are also line maintenance items listed in the aircraft operating manual.

The basic A check interval is 250FH. There are 30 1A tasks, and three other A check tasks group multiples: the 2A, 4A and 8A tasks, with intervals that are the relevant multiple of the basic 1A interval. That is, up to 2,000FH for the 8A tasks. The A check cycle comprises eight checks. In total there are 216 A check tasks.

Two small groups of tasks with intervals of 200FH and 1,000FH can be planned into A checks if required.

The basic C check interval is 4,000FH. There are 654 1C tasks; the largest task group in the 737CL's MPD. These include 39 CPCP tasks.

There are also 128 2C tasks, which includes 18 CPCP tasks. These have an interval of 8,000FH.

There are 62 4C tasks, including: eight CPCP tasks, with an interval of 16,000FH; 43 6C tasks, including 21 CPCP tasks, with an interval of 24,000FH; and five 8C tasks, with an interval of 32,000FH.

There are two groups of D check tasks and a large group included in the structural inspection (SI) programme.

There are 33 1D tasks from the SI programme, which have an interval of 24,000FH; and so match the 6C interval.

There are also 37 2D tasks, performed every second D check and with an interval of 48,000FH.

The final group of main MPD base check tasks comprises 202 tasks with an interval of 24,000FH, 195 of which are part of the SI. "As many as 1,600MH are used to perform these tasks, since they require the complete removal of the aircraft's interior," says Sandra Everest, estimator at ATC Lasham. "

The main MPD includes a small number of structural tasks with dual limits. These are multiples of 4,000FC/750 days, and all relate to inspections of main cabin door structures. All operators will reach the 750-day interval first, so it will be convenient for most planners to include them in base checks.

CPCP inspections

There are also separate CPCP tasks with calendar intervals. The 737CL entered service in 1984, and its maintenance programme was developed on maintenance steering group 2 (MSG-2) principles. The original MPD did not have CPCP tasks.

In April 1988 the failure of the upper fuselage structure on an Aloha Airlines 737-200 saw the introduction of various ageing aircraft programme inspections like the CPCP for several aircraft types.

Some of the CPCP tasks introduced are in the main body of the 737CL's MPD as structures tasks, have FH-related intervals, and are included in the 1C, 2C, 4C and 6C groups of tasks as described. "These tasks have an MPD item number prefixed with a P," explains Everest.

An additional group of 70 CPCP tasks is specified in a separate document to the main MPD tasks *(see table, page 40)*. "These also relate to structures, but they have initial and repeat intervals stated in calendar time. These tasks have MPD (different book) item numbers prefixed with a C, and then an air transport association (ATA) chapter reference," says Everest.

"Most 737 Classics have remained with an MSG-2 maintenance programme, so these C-prefix CPCP tasks have been kept as a separate document to the MPD. A small number of aircraft have been converted to an MSG-3 maintenance programme, so the CPCP tasks have been incorporated into it," adds Everest.

The initial intervals for these C-prefix CPCP tasks range from six to 15 years, while the repeat intervals vary from two to 15 years *(see table, page 40)*. Tasks can be formed into groups which have the same initial and repeat intervals, since this will influence how tasks are planned into base checks.

Some of these tasks substantially increase the workscope of base checks because of the access they need. "These include a large group that involves the inspection of the upper and lower lobes of the fuselage, and requires the removal of the aircraft's interior items. This uses several hundred MH," explains Everest.

Aircraft Commerce has sub-divided these C-prefix CPCP tasks into 13 groups according to initial and repeat intervals. These groups are summarised *(see table, page 40)*. Their heavy nature means that once most of these inspections have been performed for the first time, it would be convenient to schedule the repeat inspections every fourth, sixth or eighth check so that they are planned into D checks or checks with 4C and 8C tasks.

The tasks classified by *Aircraft Commerce* as Group 1 have 10-year initial and repeat intervals *(see table, page 40)*. The CPCP item numbers have a C32- prefix, and all relate to inspections of the landing gear components. The most appropriate first check for these tasks would be the C6/D check. The repeat interval means that they would best be scheduled with every D check.

"These seven inspections should be planned together with the landing gear removal, which has a dual interval of 10 years and 21,000 flight cycles," recommends Everest.

MPD estimates for the labour needed are 160MH for access and 12MH for the inspections *(see table, page 40).*

The tasks classified as Group 2 relate mainly to the landing gear bays and some external inspections to the fuselage lobe. These have a C53- MPD item number prefix. Their initial and repeat intervals are nine and three years, so they would probably be first planned into the C6/D check and then be performed every second check thereafter *(see table, page 40).* These inspections are relatively light, and do not require any special accesss or removal of the landing gear. About 131 MPD MH are needed for inspections.

Group 3 has the largest degree of access and the heaviest inspections. These nine tasks relate to the flightdeck compartment and upper and lower fuselage interior lobe inspections *(see table, page 40).*

There is a single task for inspection of the flightdeck interior, which requires the removal of: crew seats; ceiling, sidewall and floor panels; air conditioning ducting; and insulation blankets. This deep access has an MPD estimate of 90MH.

There are five main task cards for the upper lobe interior inspections. Three have an initial interval of 12 years and a repeat of eight years; while the other two require inspections under the galleys and lavatories and have shorter initial and repeat inspection intervals of eight and six years.

The deep nature of the first three inspections requires the complete removal of the interior equipment and furnishings for the upper lobe inspections. This means the seats, sidewall and ceiling panels, insulation blankets, in-flight entertainment equipment, curtains and many other items have to be removed. The MPD estimate to gain access for these three tasks is 1,000MH.

The other two inspections take place under the galleys and lavatories, and one of these two requires their removal. The MPD estimate for this removal is 460MH. This would be zero, however, if they were combined with the other three tasks, since the interior would have already been removed.

A third group of three tasks relates to lower fuselage lobe inspections, in particular the removal of the electronics bay sidewall panels and airstairs, and the forward and aft oxygen tank, ceiling and bulkhead panels. These have the same initial and repeat inspections as the two upper lobe under-galley and lavatory inspections. These three use an MPD estimate of 370MH for access, although this can exceed 1,000MH if auxiliary fuel tanks are fitted, since more panels and covers have to be removed.

One option is to group all nine tasks together, in which case MH for access would be minimised, since the removal of galleys and lavatories for two tasks would be zero because the whole interior would have been removed for the other three upper lobe tasks. Combining these tasks would compromise initial and inspection intervals to the sixth and then every fourth check.

The second option is to split this group into sub-groups of 3A and 3B tasks *(see table, page 40).*

The 3A tasks would be the flightdeck compartment inspection and the three upper lobe interior tasks; all with an initial interval of 10/12 years and repeat intervals of eight years. It would be convenient to perform these tasks at every C6/D check, since the complete interior would already have to be removed at this check to carry out the 24,000FH SI tasks. The 1,000MH used for gaining access for the CPCP tasks when performing them on their own would be reduced to zero.

The 3B tasks would be the two upper lobe inspections under the galleys and lavatories, and the three lower lobe interior inspections. These five tasks have initial intervals of eight or 12 years, and all have a repeat interval of six years. It would therefore make sense to perform these first at the C6/D1 check, and then every fourth check.

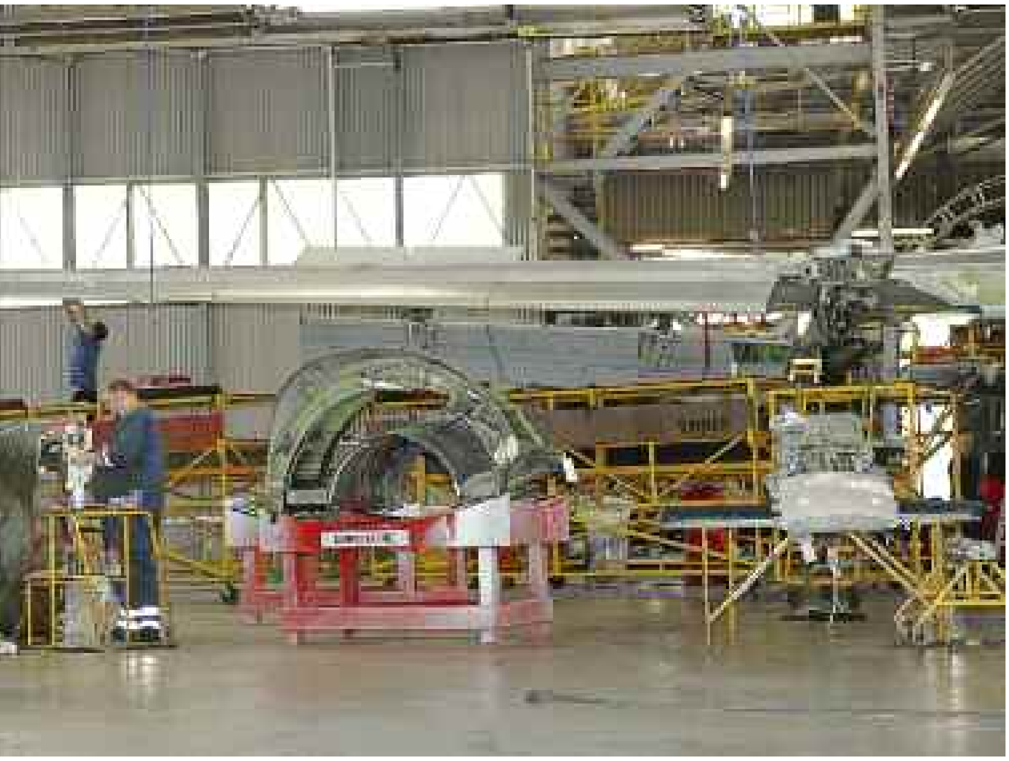
The result of this is that the 3B tasks would be performed together with the 3A tasks for the first time at the D1 check, and then at the C12/D2 and C24/D4 checks. The 3B tasks would be performed

737 C-PREFIX CLASSIC CPCP TASKS

CPCP TASK GROUP	DESCRIPTION	INITIAL INTERVAL -YEARS	REPEAT INTERVAL -YEARS	POSSIBLE INITIAL INTERVAL	POSSIBLE REPEAT INTERVAL	MPD ACCESS MH	MPD INSPECTION MH	MPD TOTAL MH
Group 1: Landing gear								
C32-	Various landing gear attachment inspections	10	10	C6/D check	Every 6 checks	160	12	172
Group 2: Landing gear bay								
C53-	Landing gear bay & external upper lobe inspections	9	3	C6/D check	Every 2 checks	0	131	131
Group 3A: Fuselage interior								
C53-101-/107-	Flightdeck compartment and upper & lower lobe interior inspections	10/12	8	C6/D check	Every 6 checks	1,056	106	1,162
Group 3B: Fuselage interior								
C53- 107-/202-	Upper lobe under galleys & lavs & lower lobe interior inspections	8/12	6	C6/D check	Every 4 checks	460	81	540
Group 4: Lower fuselage								
C53-	Lower lobe cargo doors & bilge, and keel beam	6	6	C4 check	Every 4 checks	35	22	57
Group 5: Lower fuselage								
C53-	Wing-body fairings	9	6	C6/D check	Every 4 checks	101	20	121
Group 6: Vertical & horizontal stabilisers								
C53-/55-	Vertical & horizontal stabiliser fittings & interior	12 12	6/8 6/8	C8 check C8 check	Every 6 checks	359	50	408
Group 7: Vertical & horizontal stabiliser								
C55-	Vertical & horizontal stabiliser exterior	12	3	C8 check	Every 2 checks	0	13	13
Group 8: Engine pylons								
C55-	Engine pylon attachments	10	10	C8 check	Every 4 checks	154	4	158
Group 9: Engine pylons								
C54-	Engine pylon attachments	15	15	C8 check	Every 8 checks	242	12	254
Group 10: Wing fuel tanks								
C57-	Center & main outboard fuel tanks	15	8/10	C8 check	Every 6 checks	116	32	148
Group 11: Flaps & slats								
C57-	Exterior flap track attachments & slat tracks	6	3	C4 check	Every 2 checks	113	8	121
Group 12: Flaps & slats								
C57-	Flap & slat attachments & various	8	2	C6/D check	Every check	39	8	47
Group 13: Flaps & slats								
C57-	Wing exterior & flaps & slats	12	6	C8 check	Every 4 checks	146	42	194

separately to the 3A tasks at the C8, C16 and C20 checks. On these occasions 460MH would be needed to remove the galleys and lavatories to perform the inspections underneath them.

Group 5 CPCP relates to two inspections of the wing-to-body fairings and air conditioning bay. They require 101MH for access and 20MH for the inspections *(see table, page 40)*. Because they have the same intervals as the Group 3B tasks, it would be best to plan them



The 737 Classic has several groups of CPCP tasks and other 15- and 45-month inspections that all relate to engine pylon inspections. Careful planning is required to group these together in the same checks, and so minimise repetitive downtime and access for these inspections that have a wide range of intervals.

into the same base checks.

Group 4 tasks relate to some lower fuselage inspections *(see table, page 40)* of the lower deck cargo doors, lower lobe bilge and the keel beam. The bilge inspections require the removal of the main deck floor boards. MPD estimates are 35MH for access and 22MH for inspections. The four inspections have initial and repeat intervals of six years, and so could best be performed every fourth check *(see table, page 40)*.

The second largest group comprises Group 6 CPCP inspections *(see table, page 40)*. These relate to the horizontal and vertical stabilisers. All 12 tasks have initial inspections of 12 years and repeat intervals of eight years. These inspections affect few other parts of the aircraft, but do have an MPD estimate of 360MH for access, and 50MH for the inspections. Their initial interval means they are best planned into either the C6/D check or C8 check with the 4C and 8C tasks; and then performed every six checks afterwards for repeat inspections, at every D check. Operators may find it simpler to perform them at every C6/D check.

Group 7 CPCP tasks also relate to the vertical and horizontal stabiliser. Although they are small, needing no MH for access and only 15MH for the inspections, they have short repeat intervals of three years and so have to be performed every second base check *(see table, page 40)*.

Group 8 and Group 9 CPCP tasks are four inspections of the engine-to-pylon and pylon-to-wing attachment fittings. The first two inspections require engine removal, so 155MH is allowed in the MPD for access. The second two tasks require both engine and pylon removal, so 245MH is allowed for access.

The first two tasks have initial and repeat intervals of 10 years, and the other two have initial and repeat intervals of 15 years. Despite the differences in intervals, these four tasks should be grouped into the same check to save access MH for the initial inspections. The initial inspections could therefore be made at the C8 check, and then the two pairs of tasks could have repeat inspections every four and every eight checks *(see table, page 40)*.

The Group 10 tasks inspect the centre and outboard main fuel tanks. These three have an initial interval of 15 years, and repeat intervals of eight and 10 years. It may be convenient to group the initial inspections with the C6/D check, and then repeat inspections every six checks at each C6/D check.

The Group 11, 12 and 13 tasks all relate to the slats and flaps. They only require access to areas of the wing, and some involve removing panels and flap tracks. The three groups have different initial and repeat intervals. They can be first scheduled into the C4, C6 or C8 checks. Convenient repeat intervals are with heavier checks; and so every check, every second or every fourth base check.

Additional & OOP tasks

A large number of tasks, classed as OOP or 'additional' tasks, has intervals specified in calendar time, FH or FC. Each group has a relatively small number of tasks.

There are seven different groups of calendar interval tasks, ranging from 15 months to 12 years. Each group can be planned into A or base checks, depending on the access needed.

"The 15-month tasks are engine pylon inspections and can be made with the engines still mounted," says Everest.

A typical annual utilisation rate of 2,400FH means that an aircraft will only accumulate 3,000FH in a 15-month period. This is less than a typical interval of 3,500FH that maintenance schedulers could achieve if only the standard base check tasks and the limitations of airline scheduling were taken into consideration.

Another group of tasks comprises 14 inspections with a 45-month interval. "These are inspections on the engine pylons," says Everest. "These use a lot of MH because the engines must be removed and reinstalled." Given that the removal intervals of many CFM56-3 engines are similar to the calendar limits of these inspections, it could be convenient to schedule the planned removal of engines at particular A or C checks and carry out these inspections at the same time.

Other groups of calendar tasks could more easily be planned into light or base checks. These have intervals of 24 months, 36 months, six years, 10 years and 12 years.

The 24- and 36-month tasks only total two light tasks, which could be planned into line or A checks.

The six- and 12-year tasks are structural fuel tank inspections, and should be planned into heavier checks. These are only likely to be performed twice in an aircraft's operational life, and could be planned into heavier checks. They could be grouped together with the Group 10 CPCP tasks, so they could first be performed in the C8 check.

There is a 10-year task. "This is a landing gear well and trunnion inspection. The tasks at 21,000FC are the landing gear removal/overhaul, so the two should clearly be grouped together," advises Everest.

Given the large access MH for the Group 1 and Group 2 CPCP tasks, it may be efficient to put them with the related 10-year and 21,000FC inspections in the most appropriate check, such as a C6/D.

There are also nine groups of tasks with FH intervals. The 8,000FH, 12,000FH and 16,000FH tasks could be included in the 2C, 3C and 4C task groups respectively. The 12,000FH group has four tasks, three of which are part of the SI programme.

The 6,000FH, 6,500FH, 10,000FH, 12,500FH, 22,500FH and 30,000FH groups of tasks could be regarded as OOP tasks, and have their intervals brought forward so that they can be planned into base checks. An alternative is to plan them into A checks at more convenient intervals if they do not require deep access. Each group only has a small number of tasks.

Major ADs & SBs

The 737CL has had relatively few major service bulletins (SBs) and airworthiness directives (ADs).

"One major AD that affected the 737CL was the scribe line inspection," says Celal Kalkan, production planning manager at MNG Technic. "This relates to scratching along the lap joints and skin panels made during inspections around the window belts and side of the fuselage. This was AD 2010-05-13, and superseded the initial mandatory AD, which is AD 2006-07-12. For zone 1A of the fuselage, the AD requires an initial inspection to be made up to 40,000FC. If findings are made the aircraft can fly for up to another 10,000FC before repairs are required. The intervals are different for other zones of the aircraft.

"All zones of the aircraft must have scribe line scratches and damage on the aircraft repaired by the time 70,000FC are accumulated," continues Kalkan. "As many as 100-200MH can be needed per C check, because one zone of the aircraft is done at each C check."

A second major AD is the installation of the nitrogen generating system (NGS). "The AD for this has not been issued yet, but it is coming and maintenance planners should assume the AD will require 100% of the fleet to be modified by 2017," says Kalkan. "This AD relates to the fuel arcing incident in the TWA 747 in 1996. The AD will require a modification so that nitrogen gas can be pumped into the empty fuel tank after fuel has been used. Boeing estimates that half of the 737CL fleet will have been modified by 2014. It is expected the AD will cost up to $400,000, half of which will be for materials. The other half will be 2,000-2,500MH for labour."

A major SB that has been issued as a mandatory modification is the installation of new fire-resistant insulation blankets in the fuselage walls. "The SB number is 737-25-1572, and compliance deadline is mid-2016," says Kalkan. "It is estimated that it will need more than 2,000MH because it requires the removal of seats, sidewall panels and other interior items."

The SB should be planned into a D or heavy C check when the interior and sidewall panels have already been removed for interior refurbishment, or to perform some of the CPCP inspections. "This would significantly reduce the number of MH used to install the blankets to 160-200MH. Materials cost about $150,000," says Kagan Kussan, engineering and planning maintenance planning engineer at MyTechnic.

Two other major ADs have been issued for the 737CL in relation to structural problems. "The bigger of these was triggered by the release of AD 2002-07-08," says Everest. "This concerns cracking of the skin and lapjoints along the window belts of the fuselage side. This includes cracks at window corners, as well as delamination of the skin layers along the window belt. The AD is a lapjoint cutout repair and window cover inspection with compliance limits of up to 50,000FC. The AD also covers a lower lobe inspection with a compliance limit of up to 70,000FC.

"Several ADs have been issued that relate to this problem, since there are several types of inspection and repairs made at different intervals and in different areas. These include: AD 2002-07-10 for the replacement of obsolete structural repair manual (SRM) lapjoint repairs; AD 2002-07-11, which is a SRM repair of local areas aft of the wings; and

737 CLASSIC MAIN BASE CHECK TASK GROUP ORGANISATION

Base Check	Main Base Check Task Groups	Interval FH	Number of MPD tasks	Number of OOP tasks	CPCP task Groups
C1	1C	4,000	654	18	
C2	1C + 2C	8,000	782	38	
C3	1C	12,000	654	24	
C4	1C + 2C + 4C	16,000	844	43	Gp4 + Gp11
C5	1C	20,000	654	18	
C6/D1	1C + 2C +6C + D1 +24,000FH/SI	24,000	1,022	38	Gp1 + Gp2 + Gp3A + Gp3B + Gp5 + Gp8 + Gp10 + Gp 11 + Gp12
C7	1C	28,000	654	25	Gp12
C8	1C + 2C + 4C + 8C	32,000	849	69	Gp2 + Gp3B + Gp4 + Gp5 +Gp6 + Gp8 + Gp9 +Gp11 + Gp12 + Gp13
C9	1C	36,000	654	18	Gp12
C10	1C + 2C	40,000	782	44	Gp2 + Gp7 + Gp11 + Gp12
C11	1C	44,000	654	18	Gp12
C12/D2	1C + 2C + 4C + 6C + D1 + D2 +24,000FH/SI	48,000	1,159	42	Gp1 + Gp2 + Gp3A + Gp3B + Gp4 + Gp5 + Gp6 + Gp7 + Gp8 + Gp10 + Gp11 + Gp12 + Gp13
C13	1C	52,000	654	24	Gp12
C14	1C + 2C	56,000	782	39	Gp2 + Gp7 + Gp11 + Gp12
C15	1C	60,000	654	18	Gp12
C16	1C + 2C +4C +8C	64,000	849	61	Gp2 + Gp3B + Gp4 + Gp5 + Gp7 + Gp8 + Gp9 Gp11 + Gp12 + Gp13
C17	1C	68,000	654	32	Gp12
C18/D3	1C + 2C + 6C +D1 +24,000FH/SI	72,000	1,060	38	Gp1 + Gp2 + Gp3A + Gp6 + Gp7 + Gp10 + Gp11 + Gp12 + Gp13
C19	1C	76,000	654	18	Gp12
C20	1C + 2C	80,000	844	43	Gp2 + Gp3B + Gp4 + Gp5 + Gp7 +Gp8 + Gp11 + Gp12 + Gp13
C21	1C	84,000	654	19	Gp12
C22	1C + 2C	88,000	782	44	Gp2 + Gp7 + Gp11 + Gp12
C23	1C	92,000	654	18	Gp12
C24/D4	1C + 2C +4C + 6C + 8C + D1 + D2 + 24,000FH/SI	96,000	1,164	61	All Groups from Gp 1 to Gp13

AD 2003-08-15, which mandates an inspection that is described in SB 737-53A1255," continues Everest. This SB requires an inspection of the fuselage skin at the crown skin lapjoint to detect cracking at stingers 4, 10 and 14 along most of the fuselage length.

Other ADs that have been issued in relation to this issue are AD 2004-18-06, AD 2003-14-06 and AD 2006-07-12.

The issue was dealt with by several SBs that repaired the cracked skin belts. Other SBs have been issued to repair various parts of the window belt skins. The latest revision of the SB, to be released late in 2012, will be a mandatory replacement of the window belt by a set number of cycles. This could be 40,000FC or 45,000FC, equal to 23 years of service for aircraft operating at average rates of utilisation. About 400 units of the active and parked fleet have accumulated more than 40,000FC.

It is expected that an SB will be issued within a year to cover alternative methods of compliance (AMOC) for all the ADs issued so far in relation to this.

"To date, many operators have got around the issue by making repairs along with the SRM, or having a Boeing-approved repair made. These, however, lead to an untidy-looking fuselage and add a lot of weight," says Everest. "An all-encompassing AD would resolve the issue by replacing the window belt skin with a wider piece of fuselage skin. There are four skin belts, since there is a piece either side of the emergency exits. Removing the old belts and fitting new ones can only be done by jacking the aircraft up on jigs, completely stripping it, and using laser equipment to keep the aircraft still."

Another large AD that relates to the aircraft's structure initiates from AD 2002-07-08 and AD 2003-08-15. These had SBs that detailed stringer 4 lapjoint inspections with an eddy current to check between body stations 540 and 727. This had to be done before the aircraft had accumulated 50,000FC. However, the ADs only covered certain line numbers, and excluded later aircraft from line numbers 2,553 to 3,132.

Stringer 4 failed on a Southwest Airlines 737-300 in early 2011. The aircraft had accumulated almost 40,000FC and about 49,000FH. This was a later line number unaffected by the two ADs.

The failure resulted in rapid decompression and left a four-feet-long hole in the aircraft cabin. Boeing therefore issued emergency AD 2011-08-51, which mandated SB 53A1319. This requires an external eddy current inspection of the lapjoints at stringer 4 along the entire fuselage length. If cracks are found, further SBs require internal eddy current inspection, or modification of the crack. The AD requires the modification to be completed before 45,000FC are accumulated. The modification is expensive: Kalkan says it can exceed $1 million. This could make it a retirement watershed, so that aircraft with a high number of FCs become a high risk for operators and investors.

The ADs relating to the installation of new insulation blankets, replacing window belt skins and the repair of stringer 4 should all be dealt with together in a major check like a D check, because they all require a lot of access and the removal of all cabin items. The labour to complete all three together could be 4,500-6,000MH. Some operators have already started to buy kits and are preparing to keep the aircraft in service for another 10 years.

Base cycle arrangement

There are two methods for arranging base check tasks into block checks *(see table, this page)*. One is to plan task groups so that the 4C tasks are included in the C4 and C8 checks, and the 8C tasks included in the C8 check, while the 6C and 1D tasks are included in the C6/D check. The C6 check at 24,000FH also includes the 24,000FH SI tasks. This has a total of 1,022 base check MPD tasks.

This system has six checks in the cycle, but the 4C and 8C tasks are out of phase with the D check. This allows the 4C and 8C tasks to fully utilise their intervals, and also results in three large checks in the cycle: the C4, C6 and C8 checks *(see table, page 44)*. The result is that while the largest checks are the sixth check with the 6C, D and SI tasks, these are out-of-phase with the 4C and 8C tasks which occur every fourth check. The size of the checks in terms of MPD tasks therefore varies with each cycle.

The second method is for operators to bring the 4C and 8C tasks forward to the C6 check, and so complete the cycle. While this means the 4C and 8C tasks will not fully utilise their intervals, there are still six checks in the cycle, where the fourth and sixth check are the two largest checks in the cycle. The 4C, 6C, 8C, D and 24,000FH SI tasks are also grouped together in the sixth check in every base check cycle.

Kalkan says that most operators use the first system to maximise utilisation of 4C and 8C task intervals. "The base check cycle is still regarded as having six checks and terminating at the sixth. The 4C and 8C tasks just do not occur in the same check sequence in each base check cycle," says Kalkan.

The arrangement of the main task groups as shown *(see table, page 44)* assumes that the aircraft maintains a constant rate of typical utilisation, the task groups all remain in phase, the aircraft is not parked or inactive for a time, and that no bridging maintenance is required due to change of operators or registration. "The reality is that task groups do get out-of-phase during the aircraft's life," says Everest.

The assumption that rates of aircraft utilisation are average and remain constant and that task groups remain in phase illustrates how task groups can be planned into checks, and how the size of workscopes varies.

Planning 4C and 8C tasks into the fourth and eighth checks, to fully utilise their interval, results in the MPD tasks in each check in the first base check cycle varying from 654 for the C1, C3 and C5 checks which have just the 1C tasks, to 782 tasks for the C2 check with the 1C and 2C tasks. The C4 and C8 checks are almost identical with 844 and 849 MPD base check tasks *(see table, page 44)*, with the first having the 1C, 2C and 4C tasks, and the second just five extra 8C tasks.

The largest check is the C6/D check, with 1,022 MPD base check tasks and five main task groups: the 1C, 2C, 6C, 1D and 24,000FH/SI tasks *(see table, page 44)*.

Base check inputs

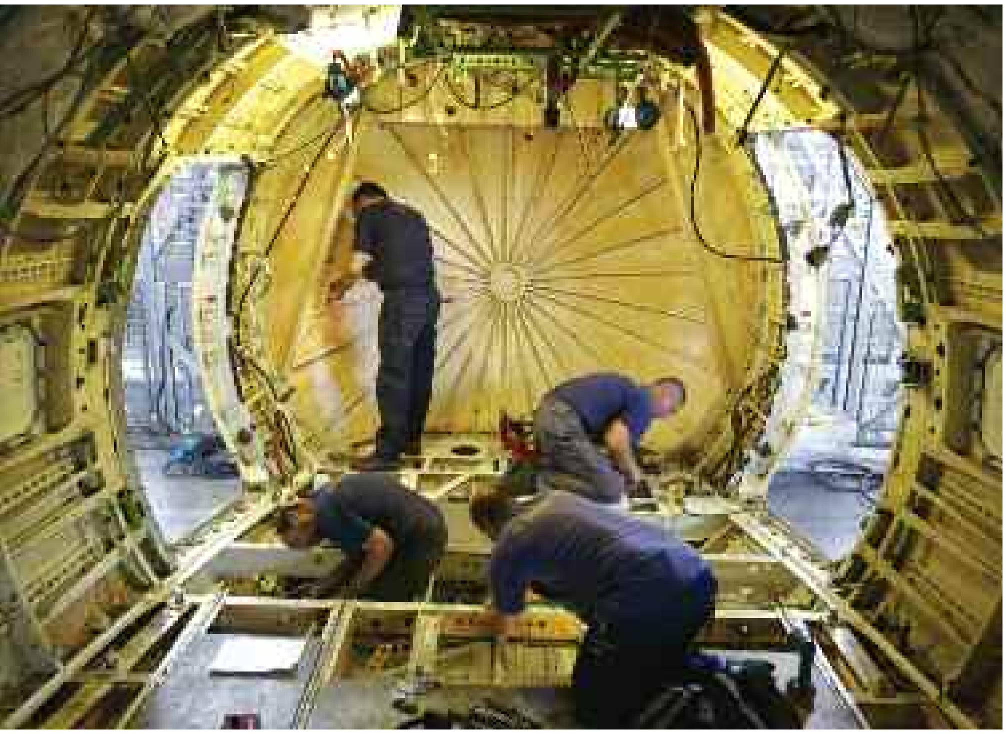
Several elements of base checks account for all the labour and material inputs. The main elements of main base check tasks and inspections, OOP and additional items, CPCP tasks and major ADs have been described.

Other elements of base checks will usually include A check tasks, customer-specific items, the clearing of accumulated defects, non-routine rectifications, interior cleaning, interior refurbishment, ADs and SBs, heavy component changes, and stripping and repainting.

Most of the labour MH used in each check will be accounted for by routine inspections that include clearing outstanding defects and non-routine defect rectifications, and major ADs. Other elements account for a smaller portion of total labour used.

Task groups can easily get out of phase, so maintenance planners can schedule major ADs and calendar-limited CPCP tasks into checks according to the aircraft's needs, and other factors (for example aircraft can change operators and countries of registration).

The number of routine and CPCP tasks, and the number of MH for access and for inspections will nevertheless



The 24,000FH SI, several upper and lower lobe CPCP tasks and two major ADs all require complete removal of the aircraft's interior to gain access to make inspections and modifications. This removal and reinstallation of the interior can use up to 2,000MH, and so these inspections and modifications should all be grouped into D checks whenever possible.

increase steadily with age, and with each base check cycle. The non-routine defect ratio will also increase with age, so the total MH used for each successive base check cycle will also rise.

The associated cost of materials, parts and rotable components, life-limited parts, and interior parts and equipment will also rise with increased labour MH.

Routine inspections

The possible arrangement of routine inspections and CPCP tasks has been described. As well as routine inspections, OOP, additional and CPCP tasks, the routine element of a check in this analysis also includes aircraft preparation and docking, opening panels and gaining access to make inspections, closing panels and other aircraft zones after inspections have been made, technical cleaning of some components when routine inspections are being made, clearing of outstanding defects, and A check tasks.

The MPD indicates inspection MH for MPD inspection tasks, while the CPCP document for C- suffix tasks has Boeing's prediction of the MH needed for access and inspection for each task or task group. One key issue is the escalation factor from MPD MH to actual MH. "The MPD MH estimates are closer to the actual MH used for the 737CL than for types like the 757 and 767," says Kalkan. "The 737CL therefore needs a smaller escalation factor, because the 737CL's MPD provides for some access MH. We think an escalation factor of 2.5-3.0 is about right for the 737CL, depending on the check and workscope size, compared to a factor of 4 or 5 for the 757.

"The overall escalation factor also varies depending on which MPD and CPCP tasks are combined," says Kalkan. "If CPCP tasks are combined with the right base check tasks then MH for access can be saved and duplication avoided."

One example is combining Group 3 CPCP tasks with the D check, full cabin refurbishment and the AD for the insulation blanket installation or window belt skin replacement whenever possible, since the cabin must be completely removed for these. This reduces repetition of access MH in other checks, and saves labour inputs.

"Another contributor to the 737CL's lower escalation factor is that it has been designed as a more maintenance-friendly aircraft," says Kalkan. "Total MH used are generally MPD MH multiplied by an escalation factor, plus access MH.

Guides to the approximate number of MH used for the routine portion of base checks can be given, but workscopes will vary by aircraft and airline. The number of main base check tasks is relatively easy to predict *(see table, page 44)*, but variation in check workscope depends on the additional A check tasks, customer-specific tasks, OOP and additional tasks, and CPCP tasks. The number of OOP tasks in each check throughout the cycle will vary from 18 to 43.

Light/C1 checks

"Generally, light C checks will use 1,200-1,400MH for routine inspections," says Kalkan. "These are the checks that generally comprise just the 1C tasks: 654 MPD tasks and 18 OOP tasks."

The MH used for base checks with just 1C tasks would rise in the second and subsequent base check cycles, since Group 12 CPCP tasks would be added to the workscopes of these light C checks *(see table, page 44)*. These alone would add 50MH, and a few other items mean routine MH for these might reach about 1,400MH in some cases."

Everest gives examples of workscopes for C1 checks. One includes the 1C tasks, all outstanding A check tasks, and 15-month engine pylon tasks. "This would use 1,050-1,100MH, and if 45-month pylon tasks needing engine removal were added, they would use another 90MH."

C2 checks

The next heaviest checks in the base check cycle are those with the 1C and 2C tasks, totalling 782 MPD tasks: the C2 check in the first base check cycle; the C10 check in the second; the C14 in the third; and the C22 in the fourth. Estimates are that these checks can use 1,500-1,800MH for all routine tasks and OOP and additional tasks, plus some A check or customer-specific items. Some variation will depend on the inclusion of the 15- and 45-month pylon tasks.

The C2 check, however, will not have any CPCP C- prefix tasks, while the C10, C14 and C22 checks in later base check cycles will have several CPCP task groups. These are likely to be Group 2, Group 7, Group 11 and Group 12 tasks *(see table, page 44)*. This accounts for an increase in the workscope of 400-600MH compared to the lighter C checks.

C4/C8 checks

The next highest checks are those with 1C, 2C and 4C tasks; and larger checks which also have the five 8C tasks. These are the C4 and C8 checks, in the first and second base check cycles, and the C16 and C20 checks in the third and fourth if all tasks remain in phase throughout the aircraft's operational life.

The MH for the main base check elements, basic OOP, additional and A check tasks will be 1,900-2,100MH.

The C4 check, with the three task groups that account for 844 MPD tasks, would also be the first to have C- prefix CPCP tasks. These are likely to be Group 4 and 11 CPCP tasks, which have an MPD estimate of 180MH. This could have an actual MH consumption for the routine elements of 2,000-2,300MH.

The later C8, C16 and C20 checks,

however, would also have another seven groups of CPCP tasks, including the Group 3B CPCP tasks, which are the second largest in terms of labour input because the galleys and lavatories must be removed to make inspections underneath.

The other six CPCP groups are likely to be the Group 2, Group 5, Group 8, Group 9, Group 12 and Group 13 CPCP tasks *(see table, page 44)*.

These seven groups can use up to 1,800MH. The only exception is the C20 check, which would exclude the Group 9 tasks, which is a large group.

The full workscope of the C8 check could therefore use up to 4,500MH. The C16 and C20 checks would use 400-700MH less. These tasks form the second largest checks in each base check cycle.

C6/D checks

The other large checks in each base check cycle are the C6/D checks. The main base checks always included in these checks are the 1C, 2C, 6C, D1 and 24,000FH SI tasks. This would be the case for the checks in the first and third base cycles if all tasks remained in phase. This would total about 1,128 MPD tasks, as well as 38 OOP tasks.

The D check in the second base cycle would also have the 4C and D2 tasks, adding another 99 MPD tasks.

The D check in the fourth base cycle would also have the 8C tasks.

The groups of main C, D and SI tasks, as well as the 15- and 45-month pylon tasks, and A check tasks would take the routine labour requirement up to 5,000MH. This includes a large number of MH for the complete removal of the aircraft interior, which is required due to the 24,000FH SI tasks. The SI tasks themselves account for 1,650MH of the 5,000MH of the routine inspections.

The first D check also comprises several CPCP groups. The most important are the Group 3A tasks, which are the upper lobe interior inspections. These also require the complete removal of the interior. Planning them into D checks saves about 1,600MH.

A large number of other groups of CPCP tasks are used in C6/D checks. These are Group 1, Group 2, Group 3, Group 10, Group 11 and Group 12.

Most of the four D checks in the first four base check cycles also include the Group 3B, Group 4, Group 7, Group 8, Group 9 and Group 13 CPCP inspections *(see table, page 44)*.

All CPCP inspections add 1,400MH for the C6/D1 and C18/D3 checks, 2,100MH for the C12/D3, and 2,300MH for the C24/D4. These are net additional MH, taking into account the 1,600MH that is saved, but would otherwise be required to remove the interior.

This takes total labour for routine inspections to 6,400-6,500MH for the C6/D1 and C18/D3 checks, 7,000MH for the C12/D2 check, and 7,300MH for the C24/D4 check.

These inputs total 12,000MH for the main C, D and SI tasks; OOP and additional tasks; and A check tasks. This figure varies only slightly with each successive base check cycle, but does not increase throughout the aircraft's life.

The labour inputs for C- prefix CPCP tasks are initially low in the first base check cycle at 1,600MH. This is because few of the task groups reach their initial interval during the first base check cycle.

The inputs for these CPCP tasks rise to 4,000-5,000MH per base check cycle for the next three cycles. Cycles vary according to the CPCP tasks' different initial and repeat intervals, and planners' ability to group tasks into base checks.

MH required for all routine elements of the base checks total 13,500MH for the first cycle, climbing to 16,000-17,100MH per cycle for the next three.

Defects & non-routine

The defect ratio that indicates the number of MH required to complete non-routine defects applies more to CPCP tasks, than to MH used for access.

Rectification of defects includes: repair of interior furbishings; repair or replacement of worn and dilapidated components and structures, or ones with manufacturing flaws; and treatment of corrosion.

Everest explains that the non-routine ratio will climb for approximately the first two D check cycles, but then plateau or at least climb at a slower rate for a well-maintained aircraft, for subsequent base check cycles.

It will start at 0.10-0.20MH of non-routine rectifications for each MH of the routine of a check, and reach 0.80 by the C6/D1 check. A large workscope at this check will reduce the non-routine ratio for the start of the second base check cycle to 0.40, and then rise steadily again to reach 1.00 by the C12/D2 check.

The rate of increase in defect ratio slows down after the second base check cycle because most manufacturing flaws will have been picked up by the C12/D2 check. While further interior and structural items are required during later base check cycles, other defects will have been dealt with in the first two cycles.

This defect ratio results in 8,300MH for non-routine rectifications in the six checks of the first cycle, and increases to 12,400MH for defects and non-routine work in the second cycle.

The defect ratio will continue to rise steadily during the third and fourth base check cycles, however, for a poorly maintained aircraft. The defect ratio could reach 1.15 by the C18/D3 checks, and 1.30-1.50 by the C24/D4 checks.

On this basis, the labour required for defects continues to rise to 13,700MH for the third base check cycle, and 17,100MH for the fourth.

Routine & non-routine

The total labour used for the main routine and CPCP inspections, access and non-routine defects therefore reaches 1,400-2,100MH for the C1, C2, C3 and C5 checks. Labour for the C4 will exceed 3,200MH, while the C6/D1 check will reach 11,300MH *(see table, page 49)*. The total for the six checks in the cycle will be 22,000MH.

The labour for these elements will rise steeply in the second base check cycle to 29,500MH, with the C12/D2 check consuming 14,000MH *(see table, page 49)* because several groups of CPCP tasks come due for the first time in this cycle. The defect ratio steadily rises.

Labour requirements continue to rise, although not at the same rate, during the third base check cycle to a total of 29,700MH *(see table, page 49)*, and to 33,750MH in the fourth. The C18/D3 check will consume 13,650MH, and the C24/D4 check 16,800MH.

Interior cleaning

Interior cleaning comes mainly from customer-specific task cards. "Most airlines like to regularly clean carpets, seat covers, sidewall panels and other interior items. These vary in workscopes between carriers, but 110MH should be allowed for the four lighter C checks in each cycle, and 130MH for the heavy C check and D check in the cycle," says Kalkan. This totals about 700MH.

Interior refurbishment

The complete removal of the interior at each D check because of the need to perform SI tasks provides the best opportunity to refurbish the aircraft's main interior items.

"The aircraft's main cabin floor will have been removed for the main inspections, so this is an ideal time to replace the carpets," says Kalkan. "The labour inputs for refurbishment of items already removed to allow inspections will be for the seats, galleys, lavatories, window shades, and overhead bins and passenger service units. An average of 1,600MH can be budgeted for each base check cycle, most of which will be used in the D check. Repairs for damage to these items will be included in the MH used for non-routine rectifications."

EOs, ADs & SBs

Kalkan advises that allowances should be made for labour used for engineering orders (EOs), ADs and SBs.

"Small ADs and SBs will be issued regularly, so an allowance for labour and materials should be made for these," says Kalkan. "Larger checks provide a greater opportunity for more of the smaller ADs and SBs to be included in the checks, so labour allowances vary with the size of each workscope. The MH used for checks tend to gradually increase with age. Lighter checks in the first cycle use 160-200MH, while larger checks use 300-400MH. The D check will use 550MH."

This takes the total for the first cycle to 1,800MH. The total then increases by

SUMMARY OF MH & MATERIAL INPUTS FOR FOUR BASE CHECK CYCLES - PASSENGER-CONFIGURED 737 CLASSICS

Check	Routine MH	CPCP MH	TOTAL 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	1,200		1,200	0.17	200	1,400	110		160			1,670	30,000
C2	1,500		1,500	0.40	600	2,100	110		290			2,500	45,000
C3	1,200		1,200	0.50	600	1,800	110		190			2,100	38,000
C4	1,900	200	2,100	0.55	1,155	3,255	130		390		1,200	5,000	119,000
C5	1,200		1,200	0.60	720	1,920	110		200			2,230	40,000
C6/D1	4,900	1,400	6,300	0.80	5,000	11,300	130	1,600	550	400		14,000	407,000
Total 1st base cycle	**11,900**	**1,600**	**13,500**		**8,300**	**21,800**	**700**	**1,600**	**1,800**	**400**	**1,200**	**27,500**	**680,000**
C7	1,200	50	1,250	0.40	500	1,750	110		375			2,235	40,000
C8	2,100	2,400	4,500	0.50	2,250	6,750	130		555		1,200	8,635	185,000
C9	1,200	50	1,250	0.55	700	1,950	110		420			2,470	45,000
C10	1,500	310	1,810	0.65	1,200	3,000	110		690			3,800	68,000
C11	1,200	50	1,250	0.60	750	2,000	110		440			2,550	46,000
C12/D2	5,000	2,050	7,050	1.00	7,050	14,100	130	1,600	3,970	500	1,200	21,500	900,000
Total 2nd base cycle	**12,200**	**4,900**	**17,100**		**12,400**	**29,500**	**700**	**1,600**	**6,500**	**500**	**2,400**	**41,200**	**1,300,000**
C13	1,200	50	1,250	0.55	690	1,940	110		465			2,515	45,000
C14	1,500	310	1,810	0.60	1,090	2,900	110		715			3,720	67,000
C15	1,200	50	1,250	0.60	750	2,000	110		525			2,635	47,000
C16	2,100	2,000	4,100	0.75	3,075	7,175	130		900		1,200	9,400	200,000
C17	1,200	50	1,250	0.65	815	2,065	110		540			2,715	49,000
C18/D3	4,900	1,450	6,350	1.15	7,300	13,650	130	1,600	1,230	500		17,100	518,000
Total 3rd base cycle	**12,100**	**3,900**	**16,000**		**13,715**	**29,715**	**700**	**1,600**	**4,400**	**500**	**1,200**	**38,100**	**926,000**
C19	1,200	50	1,250	0.75	940	2,190	110		560			2,860	51,000
C20	2,000	1,800	3,800	0.80	3,040	6,840	130		885		1,200	9,055	193,000
C21	1,200	50	1,250	0.80	1,000	2,250	110		640			3,000	54,000
C22	1,500	310	1,810	0.90	1,630	3,440	110		1,130			4,680	84,000
C23	1,200		1,200	0.85	1,020	2,220	110		660			2,990	54,000
C24/D4	5,000	2,300	7,300	1.30	9,500	16,800	130	1,600	1,550	500	1,200	21,800	722,000
Total 4th base cycle	**12,100**	**4,510**	**16,610**		**17,120**	**33,730**	**700**	**1,600**	**4,530**	**500**	**2,400**	**43,460**	**1,158,000**

800-1,000MH with each cycle, reaching 3,500MH by the third cycle and 4,500MH by the fourth.

The second element will be labour and material inputs used for the major ADs and SBs as described in detail.

"An allowance of 100-200MH should be made in each base check for the scribe lines issue," says Kalkan. Given the issue date, use of MH would have started during the second or third base check cycle for most aircraft in the fleet.

Installation of the NGS is yet to come, and will require $200,000 for materials and parts and 2,500MH for compliance, which is probably due by 2017. It is best completed during a D check, probably the second or third.

Operators will also have to comply with the installation of new insulation blankets by 2016. Like the NGS, it is best completed during a D check, likely to be the second or third for most aircraft. It will use $150,000 of materials and 160-200MH.

The AD requiring skin replacement on the fuselage window belts and the AD relating to the stringer 4 modification will both use a large number of MH. The cost may then be too high, and so represent a retirement watershed for the aircraft. Compliance with these two ADs is at 40,000FC and 45,000FC respectively. With many passenger-configured aircraft completing 1,500-1,900FC per year, they will reach these compliance deadlines at 21-26 years of age.

Heavy component changes

MH for scheduled engine changes are allowed with the 45-month OOP tasks, included in the main group of routine tasks in the check. Engine removal and installation uses 110-125MH.

Other large component changes during base checks include swapping life-limited rotable components and unscheduled engine changes. Kalkan suggests budgeting 400-500MH for each base check cycle.

Stripping & repainting

The timing of stripping and repainting the aircraft has to take into consideration the most appropriate check in terms of its workscope, as well as a suitable interval in terms of maintaining an acceptable appearance.

The complete removal of the aircraft interior at the D check makes this a suitable check at which to strip and repaint the exterior. "It also makes sense to strip the aircraft at the same time that the scribe line inspections are made, since paint has to be removed to do these inspections," advises Kalkan.

An average interval of four checks means replacing the livery every six years, so one or two strip and repaints in a base check cycle. The C4/8 checks may be the most convenient for planners.

Kalkan advises an allowance of about 1,200MH of labour and $30,000 of paint to strip and repaint a 737CL.

Materials & parts

There are four main cost elements of materials and parts used in base checks: consumables and parts used in the base checks; replacing rotable components; the items used in the refurbishment of major interior items; and paint.

Consumables and parts used in base checks include materials such as fasteners, nuts, o-rings, chemicals and primers. The amount used depends on the level of defects and non-routine work, parts that must be replaced, and the portion of MH used to gain access to allow inspections.

One way to budget for materials and parts used during checks is to apply a simple ratio or cost per MH, although heavier workscopes may use a higher rate of parts per MH than lighter checks.

The cost of materials and parts for lower checks will be $30,000-50,000, depending on workscope and labour. This will rise to $90,000 for the C4 check and $250,000 for the C6/D check. The total for the base check cycle will be $500,000 *(see table, page 49)*.

The cost of materials and parts will steadily rise to $800,000 for the second base check cycle, and to $900,000 by the third or fourth.

An additional budget for materials and parts used in the ADs relating to the installation of insulation blankets and NGS will be about $300,000, and be used in the second or third D check.

The second element of rotables will see the cost per check vary. An allowance of $100,000 should be made for the first base cycle; with most being used in the C6/D1 check. This will steadily rise with each base check cycle, and allowances should rise accordingly.

The third element of interior refurbishment will see replacement of decorative foils, panels and bulkheads, wall coverings, replacement components and window shades, and flooring material and carpets.

A budget of $55,000 should be made for the first base check cycle. This can rise to $60,000-70,000 for the second and third, and then beyond by the fourth.

The fourth element of materials and parts will be the cost of paint used in stripping and repainting: $30,000 per repainting event should be used.

The total cost of materials and parts will therefore reach $700,000 for the first base check cycle, and climb to at least $1 million for subsequent base check cycles. Another $300,000 will be needed for the NGS and insulation blanket installation.

Summary

The 737CL family illustrates how the maintenance costs of older generation aircraft rise with age and base check cycles.

A main reason for this is the group of CPCP tasks. Not only are these out of phase with the main base check tasks, but they cause a steep rise in MH during the second base check cycle because they are a separate group of inspections, have initial and then shorter intervals, and many require extensive access.

The 737CL is therefore heavily burdened with maintenance requirements compared to younger generation aircraft.

The rise in maintenance requirements and inputs during the second to fourth base check cycles, and the burden of extensive ADs, all put increasing cost pressure on 737CLs. Aircraft will reach their C12/D2 checks by about 17 years, and will be due for their C18/D3 checks by 25-26 years old.

The size of the C18/D3 workscope could be a retirement watershed for the aircraft. Those built in the late 1980s, which are now about 25 years old, are due these checks. The cost may be prohibitive, especially given the new narrowbodies' competitive lease rates.

Younger 737CLs will not yet be due their C18/D3 checks. The size of the probable workscopes, and the inputs due for the heavier CPCP inspections and the large ADs make it less likely that operators will be willing to put aircraft through a third heavy check so they can operate for a fourth base check cycle.

The oldest 737CLs are not due their C24/D4 checks until 2019. Their size is more likely to present a retirement watershed for the 737CLs that have been through their C18/D3 checks. AC