Aircraft that perform regional or domestic routes often operate sectors of about one flight hour. This is a competitive market in which regional airlines must plan maintenance events meticulously in order to minimise operational disruption. The CRJ family is well suited to the demands of domestic operation. An overview of its various maintenance documents is examined.

CRJ family airframe maintenance analysis

The Canadair Regional Jet (CRJ) family includes five main types, with capacity ranging from 50 to 100 seats. The first type to enter service was the CRJ100, shortly followed by the CRJ200 in 1993. The larger CRJ700, CRJ900 and CRJ 1000 followed in 2000, 2001 and 2011.

This analysis explores the airframe maintenance requirements for the CRJ family. It will investigate task types and labour requirements. It will also demonstrate an example of grouping tasks into check packages, that best accommodate typical rates of an operators' utilisation.

Average utilisations

There are 558 passenger-configured CRJ100s and CRJ200s in service. The average daily utilisation across the fleet is over six hours (FH), and about five flight cycles (FC) per day. This gives an approximate FH:FC ratio of 1.16:1.00, and an annual average utilisation of 2,300FH and 2,000FC.

The CRJ 700 worldwide fleet totals just over 300. The average fleet age is about 11 years, and daily utilisation is 7FH to 5FC; an FH:FC ratio of about 1.46:1.00. The annual utilisation rate is about 2,560FH and 1,750FC.

There are almost 400 CRJ900s in operation. The average age is just under seven years, and daily usage averages 5.9FH and 4.4FC. Annual utilisation is about 2,200FH and 1,640FC.

The CRJ1000 is new into service. Recent figures suggest 47 are in operation. Daily utilisation is about 4.2FH to 4.0 FC, which is an FH:FC ratio of 1.05:1.00. This may be lower due to the new type and a staggered entry into service (EIS).

The maintenance planning documents (MPDs) for all members of the CRJ adopt the same approach to maintenance. "The maintenance review board report (MRB) for the Canadair Regional Jet, CL-600-2B19, was developed using MSG-3 philosophy," says Peter Bogataj, maintenance programme engineer Adria Airlines Tehnika (AATEH). "Revision 1 was dated 31st March 1988. The analysis relating to the aircraft systems and powerplant, structures and zonal programme for the CRJ100/200/440 is performed using the guidelines of MSG-3 revision 2, issued September 1993."

"The MRB for the Canadair Regional Jet CL600-2C10, CL600-2D15 and CL600-2D24 was developed using the same MSG-3 revision," continues Bogataj.

AATEH is the maintenance provider for Adria Airways, which operates six CRJ900s, two CRJ700s and a CRJ200. The maintenance facility was the first to perform warranty modification work for the CRJ700, and to date has completed more than 700 maintenance visits on CRJ100, 200, 700 and 900 aircraft.

Maintenance revisions

The documents used for the purposes of this analysis are as follows. For the CRJ100 and CRJ200, data have been analysed from part one and two of the maintenance requirements manual (MRM), revised April 2016. This is the 20th revision of the MRM. The Airworthiness Limitations (AWL) section has also been reviewed. Last, the maintenance planning manual (MPM) is a source; specifically revision 32.

For the CRJ 700, 900 and 1000 aircraft types, data has been provided from revision 16 of the MRM, in addition to revision 18 of the maintenance planning document (MPD).

Key changes to note include escalations and additional checks for the CRJ700, 900 and 1000 aircraft. "There have not been any major changes regarding maintenance programme for the CRJ 100/200," explains Bogataj. "For the CRJ700/900, however, there are changed A check intervals and out-of-phase (OOP) tasks in line maintenance. There are also major changes in the base maintenance programme in respect of OOP tasks and the way they are grouped. There are also additional threshold and repeat interval tasks."

While throughout the document, the main airframe checks will be referred to as A and C checks, this is not the way these checks are directly described in the MPD, MRM or MPMs. "In reality, no letter checks, such as the A check and C check, exist anymore. All tasks in the Bombardier MRM and MPD are stated in FH, FC and calendar limits," adds Bogataj. "Operators still use the letter check terms for planning purposes, it is just that the maintenance programme does not refer to the tasks in this way."

It is important to note that the numbers of tasks will vary from operator to operator. An MPD will take into account engine types, airframe variants, modifications, and airworthiness directives (ADs) and service bulletins (SBs). Only some of these will apply to each operator's fleet, depending on its aircraft type and the particular line numbers it operates. Some operators may have additional tasks in their maintenance programmes, MRMs and MPDs that reflect the true status of their fleet. Some variations in task numbers and overall man-hours (MH) should therefore be expected.

CRJ100/CRJ200 MPD TASK NUMBERS

Task group	Number of MPD tasks
Zonal*	140
Structural*	192
System*	375
Total tasks MPD* **	**707**
APU****	14
FH*	424
FC*	3
Calendar*	249
CPCP related*	54
EWIS related*	24
Vendor recommended**	25

CRJ700/900 MPD TASK NUMBERS

Task group	Number of MPD tasks
Zonal*	138
Structural*	106
System*	414
Total tasks MPD* **	**658**
APU****	10
FH*	495
FC*	12
Calendar*	103
CPCP related*	81
EWIS related*	52
Vendor recommended**	31

*Note: MRM Part 1 and MRB report tasks used for these numbers. MRM Part 2 tasks are not counted.
**VenRec tasks: MRB tasks with MRB "Note 1: task interval based on manufacturer's recommendation " were counted.
***Total MPD: Zonal + Structural + System tasks are counted (part of MRB tasks only).
****APU: only tasks limited in APUH were counted.

Maintenance tasks & checks

The maintenance documents for the CRJ family consist of FH-, FC- and calendar-driven tasks. These focus on a range of zonal, system and structural inspections. There are check tasks, where large groups of tasks fall due at the same intervals, therefore forming obvious check packages; and there are other smaller groups of tasks that do not meet these parameters. These are OOP tasks.

There are also tasks known as certification maintenance requirement (CMR) tasks and AWL tasks. AWL tasks centre around assessing fatigue and damage tolerance on maturing aircraft.

The CMR tasks are mandatory scheduled maintenance tasks, and vital for the continuing airworthiness of the aircraft. These tasks are critical to the safety and reliability of an aircraft.

Last, there are corrosion prevention and control programme (CPCP) tasks and engine and auxiliary power unit (APU) inspection tasks. Again, one must note that the task numbers quoted in this article are taken from one version of an MRM and MPD for each aircraft type. The numbers will vary for operators depending on aircraft variant and operational habits. These numbers should therefore be treated as outline and approximate.

The article will also address how operational activity affects the structure of an airline's maintenance programme. It will explore low utilisation, and both equalised and block check programmes.

Grouping tasks

Operators will look to group as many tasks together as possible to limit the number of maintenance events that keep an aircraft out of operation. "It is hard to define exactly how many tasks there will be in any one check, since it depends on each aircraft's utilisation and planning concept," says Pavel Prhavc, manager marketing and sales at AATEH. "Most operators maintain their CRJ aircraft on block maintenance, and will try to keep their aircraft maintenance-free between C checks. An example is the CRJ700/900, on which C checks typically happen about every two years with minimal downtime in the interim if utilisation is normal."

A combination of FH-limited C checks at 6,000FH and structural tasks will drive the period when the aircraft is due for the next base airframe maintenance check. If the annual utilisation is higher, for example, 3000FH, then a C check is due every two years (2YE). The C check interval will align with the AWL groups of tasks which commence at 6YE (6YE/6YE). The 9YE tasks can be brought forward, and the 12YE tasks could be aligned with the sixth C check. This is if the C checks are performed at five to six year intervals. This grouping of tasks will change if the aircraft has a lower rate of annual utilisation, such as 2,000-2,500FH.

While many operators follow the block concept, some have divided A checks into equalised maintenance packages to ease the burden on line maintenance. "For example, the CRJ700/900 has a basic A check interval of 600FH. This interval fits well with later tasks that arise at 1,200FH and 2,400FH," continues Prhavc. "A task such as the lubrication of fan blade retaining pins is required every 1,200FH, and concerns the removal of each fan blade. If adopting equalised maintenance, an operator may perform the task on just one engine every 600FH, thereby reducing downtime."

If an operator performs equalised maintenance it can individually divide typical A check tasks into smaller packages as it likes, since there is no formal guidance or regulation directing this. "As long as tasks are performed as or before they become due, an operator can choose to have 20 A check packages," says Prhavc. "Eight packages is most common. It also means that OOP tasks can be neatly inserted into these packages, which can be problematic if block checks are used.

"Each A check package is due 600FH after the last one was completed. It will contain all of the 600FH tasks and part of the remaining 1,200FH, 1,800FH, 2,400FH and 3,000FH tasks," continues Prhavc. Focusing on the 1,200FH tasks, this means that these tasks would be split into two groups, with each group being completed at every second A package.

CRJ 100 & 200

While CF34-3B1 engines give the CRJ200 a number of performance advantages over the CF34-3A1-powered CRJ100, maintenance differences on the airframe are minor. The CF34-3B1 on the

CRJ200 features improved clearances and durability improvements in the low pressure turbine section.

The engine type is the only factor that determines which variant an airframe is certified as. CF34-3A1 and CF34-3B1 engines are interchangeable between the airframes. In addition, no structural changes are required in order to change between ER and LR variants of the CRJ100 and CRJ200. There have been no significant changes to the CRJ100's and 200's MRM in recent years *(see Aircraft Commerce, CRJ100/200 airframe maintenance cost analysis, June/July 2007, page 52)*.

From Part 1 of the MRM, a total of 707 zonal, system and structural tasks are counted *(see table, page 42)*. These do not take into account any CMRs, AWLs, LLP or engine tasks that are in Part 2 of the MRM.

Of the 707 tasks, there are 140 zonal tasks, 192 structural tasks and 375 system tasks. There are 14 APU-related tasks, 54 based around CPCP inspections, and a further 25 that are vendor-recommended (VENREC) items.

"The design service goal (DSG) of the CRJ200 is 80,000FC," says Mirjana Ceh, deputy chief executive officer AATEH. "The majority of structural AWL tasks have FC parameters. These have the initial threshold inspection at 40,000FC.

"Most structural tasks are calendar limited, with repeat intervals that are lower than their initial thresholds," continues Ceh. "These tasks are due at 48MO, 72MO/48MO, 72MO, 96MO/48MO, 96MO/72MO."

Block checks

The basic A check cycle is based on 500FH; with multiples of this forming the A2, A3, A4 check and so on.

With normal annual utilisation of 2,300-2,500FH, an operator will have four to five A checks in its A check cycle; which would therefore repeat every 2,500FH (or one year). According to the reviewed MPD, the 1A set of tasks totals 33, and requires about 50MH to perform *(see table, page 44)*. The 2A tasks, performed at 1,000FH total 15 additional tasks and require 80MH to carry out. There are only three 3A tasks, which become due at 1,500FH. These take another 50MH to complete according to the MPD. At 2,000FH the 4A tasks are referenced by the MPD as taking 95MH to perform, comprising 12 tasks *(see table, page 44)*. Last, the 5A tasks that occur at 2,500FH require another 80MH, due to an additional 11 tasks.

"The basic C check interval is 5,000FH and multiples thereof. That is, at 10,000FH, 15,000FH, 20,000FH and 25,000FH," says Prhavc. We also bring the 16,000FH OOP tasks forward into the third C check at 15,000FH.

"In general, the zonal task intervals coincide with the C checks at multiples of 5,000FH," continues Prhavc.

There are 233 tasks that fit in with the parameters set by the block C check. That is, they have intervals of 5,000FH, 10,000FH, 15,000FH, 20,000FH and 25,000FH. Under normal utilisation, it is expected that there will be five base checks in a typical base check cycle, which will span about 25,000FH for operators. "The 1C set of tasks comes due every 5,000FH, and consists of 131 items," says Ceh. "This set of tasks will take about 250MH to perform *(see table, page 44)*.

"The 2C set of tasks, which has an interval of 10,000FH, comprises 78 tasks in the MPD. Carrying out these additional tasks will take a further 320MH," continues Ceh. There are then the 12 tasks that are the 3C set, which come due every 15,000FH. These will take 60MH in inspection time. The 20,000FH, 4C set of tasks are made up of seven further items that have 32MH attributed to them in the MPD. Last, the five additional tasks that make up the 5C tasks at 25,000FH are quoted as requiring 10MH of routine inspection time in the MPD.

CRJ100/200 ROUTINE MAINTENANCE TASKS & INTERVALS

A check tasks	Interval	Number of tasks *	Routine MPD MH
1A	500FH	33	50
2A	1,000FH	15	80
3A	1,500FH	3	50
4A	2,000FH	12	95
5A	2,500FH	11	80
APU1	300APUH	5	2
APU2	700APUH	2	2
APU3	1,200APUH	1	2
APU4	1,500APUH	1	2
APU5	1,800APUH	1	2
APU6	3,000APUH	1	2
APU6	3,500APUH	3	2
OOP	440FH	1	3
OOP	600FH	2	5
OOP	1,200FH	1	10
OOP	3,000FH	1	12
C check tasks	**Interval**	**Number of tasks ***	**Routine MPD MH**
1C Tasks	5,000FH	131	250
2C Tasks	10,000FH	78	320
3C Tasks	15,000FH	12	60
4C Tasks	20,000FH	7	32
5C Tasks	25,000FH	5	10
GP1 OOP	4,000FH	9	70
GP2 OOP	5,500FH	2	12
GP3 OOP	6,000FH	3	16
GP4 OOP	6,500FH	2	10
GP5 OOP	8,000FH	7	40
GP6 OOP	12,000FH	2	2
GP7 OOP	16,000FH	7	50
GP8 OOP	24,000FH	5	80
12MO	12 MO	6	20
18 MO	18 MO	2	4
24 MO	24 MO	14	40
36 MO	36 MO	3	7
48 MO	48 MO	47	320
60 MO	60 MO	5	20
72 MO	72 MO	29	890
96 MO	96 MO	64	780
120 MO	120 MO	2	64
144 MO	144 MO	2	2
180 MO	180 MO	1	5

APU tasks

There are a small number of APU tasks referenced in the MPD that concentrate on the CRJ100's and 200's APU. The parameter ascribed to these tasks is 'APU' hours (APUH), which will differ from the engine or airframe FH.

The first set of five APU tasks arise at 300APUH, and require about 2MH. APU2 is two tasks, and come due at 700APUH, and a single APU3 task is due at 1,200APUH.

Single APU tasks are also due at 1,500APUH, 1,800APUH and 3,000APUH. The last set at 3,500 APUH consists of three tasks. Total APU tasks listed in the CRJ100's and CRJ200's MPD therefore need 14MH across 14 tasks.

Out-of-Phase tasks

Assuming normal utilisation, the OOP items that fall within the A check cycle (that is, they come due before the C check) have intervals of 400FH, 600FH, 1,200FH and 3,000FH *(see table, this page)*. There is a single task at 400FH that the MPD forecasts as requiring 3MH to perform. The two tasks at 600FH appear to require 5MH, while a single task at 1,200FH needs 10MH. Last, the task due at 3,000FH should take about 12MH to perform, according to the MPD.

The 4,000FH group of tasks falls between A checks and C check maintenance tasks. "Some operators treat this group as a 'half C check', and therefore seek base maintenance, repair and overhaul (MRO) support for this task group," explains Prhavc. "These task groups were formed as a result of the historic C check escalation from 4,000FH to 5,000FH, which is the revised 1C task group and C check interval. The 4,000FH task group on the CRJ200 did not make it through the escalation process to 1C tasks, and so the 4,000FH group of tasks is now a OOP group of tasks.

"Many OOP tasks present an additional task group that is not treated at an A check," continues Prhavc. "They do not align well with A checks in terms of planning or task requirement. The 4,000FH group is therefore treated by many operators as the 'lightest' base maintenance check, hence our reference to this group of tasks as a 'half C' check."

OOP tasks that fall within C check intervals have intervals of 5,500FH, 6,000FH, 6,500FH, 8,000FH, 12,000FH, 16,000FH and 24,000FH. There are 37 tasks split over these intervals.

As discussed, the 4,000FH were originally C check tasks that were not escalated. These are therefore due 1,000FH before the first C check. Nine tasks fall due at this period, and require 70MH to perform according to the MPD.

At 5,500FH there are another two tasks that require 12MH. The MPD specifies that 16MH are needed to perform three tasks at 6,000FH.

At 6,500FH, two tasks require 10MH to carry out. The seven tasks at 8,000FH are estimated by the MPD as needing 40MH. There are two relatively minor tasks at 12,000FH that only need 2MH. The MPD states that seven tasks that come due at 16,000FH need 50MH for inspection. Last, 80MH worth of tasks are due at 24,000FH, split across five inspection tasks.

Calendar tasks

Last, there are several calendar tasks included in the MPD. There are 249 in Part One of the MRM alone *(see table, page 42)*. These will often have an initial threshold (T:) followed by a repeating interval (I:). This is the interval at which the task should be repeated following the initial inspection at the threshold interval. The repeat interval is usually shorter than the Threshold (T) interval, so the task is performed more frequently. This will be defined throughout the article as (T/I), so if a task has an initial threshold of 96MO and a repeat threshold of 72MO, it shall be represented as 96MO/72MO.

There are six tasks that come due at 12MO. These require 20MH to perform the inspections according to the MPD *(see table, this page)*. At 18MO there are two tasks requiring 4MH to perform the routine maintenance tasks. At 24MO there is a collection of 14 tasks that will take at least 40MH to carry out. The

CRJ100/200 A & C/BASE CHECK TASK GROUPS

A check name	Scheduled FH interval	Actual FH interval	A check tasks	APU tasks	Routine MPD MH
A1	500	400	1A		53
A2	1,000	800	1A+2A		133
A3	1,500	1,200	1A+3A	APU1+APU2+APU3+APU4	111
A4	2,000	1,600	1A+2A+4A	APU5	230
A5	2,500	2,000	1A+5A		133
A6	3,000	2,400	1A+2A+3A	APU1+APU2+APU3+APU4+APU6	265

C/base check name	Interval years	Actual FH interval	C check tasks	OOP C check tasks	Calendar tasks	Routine MPD MH
C1	2	4,800	1C	GP1+GP2+GP3	12MO+18MO+24MO +36MO	389
C2	4	9,600	1C+2C	GP1+GP2+GP3	12MO+18MO+24MO +36MO+48MO+60MO	919
C3	6	14,400	1C+3C	GP1+GP2+GP3 +GP5	12MO+18MO+24MO +36MO+72MO	1,389
C4	8	19,200	1C+2C+4C	GP1+GP2+GP3	12MO+18MO+24MO +36MO+48MO+60MO+96MO	1,725
C5	10	24,000	1C+5C	GP1+GP2+GP3 +GP4+GP6	12MO+18MO+24MO +36MO+120MO	538

36MO tasks consist of three tasks that will take about 7MH to inspect, per the MPD *(see table, page 44)*.

At 48MO (four years) a larger number of calendar tasks arise. These could be combined with a second base check depending on operator's utilisation. "There are three (48MO/24MO) tasks and 44 (48MO/48MO) tasks, equalling 47 tasks that occur at four years," says Ceh. "These will take about 320MH to carry out as guided by the MPD."

Five tasks are carried out at 60MO, which will take 20MH to inspect appropriately. At 72MO, or 6YE, another large group of tasks forms. "There are five 72MO/48MO tasks, 21 72MO/72MO tasks, and three further system tasks that come due at 72MO," explains Ceh. "These total 29 tasks, which will take almost 900MH to perform *(see table, page 44)*."

Similar task requirements then arise at 96MO, with a total of 64 tasks needing to be addressed. There are 10 (96MO/48MO) tasks and 54 (96MO/72MO) tasks. "These tasks are referenced in the MPD as requiring almost 800MH for inspection," says Prhavc.

Remaining calendar-limited tasks in the MPD arise at 120MO, 144MO and 180MO. The 120MO interval has two tasks, which involve substantial inspection in that they require 64MH. The 144MO interval consists of two tasks that require 2MH, and the 180MO is a single task that takes 5MH.

Task groups

The table outlining task groups *(see table, this page)* has grouped items with FH and MO intervals, and the OOP and APU task groups, based on a normal utilisation of about 2,400FH and 2,100FC a year. This is slightly less than the 2,500FH set by the maintenance documents. Again, this should be taken as an approximation as there are a number of parameters that affect how operators could group tasks into checks. This is therefore an example of how tasks can be aligned with operator's utilisation.

A checks

For the line and A checks, this article shall look at a cycle of six A checks as outlined previously. The A1 check, which occurs at 500FH, will include the 1A set of tasks. These can be combined with three OOP tasks if carried out at 400FH *(see table, this page)*. It is not unusual for operators to not utilise at least 10% of the interval so they can combine task groups appropriately. A non-routine (N-R) ratio may be applied by the MRO to budget for N-R findings. This could be 50% on top of the anticipated routine MH outlined by the MPD.

The A2 check, which is set at 1,000FH, would in reality be carried out closer to 800FH. It includes the 1A and 2A tasks, alongside the OOP tasks that need to be carried out every 400FH and 600FH *(see table, this page)*. Combining total routine and non-routine MH would mean that the A2 check would take 235MH.

An A3 check that is performed at 1,200FH, rather than the forecasted 1,500FH, would include 1A and 3A tasks, alongside the three 400FH OOP tasks. In addition, there are eight APU tasks that can be incorporated into the A3 check. Routine MH to carry out all tasks add up to 111MH, while a further 56MH would be added if a 50% N-R is applied.

Including some cosmetic work, such as interior refurbishment, could make the planned labour for the A3 check just over 200MH.

The A4 check, which could be carried out at 1,600MH rather than 2,000FH, comprises the 1A, 2A and 4A sets of tasks *(see table, this page)*. In addition, there is an APU5 set of routine tasks that can be combined with the check, alongside the three OOP tasks with a 400FH interval. Total MH for routine, N-R, interior and defect related tasks could be planned at close to 400MH by maintenance planners.

The last two checks in the first A check cycle are the A5 and A6 checks. These could take place at 2,000FH and 2,400FH respectively if adopting a normal utilisation approach. The A5 check would consist of 1A and 5A tasks, and the three 400FH OOP tasks. The A6 check is made up of 1A, 2A and 3A sets of tasks. It can also be combined with the APU1, APU2, APU3, APU4 and APU6 sets of tasks, in addition to the three 400FH OOP tasks. Total labour including non-routine and cosmetic work, could be 450MH if working on these task groups.

C checks

The C check tasks when grouped will require more downtime, due to the deep access and structural tasks that these include. For a CRJ200 operating at about 2,400FH a year, the C check would actually be carried out every two years and 4,800FH *(see table, this page)*, instead of the 5,000FH interval. The first C check, the C1 check, would include the

1C set of tasks. This has routine MH requirements of about 250MH. There are also significant groups of Calendar and OOP tasks that can be combined with this *(see table, page 44)*. "The C1 and C2 checks are seen as relatively light base maintenance checks. C2 requires much more access opening and inspections/checks however," explains Ceh.

There are three groups of OOP tasks in the table that can be combined with the 1C tasks. These are referred to in the table as GP1, GP2 and GP3 tasks and require an additional 110 routine MH to carry out. There are also tasks arising at 12MO, 18MO, 24MO and 36MO that have 68MH between the according to the MRM. This brings total routine MH to the C1 check of 390MH if incorporating these tasks *(see table, page 46)*.

A 50% N-R ratio makes this downtime almost 600MH. Allowing time for SBs, or additional engineering orders (EOs) to be carried out, together with cosmetic work and defect clearance, the total MH for the C1 check comes to at least 900MH, in this example, with no adjustment applied to the routine MH.

The C2 check, if adopting this approach would take place at four years and/or about 9,600FH. It would consist of the 1C and 2C sets of tasks, alongside GP1, GP2 and GP3 OOP tasks. The 12MO, 18MO, 24MO and 36MO calendar checks could also be carried out again here, but this time 48MO and 60MO tasks would be combined. Total routine MH given by the MRM to carry out these tasks is more than 900MH.

A non-routine ratio if applied, may be 70% rather than 50% at this stage in order to accommodate more N-R findings occurring as the aircraft ages. This would add another 650MH to the labour forecast in this scenario, in addition to any cosmetic, or SB work that needs to be carried out during this check.

The C3 check, carried out at 72MO/14,400FH in this example, would be made up of 1C and 3C tasks. These total 270 routine MH. Alongside the GP1, GP2 and GP3 tasks there is an extra group of GP5 OOP tasks that could be added to this check. The GP5 tasks are an additional 50MH to perform. While the 12MO, 18MO, 24MO and 36MO calendar checks also apply, there is a 72MO set of tasks that can also be performed in the C3 check. This brings the total routine MH of the C3 check to almost 1,400MH *(see table, page 46)*.

Applying a 70% N-R ratio to this adds another 970MH to the downtime.

The C4 check consists of 1C, 2C and 4C sets of tasks, and would be carried out at 19,200MH. Calendar tasks involved could be the 12MO, 18MO, 24MO and 36MO calendar tasks; but in addition to the 48MO, 60MO and 96MO tasks that can be combined at this stage *(see table, page 46)*. Total routine MPD labour MH for these task groups is 1,725MH.

By this point in the base check cycle, the N-R ratio may be as high as 80% to account for unforeseen findings. Total MH could be 3,700MH when accounting for cosmetic work, defect clearance and SB task management. This is with no adjustment applied to the routine MH.

Last, the C5 check in the base check in the cycle may be carried out at 24,000FH if the utilisation is 2,400FH a year. This means the time to complete the first base check cycle is 10 years in this example. The C5 check includes the 1C and 5C sets of tasks, the GP1, GP2, GP3, GP and GP6 sets of tasks, and the 12MO, 18MO, 24MO, 36MO and 120MO sets of calendar tasks. Total routine MPD MH for these groups is 538MH.

Adding an N-R ratio of 80% to this, and considerations relating to cosmetic and defect work, brings total labour to 1,300MH for the C5 check. This is with no adjustment applied to the routine MH.

It should be noted that once the base check cycle has completed and another commences, defects should have been cleared throughout the previous cycle.

CRJ700/900 ROUTINE MAINTENANCE TASKS & INTERVALS

A check tasks	Interval	Number of tasks *	Routine MPD MH
1A	800FH	23	60
2A	1,600FH	9	75
3A	2,400FH	10	90
4A	3,200FH	7	75
APU1	500APUH	2	2
APU2	1,000APUH	2	4
APU3	2,000APUH	3	8
APU4	3,000APUH	2	8
APU5	4,000APUH	2	12
OOP	400FH	1	6
OOP	600FH	5	12
OOP	1,000FH	2	4
OOP	1,200FH	8	18
OOP	1,500FH	1	2
OOP	2,000FH	7	12
OOP	2,500FH	2	10
OOP	3,000FH	8	24
C check tasks	**Interval**	**Number of tasks ***	**Routine MPD MH**
OOP	4,000FH	23	40
OOP	4,500FH	2	16
OOP	4,800FH	1	8
OOP	5,000FH	2	12
OOP	5,600FH	4	16
1C Tasks	6,000FH	200	280
2C Tasks	12,000FH	129	350
3C Tasks	18,000FH	3	12
4C Tasks	24,000FH	0	0
5C Tasks	30,000FH	1	5
GP1 OOP	6,400FH	3	18
GP2 OOP	6,500FH	1	4
GP3 OOP	8,000FH	18	80
GP4 OOP	10,000FH	4	16
GP5 OOP	16,000FH	7	32
GP6 OOP	20,000FH	14	60
GP7 OOP	25,000FH	5	18
GP8 OOP	30,000FH	1	12
12 MO	12 MO	7	20
18MO	18 MO	1	2
24 MO	24 MO	6	18
36 MO	36 MO	6	18
48 MO	48 MO	2	8
60 MO	60 MO	3	8
72 MO	72 MO	1	3
120 MO	120 MO	2	18
144 MO	144 MO	2	2
180 MO	180 MO	2	5
6YE/6YE	6YE/6YE	15	80
9YE/6YE	9YE/6YE	2	24
9YE/9YE	9YE/9YE	19	120
12YE/6YE	12YE/6YE	1	12
12YE/9YE	12YE/9YE	33	220
12YE/12YE	12YE/12YE	4	36

The N-R should therefore reset.

"Heavier base maintenance checks could be considered as a combination of major structural (calendar limited) groups: the 48MO, 72MO/48MO, 72MO, 96MO/48MO, and 96MO/72MO tasks, with the higher C check tasks," continues Prhavc. "As the aircraft ages, also the FC-expressed AWL tasks that focus on the fatigue of the airframe will affect the scope of the checks carried out. For example, based on normal annual utilisation of 2,500FH for a CRJ200, a 48MO check (which is the first heavy structural check) could align well with the 10,000FH (2C) set of tasks. This would therefore form the 'C2' check if traditionally termed."

Deep access tasks emerge in the CRJ200's maintenance programme initially at 10,000FH and 48MO. The number of these escalate depending on the aircraft's position in its base check cycle. "All AWL items require deep access too," summarises Ceh. "A large group of AWL tasks coming due at 40,000FC increases the number of deep access tasks."

Refurbishment

"Stripping and repainting usually occurs during a C check," explains Ceh. "This can involve partial repaint work, such as the wing, tail, and areas of the fuselage." Carpets are refurbished at various intervals depending on whether it is aisle or seat carpet *(see table, page 52)*.

Seat covers are typically replaced every 14,400FH, while inspections of panels and bins are usually carried out annually. These are refurbished every six years or so, assuming normal utilisation. Total cost to refurbish the main elements of the cabin alongside a strip and repaint is about $200,000.

CRJ 700, 900 & 1000

HOP! operates a fleet comprising CRJ 700 and 1000 aircraft which are maintained internally by its engineering and maintenance directorate. It also offers engineering and MRO services to third-party customers and airlines. "The CRJ700, 900 and 1000 all have similar maintenance requirements, reflected in their shared maintenance documents," says Thibault Liblin, director engineering & maintenance at HOP!. HOP! operates its fleet on a relatively low utilisation of 1,800FH and 1,800FC per year (A 1.0:1 FH:FC ratio). This is due to its business as a French domestic operator.

"The standard programme for the CRJ 700, 900 and 1000 is focused on aircraft operating about 2,500FH a year," continues Liblin. "This utilisation is more accurate for US operators, which operate slightly longer sectors." The low utilisation maintenance programme (LUMP), however, is for aircraft operating at less than 1,500FH per year.

"Most tasks in the CRJ700, 900 and 1000 MPD are monitored in FH," describes Liblin. "These are mainly system and zonal tasks, with relatively few structural tasks in comparison." Structural tasks and AWL items, however, tend to be FC-limited. There are also calendar-driven tasks that are mostly grouped into A and C checks.

According to the MRM part one, there are 138 zonal tasks, 106 structural tasks and 414 system tasks for the CRJ 700, 900 and 1000. This totals 658 items, but does not include the CMRs, AWLs and engine-related tasks referenced in Part 2, for example. There are 10 APU

CRJ700/900 A & C/BASE CHECK TASK GROUPS

A check name	Scheduled FH interval	Actual FH interval	A check tasks	APU tasks	Routine MPD MH
A1	800	640	1A	APU2	60
A2	1,600	1,280	1A+2A	APU2+ APU3	135
A3	2,400	1,920	1A+3A	APU2 + APU4	150
A4	3,400	2,720	1A+2A+4A	APU2 + APU3 + APU5	210

C check name	Actual MO Interval	Actual FH Interval	C check tasks	OOP C check tasks	Calendar tasks	Routine MPD MH
C1	24	5,000	1C	GP1+GP2+GP3	12MO+24MO	420
C2	48	10,000	1C+2C	GP1+GP2+GP3 +GP4	12MO+24MO+48MO +60MO	802
C3	72	15,000	1C+3C	GP1+GP2+GP3 +GP5	12MO+24MO+72MO +36MO+6YE	565
C4	96	20,000	1C+2C	GP1+GP2+GP3 +GP4+GP6	12MO+24MO+48MO +60MO+9YE/6YE+9YE/9YE	1,006
C5	120	25,000	1C+5C	GP1+GP2+GP3 +GP7	12MO+24MO+120MO	461
C6	144	30,000	1C+2C+3C	GP1+GP2+GP3 +GP4+GP5+GP8	12MO+24MO+36MO+48MO +72MO+144MO+6YE+(3X12YE)	1,221

tasks, 81 CPCP-related items and 31 VENREC requirements.

As referenced earlier, the key change to the CRJ700/900's maintenance schedule is that there are changed A check intervals and OOP tasks in its line maintenance tasks, and changes in the base maintenance programme.

Block checks

"The basic A check interval has just been revised by Bombardier from 600FH to 800FH," says Prhavc.

"The correct terminology for an A check is the 800FH check," says Erik Blaauwbroek, head of continued airworthiness at SAMCO. "The letter checks have been cancelled in the Bombardier terminology.

"There are two options in our experience," continues Blaauwbroek. "The first is that airlines operating only one or two CRJ aircraft schedule downtime on our (timely) request. This enhances the flexibility in their flight schedule.

"The second is that airlines with more CRJ aircraft (8) have a fixed A check planning/downtime schedule," adds Blaauwbroek.

SAMCO has extensive experience in providing CRJ maintenance services, and supports a large CRJ line maintenance operation in Scandinavia. It has maintenance bases in Oslo, Stockholm, Helsinki and Trondheim. SAMCO provided Entry Into Service (EIS) assistance to Rwandair during its start-up phase in 2012, and still provides on-site maintenance. SAMCO also supports Arik Air's CRJ1000 fleet.

There are 49 tasks in the CRJ 700/900/1000 MPD that can be regarded as A check items. There are typically four A checks in the A check cycle for these series, although this depends both on operator utilisation and approach. For example, adopting the equalised maintenance programme would affect this structure. There are 23 tasks with a 800FH interval (1A), nine tasks at 1,600FH (2A), 10 tasks at 2,400FH (3A), and seven tasks at 3,200FH (4A).

"HOP!'s approach is to perform A checks at night," says Liblin. "This is between the hours of 11pm and 5am, when the aircraft is not operating." The same approach is undertaken for OOP tasks as and when possible, in order to minimise operational disruption."

The 1A set of tasks will be performed every A check interval, if adopting operating under normal parameters and a block check pattern. The 2A tasks will also be performed every second A check, therefore affecting downtime and labour consumed. "The 1A tasks in the first A check will take about 60MH to perform," says Prhavc. "For the second A check at 1,600FH, the 2A set of tasks (which take 15MH) will then be performed alongside the 1A tasks. This means that combined, the second A check will take about 75MH to carry out."

The 3A set of tasks will take about 30MH to perform individually. However, with the 60MHs worth of 1A tasks added to the check package, the third A check will take about 90MH of inspection time to perform in accordance with the MPD.

This can therefore be described as the 1A set of tasks in the first A check. The second A check will comprise the 2A and 1A tasks *(see table, this page)*. The third, A3 check will consist of 1A and 3A tasks. One can also assume that OOP tasks at 20,000FH will be combined with the 18,000FH, third C check. The fourth, A4 check, will be made up of 1A, 2A and 4A tasks. Last, the 30,000FH A5 check will consist of 1A and 5A groups of tasks.

"The 6,000FH block check schedule (formerly known as C checks) contains the 12,000H (every second 6,000H check), 18,000H (every third 6,000H check), 24,000H (every fourth 6,000H check) and 3,0000H (every fifth 6,000H check)," describes Blaauwbroek. "These are heavy checks, which require significant downtime."

"For the CRJ900's 6,000FH check there are about 168 MRB tasks," says Blaauwbroek. "The exact number, however, depends on the aircraft modification status and configuration."

Given HOP!'s utilisation as a French domestic operator, it typically performs C checks every three years on its CRJ1000 fleet, and four years on its CRJ700s.

"In the CRJ700's and 1000's MPD, there are 180 tasks with an interval of 6,000FH, 140 tasks at 12,000FH, 30 tasks due at 18,000FH and a further 10 tasks at 24,000FH," explains Liblin. Given HOP!'s operational focus, it adopts an equalised approach to its C check packages. "For example, we split the 2C interval checks between packages to keep downtime consistent," says Liblin. "Every time we try to use an aircraft that is not in operation as an opportunity to perform routine maintenance. This allows us to be proactive in achieving tasks such as replacing a component."

The exact number of tasks in each group will depend on the MPD revision being used, and the operator's approved maintenance programme.

The A check interval for the CRJ700 and 900 have been escalated by Bombardier from 600FH to 800FH. The correct terminology for an A check is the 800FH check, although airlines and MROs still use the term A check for planning purposes.

As per the table *(see table, page 48)*, there are 200 tasks recorded in the CRJ 700/900's MPD at the 6,000FH interval. These require about 280MH basic inspection time and form the 1C set of tasks. There are 129 tasks in the 2C set, which will take about 350 inspection MH *(see table, page 49)*. The 3C tasks, at 18,000FH total only three additional tasks. The MPD directs about 12MH to accomplish these. Last, there is a single task at 30,000FH. This is regarded as a 5C task for the purposes of planning, and requires 5MH of planning according to the MPD.

APU tasks

There are 11 tasks for the APU in the MPD, which are split across 5 groups. These are 500APUH, 1,000APUH, 2,000APUH, 3,000APUH and 4,000APUH. The 500APUH tasks will take about two MH to perform, and the 1,000APUH tasks will require about four MH. The scope of the tasks gradually increase in demand, so the three tasks at 2,000APUH will take about 8MH, as will the 3,000APUH tasks. Last, the fifth set of APU tasks, the 4,000APUH, comprise two items that will take 12MH out.

Out-of-Phase tasks

A significant number of the MRB tasks are classified as OOP according to SAMCO. "Most of the structural tasks have an interval which is not aligned with the 6,000FH block schedule," explains Blaauwbroek. "These structural tasks are tracked as OOP tasks, but will be scheduled in the base check, depending on their time remaining.

"If this cannot be achieved, the OOP tasks are performed when they arise," says Blaauwbroek. "When a base check is scheduled, there will be OOP tasks incorporated which will affect the flight schedule in terms of downtime, or which require special tooling/skills."

The 4,000FH, 4,400FH, 4,500FH and 5,000FH groups of OOP tasks were formed as a result of the recent C check escalation from 4,000FH to 6,000FH, which is the revised C check or 6,000FH check interval.

"Other sets of tasks that do not align with the C check intervals are at 6,500FH, 8,000FH, 10,000FH, 16,000FH and 20,000FH," says Prhavc.

There are also OOP groups at 6,400FH, 25,000FH and 30,000FH. The eight groups between 6,400FH and 30,000FH have been termed GP1 to GP8 *(see table, page 48)*.

"The OOP tasks at 8,000FH and 20,000FH are large groups of tasks that require more labour to perform. The calendar tasks that are OOP are at 12MO, 18MO and 36MO intervals. Some of these are planned together with the 4,000FH set of tasks, depending on utilisation. Others are planned with C checks," continues Prhavc.

In terms of AWL tasks, for the CRJ900 there are major groups of tasks with the following parameters: T:30,000FC/I:3,000FC and T:26,000FC/I:1310FC. These intervals are temporary, and it is expected that these will be revised to match the 40,000FC seen on the CRJ700. There are also many individual AWL tasks with lower threshold and intervals.

The MPD shows various OOP tasks that arise between 400FH and 3,000FH, which occur before the first C check.

At 400FH there is a task that involves 6MH of inspection time as guided by the MPD. At 600FH there are five tasks that require 12MH. The 1,000FH interval has two tasks that need 4MH to complete. There are more tasks at 1,200FH, 18 in total, that are referenced in the MPD as taking 8MH to perform.

The 1,500FH interval OOP item is a single task that will take 2MH to carry out, and at 2,000FH there are a further seven tasks that will require 12MH.

The last two sets of OOP tasks that will arise during the A check cycle are the 2,500FH and the 3,000FH interval tasks. These have two and eight tasks respectively.

The two tasks at 2,500FH require 10MH inspection time, and the remaining eight tasks will take 24MH, according to the MPD.

It is the OOP tasks that arise later on, with intervals from 4,000FH onwards, that present a problem for operators if attempting to incorporate them into a block check pattern *(see table, page 48)*. There are 23 tasks that come due at 4,000FH which require 40MH inspection time, and there are further tasks at 4,500FH and 4,800FH that will take about 25MH to perform. These are likely to drop out and get grouped into A checks as they come due.

At 5,000FH 12MH are needed for two tasks, and at 5,600MH 16MH are required to carry out tasks. These two groups could in fact be included in C checks, since the actual C check interval will be about 5,000FH.

How OOP tasks are actually treated is a policy decided by each operator. HOP! has a particular philosophy. "It is complicated to manage OOP tasks, which are often CMR tasks that are mandatory and cannot be postponed," says Liblin. "There are 273 OOP tasks for the CRJ 700 and 258 for the CRJ 1000, which is a lot when considering that their intervals do not fit with block checks. Therefore, HOP!'s philosophy is to manage the OOP tasks singly, as and when they come due."

Calendar, structural & ageing tasks

"The majority of the AWL structural tasks have a high initial threshold and thereafter a low recurring interval in some cases, which affects the maintenance requirements as the aircraft get older in terms of FCs," says

Operators will carry out cosmetic work, such as refurbishment, while the aircraft is undergoing base maintenance. This is because structural inspections require deep access and removal of interior items.

Blaauwbroek.

"Major structural tasks are again given calendar termed parameters," continues Prhavc. "For the threshold and interval, these are 6YE/6YE, 9YE/6YE, 9YE/9YE, 12YE/6YE, 12YE/9YE, 12YE/12YE."

"The CRJ700's and CRJ900's design service goal (DSG) is 80,000FC, and most of the structural AWL tasks have the threshold inspection at 40,000FC for the CRJ700 specifically," says Prhavc. "For the CRJ900, testing is still in progress for this, so thresholds and intervals for most of its AWL tasks are not fixed yet. Instead, temporary thresholds and intervals are stated in the CRJ900's MRM."

As described, the 12MO, 18MO and 36MO tasks can be considered as OOP in terms of the C check's 24 month probable interval. There are seven 12MO tasks, which have 20MH for inspection. There is a single, 2MH task at 18MO, and six tasks at 36MO that have 18MH.

There are six 24MO tasks. These require 18MH according to the MPD. At 48MO there are two tasks that need 8MH to carry out inspection. The next set of calendar-limited intervals is three tasks at 60MO. This requires another 8MH to perform.

At 72MO, or 6YE, the heavier sets of tasks come due. There are MO and YE tasks in the MPD that align to present substantial maintenance packages at intervals. Structural tasks start at 6YE for the CRJ 700, 900 and 1000. "HOP! will typically align these checks with the C check, to maximise aircraft availability," explains Liblin. "This is the main priority, so we expect to lose some of the threshold interval in the structural tasks to achieve this streamlined approach to maintenance operations on the fleet." According to the MPD, there are 20 structural tasks at 6YE, 40 at 9YE and 30 at 12YE. "This means that there are about 100 separate tasks focused on deep access structural inspections during the first 12 years of operation," says Liblin.

There is one task with a 72MO interval, for example, and 15 tasks with a 6YE interval. Together, 83MH are ascribed in the MPD to perform certain inspections and tests. There are 21 tasks that fall due at 9YE, which have a repeat interval of either 6YE or 9YE. These will take almost 145MH to carry out.

At 120MO, there is 18MH of inspection required for two tasks. The 144MO tasks then combine with the 12YE tasks to total 40 tasks, a substantial maintenance package with 270MH required for inspection. Last, at 180MO (15YE) there are two remaining tasks with 5MH quoted for administration by the MPD.

C check task groups

Much like the CRJ100/200, the lighter tasks in a base check cycle would typically be regarded as the first two sets of C check tasks. "The checks would again get heavier throughout the base check cycle, as more structural tasks become combined with the higher groups of C check tasks," says Prhavc. Deep access tasks emerge in the CRJ700/900's maintenance programme initially at 12,000FH and/or 6YE.

The table *(see table, page 49)* again outlines an example for grouping tasks based on annual utilisation of 2,400FH and 2,100FC for a CRJ 700/900. It therefore forecasts a C check arising every 24 months or two years.

The C1 check is again made up of 1C tasks, which total 280MH of routine work alone. The GP1, GP2, and GP3 sets of OOP tasks referenced in the table may also be performed on the C1 check, in order to avoid an additional maintenance event in between C checks. The C1 check may also incorporate the 12MO and 24MO sets of calendar tasks. Total routine MPD labour is 420MH *(see table, page 49)*.

The C2 check consists of the 1C and 2C sets of check tasks, GP1, GP2, GP3 and GP4 sets of OOP tasks, and the 12MO, 24MO, 48MO and 60MO groups of calendar tasks. Total routine MPD labour is 802MH *(see table, page 49)*.

The C3 check is made up of 1C and 3C check tasks, in addition to GP1, GP2, GP3 and GP5 OOP tasks. 12MO, 24MO, 36MO, 72MO and 6YE could also be applied in the C3 check if an operator is performing about 2,400FH a year and electing to perform check packages roughly every two years. Total routine MPD labour is 565MH *(see table, page 49)*.

The C4 check can include 1C and 2C sets of tasks. There are no 4C tasks referenced in the MPD. In addition, the GP1, GP2, GP3, GP4 and GP6 tasks might be carried out. Calendar items that may be included are the 12MO, 24MO, 48MO and 60MO tasks, alongside the 9YE/6YE and 9YE/9YE items. Total routine MPD labour is 1,006MH; the second largest check in the cycle *(see table, page 49)*.

The C5 check consists of 1C and 5C tasks, plus the GP1, GP2, GP3 and GP7 OOP tasks *(see table, page 49)*. Calendar tasks that may coincide with the C5 check, considering utilisation, are the 12MO, 24MO and 120MO inspections. Total routine MPD labour is 461MH; the second smallest check in the cycle *(see table, page 49)*.

Last, the C6 check would be performed at 30,000FH if considering an approximate utilisation of 2,400-2,500FH per year. The C6 check would typically include the 1C, 2C and 3C tasks. Given the utilisation, operators may elect to perform the GP1, GP2, GP3, GP4, GP5 and GP8 sets of OOP tasks at

CRJ FAMILY INTERIOR REFURBISHMENT COSTS

Interior item	Quantity	Refurb interval-FH	Material cost-$	MH used
CRJ100/200				
Aisle carpet	15 sq metres	2,400	86	4
Seating carpet	60 square metres	7,200	350	50
Seat covers-clean	70	4,800	405	70
Seat covers-replace	70	14,400	8,100	70
Seat cushions	7		12,000	70
Panels, bins - C check		2,400	920	400
Panels, bins - refurbishment		14,400	4,600	700
Toilets & galleys	2	19,200	1,150	200
CRJ700/900				
Aisle carpet	26 sq metres	2,500	150	8
Seating carpet	95 square metres	7,500	500	75
Seat covers-clean	86	5,000	500	100
Seat covers-replace	86	15,000	10,000	100
Seat cushions	86	5,000	15,000	100
Panels, bins - C check		2,500	1,200	400
Panels, bins - refurbishment		15,000	800	800
Toilets & galleys		20,000	2,500	500

the same time. Calendar tasks that may in turn be combined with the C6 check include the 12MO, 24MO, 36MO, 48MO, 72MO, 144MO, 6YE/6YE tasks, and the 12YE/6YE, 12YE/9YE, and 12YE/12YE tasks. Total routine MPD labour is 1,221MH; the largest check in the cycle *(see table, page 49)*.

"AATEH is performing CAMO and planning for an operator that wants to plan tasks into packages. This means joining OOP tasks with A and C checks, whenever feasible," says Prhavc. "This is so that the aircraft is maintenance-free for as long as possible between the A packages every 600FH, and free from base maintenance between C checks. This is particularly important during the summer, where operational activity is at its highest. The only exception to this is the group of tasks between 4,000FH and 5,000FH. These have to be carried out between two C checks, but again not during the summer."

Reality factors

Other considerations should be taken into account when planning work packages. One is an additional factor used by maintenance planners to provide a realistic overview of labour to customers. This gives operators an idea of the actual amount of labour MH an A or base check would use. This accounts for access, preparation time, and non-routine findings such as corrosion, or unforeseen replacement of a component or life limited part (LLP) before scheduled expiration time. "The factor we apply is affected by a number of different parameters, such as the age, weight and modification status of the aircraft undergoing maintenance," says Liblin. "For simple tasks with relatively low MH in the MPD, HOP! may attribute a factor of 2.5 to accurately capture preparation and access time. For more complex tasks,however, where MH is quoted as over 10MH for example, we mostly see the estimates provided by the MPD as accurate."

As described for the CRJ100 and 200, planners will often elect to add a non-routine ratio to the total routine MPD MH determined for a check. Initially, when the aircraft has low FC and FH, it would be expected that only few and minor defects might arise during a task or check. As the FC and FH accumulate and the aircraft matures throughout the base check cycle, however, this ratio will increase. A typical N-R ratio for an aircraft in the early stages of its base check cycle can be 50%, and will increase in stages to as much as 100% by the last check in the cycle.

Additional MH may also be applied to the total labour for a check, to accommodate new engineering orders (EOs) and SBs. This is because it cannot be predicted as and when these may arise and require action.

If an operator introduces a new fleet type, further MH may be added on to the total labour for a task or check, in order to compensate for no previous operational or maintenance experience.

Finally, most operators incorporate cosmetic work, such as interior refurbishment into major checks. This means that additional MH will be applied to allow for this work.

Refurbishment

Operators are likely to carry out cosmetic work, such as refurbishment, while the aircraft is undergoing base maintenance. "As part of a base check, the structural inspections, which require deep access, are performed. The interior will often be refurbished if the operator requests it," says Blaauwbroek.

"We refurbish interior items such as cabin panels and hat racks every C check," says Liblin. "This is every three to four years. Some elements of seat maintenance are carried out on the line, however." It is HOP!'s policy to refurbish rather than replace cabin items where possible. Panels and decorative parts usually undergo designated engineering representative (DER) repairs.

The CRJ700 needs 26 square metres of carpet for its aisle, and 95 square metres to cover the seating area. Aisle carpet is usually replaced about every 2,500FH and the carpet surrounding the seats about every 7,500FH. The 86-odd cabin seats are replaced about every 15,000FH, or every third C check. Sidewall panels, bins and sidewalls are also refurbished at 15,000FH. The total cost of repainting and interior refurbishment of the CRJ700 or 900 is just over $200,000.

Rotable components

There are 829 unique components on the CRJ900, and about 1,500 rotable part numbers.

Some components have a hard-time interval, which is different to a life limited replacement interval that applies to LLPs. These include the ACM heat exchanger, ACM condenser/re-heater, cockpit voice recorder (CVR), portable ELT, APU battery, main battery, and engine and APU extinguisher bottles.

"Depending on the type and modification status, about 1,200 rotables are maintained on condition," says Liblin. "162 components are maintained on a hard-timed basis."

"Hard-time components or rotables are not necessarily removed during major line and base checks, since they have independent limits in FH, FC and calendar intervals," says Prhavc.

"It is important to say that the CRJ900 MRM is not yet finished. There are a number of tasks, called safe life tasks, which have interim life limits. It is expected that the limits will be escalated when testing continues, or that it will disappear from the Bombardier MRM when limit goes beyond design service goal of the aircraft," continues Prhavc. AC