The 787 base check programme is a rolling series of maintenance inputs made up of Flight Hour, Flight Cycle, and Calendar task groupings as they fall due over a 24-year period. Details of the check content from the MPD and labour inputs for the first two base checks are detailed here.

787 base check maintenance analysis

There are three variants of the 787 in service: the 787-8, 787-9 and 787-10, in service since October 2011, August 2014, and January 2018 respectively. The engine options are the Rolls-Royce (RR) Trent 1000 series and General Electric (GE) GEnx-1B series.

The 787 features new design architecture including composite materials in the fuselage and wing structure. One maintenance planning document (MPD) serves all three variants of the 787, with flight hour (FH), flight cycle (FC), and calendar utilisation parameters used for inspection task threshold and repeat intervals.

The industry 'A' and 'C' check terminology is only used in 787 check planning to title the larger grouping of tasks which form a series of eight base checks at 36-month (MO) intervals over a 288MO/24-year (YE) cycle.

As a guide, A checks or lighter line inputs can be planned at 1,000FH intervals, C or base checks are at 12,000FH/36MO intervals, and the structural base checks or heavy maintenance visits (HMV) at six-year (6YE) and 12YE intervals. That is, the HMVs coincide with every second base check. FH, FC and Calendar tasks will be de-escalated and slotted into the nearest convenient base check or A checks.

Maintenance repair and overhaul (MRO) organisations have begun to perform the first lighter structural inspection HMV inputs at 6YE because the oldest in-service aircraft are now more than seven years old. A detailed look at the building blocks of all base checks is examined here.

Fleet overview

With a current production rate of 12 to 14 aircraft a month, the 787 fleet is steadily growing. A snapshot of available fleet data taken from early June 2018 lists 683 787-8s/-9s/-10s in service with 50 different operators *(see table, page 36)*. This includes 343 787-8s, 335 787-9s and five 787-10s.

From this snapshot, the largest fleets with more than 30 aircraft are Qatar Airways (30), Air Canada (35), American Airlines (35), Japan Airlines (37), United Airlines (37) and ANA-All Nippon Airways (64).

Of the 787-8 fleet, 14 are stored. The age of the stored aircraft ranges from 12 to 66 months. All apart from one aircraft are equipped with Trent engines.

Of the 787-9 fleet, 13 are stored. The stored aircraft range in age from 12 to 42 months. All are powered by Trent engines. The high number of stored aircraft in such a young fleet at present is due to unscheduled engine shop visit (SV) requirements. This relates to an airworthiness directive (AD) issued in 2018 affecting the Trent 1000's ETOPS operational limits.

Of the 50 operators, 29 have chosen the GEnx engine and 20 the Trent 1000 engine. Ethiopian Airlines has both engine options: the GEnx-1B for the 13 older aircraft in its fleet, and Trent engines for the nine aircraft that entered service in the past two years. The fleet and engine configurations are summarised *(see table, page 36)*.

Fleet age and utilisation

Information for the 787 fleet age, operator and engine type are readily available. FH and FC utilisation data for *Aircraft Commerce* to analyse was only available for half the operators.

From the information that was available, the highest FH aircraft is serial number (S/N) 34745, line number (L/N) 49, with 25,367FH, operating for Ethiopian Airlines at nearly six years old.

The highest FC aircraft is S/N 38320, with 5,653FC, operating for Qatar Airways, which is nearly six years old.

The average annual utilisation statistics show a large variation of FH and FC usage across the fleet. For operators with more than five aircraft over 1.5 years of age (to ensure a full year of active operational service), the FH average utilisation ranges from 3,536FH for the Thai Airways International fleet, to 5,641FH for Qatar Airways' fleet.

The average range of annual FC usage is 483FC, for the Aeromexico fleet, to 953FC for the Qatar Airways fleet.

As always, geographical location and individual airline operational routes result in a variation of fleet average FH to FC ratios. The lowest average is 3.19:1 for the Air France fleet. The highest is 10.05:1 for United Airlines.

An overall average annual utilisation for the 787 fleet of established in-service aircraft from the supplied data is 4,625FH and 695 FC. The average FH to FC ratio is 6.65:1 *(see table, page 36)*.

MPD development

The 787 MPD is used by operators to develop a customised scheduled maintenance programme for their 787-8, 787-9 and 787-10 fleets. Maintenance requirements are separated into three main sections: Systems and Powerplant, Structures, and Zonal.

The MPD, like all new Boeing aircraft, has used the MSG-3 operator/manufacturer scheduled maintenance development document to design the utilisation parameters and frequencies for many of the inspection tasks. The 787 MPD MSG-3 logic incorporates a corrosion prevention and control programme (CPCP), electrical wiring interconnect system (EWIS), enhanced zonal analysis procedures (EZAP), and lighting/high intensity radiated fields (L/HIRF) inspections into the base document.

Common sources of feeder document information into the MPD include the US

787 FLEET OVERVIEW - IN SERVICE & STORED FLEET AGE & UTILISATION CHARACTERISTICS*

Airline	787-8	787-9	787-10	Engine Type	Oldest Aircraft in fleet	787-8 Average annual FH (prev 12m)	787-8 Average annual FC (prev 12m)	787-9 Average annual FH (prev 12m)	787-9 Average annual FC (prev 12m)	Average FH:FC ratio -8/-9	Average FH/day -8/-9	Average FC/day -8/-9	Highest cumulative FH	Highest cumulative FC
Aeromexico	9	8		GEnx	4.9	4,622	483	5,114	567	9.27:1	13.34	1.44	20,700	2,833
Air Austral	2			TRENT 1000	2.4									
Air Canada	8	27		GEnx	4.1	5,328	657	5,296	616	8.34:1	14.55	1.74	20,107	2,538
Air China		14		TRENT 1000	2.1									
Air Europa	8	2		TRENT 1000	2.3	5,398	687			7.85:1	14.79	1.88	10,729	1,453
Air France		6		GEnx	1.6			3,805	1,193	3.19:1	10.42	3.27	4,156	1,305
Air India	27			GEnx	6.9	4,092	841			4.86:1	11.21	2.30	20,570	4,217
Air New Zealand		11		TRENT 1000	4.7			4,538	744	6.10:1	12.43	2.04	16,838	2,559
American Airlines	20	15		GEnx	3.4	4,323	449	4,446	453	9.72:1	12.01	1.24	12,505	1,952
ANA-All Nippon Airways	36	28		TRENT 1000	7.4									
Avianca	12			TRENT 1000	3.7	3,837	487			7.87:1	10.51	1.34	13,904	2,340
Azerbaijan Airlines	2			GEnx	3.6	3,356	657			5.11:1	9.19	1.80	9,015	1,696
British Airways	9	18		TRENT 1000	5	5,098	610	5,098	587	8.52:1	13.97	1.64	21,758	2,692
China Southern Airlines	10	2		GEnx	5.1									
Crystal Luxury Air	1			GEnx	1.7									
El Al		4		TRENT 1000	0.9									
Ethiopian Airlines	19	3		TRENT/GEnx	5.9	4,598	959			4.79:1	12.60	2.63	25,367	5,085
Etihad Airways		20		GEnx	3.5			4,918	640	7.68:1	13.48	1.75	16,716	1,966
Gulf Air		1		TRENT 1000	0.2									
Hainan Airlines	9	17		GEnx	5.6	4,310	949	4,654	904	4.84:1	12.28	2.54	19,101	4,340
Japan Airlines	25	12		GEnx	7.3									
Jetstar	11			GEnx	4.7									
Kenya Airways	7			GEnx	4.3	4,866	831			5.86:1	13.33	2.28	16,975	3,074
KLM Royal Dutch Airlines		12		GEnx	2.6			5,604	604	9.28:1	15.35	1.65	12,724	1,591
Korean Air		5		GEnx	1.4									
LATAM Airlines Chile	10	14		TRENT 1000	5.8									
LOT Polish Airlines	8	2		TRENT 1000	5.6	5,170	586			8.82:1	14.16	1.61	23,454	2,974
NEOS		1		TRENT 1000	0.5								1,505	204
Norwegian	8	13		TRENT 1000	4.8									
Norwegian Air UK		8		TRENT 1000	1.3									
Oman Air	4	3		GEnx	3									
Qantas		4		GEnx	0.7								1,668	242
Qatar Airways	30			GEnx	5.9	5,641	953			5.92:1	15.45	2.61	24,599	5,176
Royal Air Maroc	5			GEnx	3.5	4,416	767			5.76:1	12.10	2.10	12,733	2,266
Royal Brunei Airlines	4			TRENT 1000	4.7	4,341	657			6.6:1	11.89	1.80	19,234	3,092
Royal Jordanian	7			GEnx	3.8									
Saudia		13		GEnx	2.5			3,203	743	4.31:1	8.78	2.03	7,527	2,046
Scoot	10	7		TRENT 1000	3.4									
Singapore Airlines			5	TRENT 1000	0.3									
Somon Air	1			TRENT 1000	3									
Suparna Airlines	1			GEnx	4.3	2,500	684			3.65:1	6.85	1.87	14,647	2,997
Thai Airways International	6	2		TRENT 1000	4	3,536	772			4.58:1	9.69	2.12	14,197	3,555
TUI Airlines Nederland	3			GEnx	4	5,094	822			6.2:1	13.96	2.25	19,997	3,344
TUI Airways	8	4		GEnx	5.1	5,273	736	6,174	739	7.76:1	15.68	2.02	25,138	3,779
TUI fly	2			GEnx	4.6	4,951	641			7.73:1	13.56	1.75	22,336	3,283
United Airlines	12	25		GEnx	5.8	4,670	519	5,087	452	10.05:1	13.37	1.33	22,189	2,889
Uzbekistan Airways	3			GEnx	1.8									
Vietnam Airlines		11		GEnx	3.1									
Virgin Atlantic Airways		17		TRENT 1000	3.7			5,067	535	9.48:1	13.88	1.46	16,212	1,940
Xiamen Airlines	6	6		GEnx	3.8	4,001	779	4,090	718	5.41:1	11.08	2.05	11,992	3,403
TOTAL	343	335	5											

*FH AND FC INFORMATION FOR A/C UNDER 1.5 YEARS OF AGE HAVE NOT BEEN USED IN THE ANNUAL AVERAGE FIGURES.
INFORMATION CURRENT EARLY JUNE 2018

Federal Aviation Administration (FAA) Maintenance Review Board (MRB) reports, original equipment manufacturer (OEM) service bulletins (SBs), FAA airworthiness directives (ADs), certification maintenance requirements (CMRs), and special compliance items (SCIs).

Airworthiness limitations (AWLs) related to airframe structural or L/N-specific inspections also feed into the MPD.

The original issue date of the MPD is January 23, 2009. The quantity of revisions released of an MPD varies per manufacturer, aircraft type, and age of aircraft. For the 787, 2018 has seen revisions to various sections of the MPD almost every month.

For details of task content, the MPD revision date of May 31, 2018 has been used. This revision includes notification of change to two Systems task notes, minor changes and additions to the access data and zone diagrams, and graphic illustration changes to aircraft dimension and station diagrams.

Since the aircraft entered service, there has not been a large increase in the number of Systems, Structures and Zonal inspections in the MPD. Over the past four years, for example, the MPD inspection task quantities have changed from 940 in March 2014, to 972 in July 2016, and 1,002 in 2018, an increase of 62 tasks. A large portion of the total tasks are MRB in origin, with 947 inspections. Smaller groupings of tasks in origin are as follows: 13 AWL, 15 SCI, 23 vendor-specific (VEN), three CMR, and one local authority requested (GOV).

As with many other Boeing MPDs, Section 9 (which contains reference information on AWL, CMR and SCI requirements) is now controlled by separate documents to the MPD. These are AWL, CMR and SCI documents for the engines and the auxiliary power unit

787-8/9 SYSTEM AND POWERPLANT PROGRAMME MPD TASK NUMBERS

Initial Threshold & repeat Interval	Airframe Tasks All Types	787-8 Tasks	787-8 & -9 Tasks	787-9 & -10 Tasks	787-10 Tasks	TRENT 1000 Tasks	GEnx Tasks	TOTAL Insp HOURS	Deep Access Requirements
CALENDAR TASKS									
DAILY/3DY/7DY/3MO/6MO	7							1.97	
12MO/1YE	6							4.50	
13MO-18MO	2							0.30	
2YE/24MO	13							8.35	
2YE (1YE REPEAT)	3							10.00	
3YE	49							150.80	Numerous general access panels removals required
4YE-5YE	6							5.60	
6YE	20							19.35	Deep internal access to cargo bays and general inspection access panels
78MO	1							1.00	
7YE	7	2						15.80	
8YE-9YE	5	2						8.58	Numerous general inspection panel access
10YE	8							7.50	
12YE	1						1	35.20	Extensive internal access to fuselage upper and lower lopes & wings
150MO	1							1.00	
15YE	3							1.50	Oxygen system assembly removals
20YE	2							5.80	
FC TASKS									
100-1,000FC	3					8	2	5.80	
1,000FC (600FC REPEAT)						2	2	8.00	Engine borescope plugs
2,000FC-6,000FC	5					2	2	12.80	
10,000FC-12,000FC	1					4		3.00	Fan blade removals
16,000FC	2							18.00	
FH TASKS									
500-4,000FH	19				1	11	9	21.79	
6,000FH-8,000FH	10		4			8		16.32	
12,000FH	22	4	1	1		4	6	28.48	Numerous general access panels removals required
16,000FH-18,000FH	3		1					3.20	
24,000FH	31					5	5	41.26	Numerous general inspection panel access
30,000FH-36,000FH	7			1		2		5.60	
40,000FH	1							8.00	HSTA removal and restoration
48,000FH	11							11.10	
FH/CALENDAR TASKS									
2,000FH/12MO	1							1.00	
6,000FH/18MO	6							4.50	
18,000FH/3YE	1							1.00	
FC/CALENDAR TASKS									
200-1,000FC/2-6MO	10				1			5.20	
2,000-3,000FC/12-18MO	6							6.20	Leading edge access panels
4,000FC/2YE	1							0.20	
6,000FC/3YE	15				1	2	1	11.65	
5YE/10,000FC	1				1	2	2	0.90	
12,000FC/6YE	5							4.20	
16,000FC/8YE	1							0.75	
24,000FC/12YE	7							82.55	Landing gear removal for restorations
50,000FC/20YE	1							8.00	HSTA off aircraft inspection
FH/FC AND CALENDAR TASKS									
8,000-12,000FH/3,650FC	2							3.00	
9,000FH/1,000FC (4,5000FH/1,000FC REPEAT)						6		10.00	
12,000FH/6,000FC/3YE						14	14	2.8 Each Engine	Thrust reverser access panel
AS REQUIRED									
ENG CNG/APU CNG	2					9	7	7.80	Engine and APU removal
NOTE	8			1		2	14	9.40	Specific component removal for restorations and checks in accordance with vendor time constraints on components
LIFE LIMIT - ENG/APU & LDG GEAR COMPONENTS	3				22	16		Hrs at Shop visit	Engine, APU and landing gear removal for discard of life limited parts
SHP VST	1					4		2.00	Functional check of component off aircraft during restoration
SEE APX	3							1.40	Cabin safety equipment discard and restoration requirements per Vendor recommendation listed in Appendix of MPD
TOTAL TASKS	**355**	**11**	**6**	**3**	**3**	**105**	**80**		

(APU). As the aircraft ages, updates to these documents referenced in section 9 will feed tasks into the MPD.

Check patterns

Almost all the tasks within the MPD have FH, FC and/or Calendar initial threshold and repeat interval parameters listed. Those that do not will have interval details listed within the tasks description itself. In the 787 MPD, like many modern MSG-3 aircraft, letter checks will not appear as an individual task interval.

Boeing has based the MPD inspection intervals on a fleet utilisation of 10FH and 2.78FC per day. Larger groupings of the same threshold and repeat interval utilisation characteristics will then be grouped into line checks (A checks), base checks (C checks) and HMVs.

The guide basic phase interval of an A check is 1,000FH, 180FC, and 90DY/3MO. The C check basic phase interval is 12,000FH, 2,160FC, and 1,080DY/36MO. The HMV checks are at 6YE intervals, so every second C check.

This would ideally divide the maintenance programme into 11 A

787-8/9 STRUCTURAL MPD TASKS

Initial Threshold	Repeat Interval	Airframe Tasks All Types	787-8 9 Tasks	787-8 & -9 Tasks	787-9 & -10 Tasks	TRENT 1000 Tasks	GEnx Tasks	TOTAL Insp MH	Deep Access Requirements
6,000FC/3YE	6,000FC/3YE	13						5.55	
8,000FC/4YE	8,000FC / 4YE		1					1.50	
12,000FC/6YE	12,000FC / 6YE	23	3		1			19.65	Wing MLG support structure,empennage, aircraft keel beam and nacelle panel access.
6YE/12,000FC	6YE/12,000FC	1	1					5.40	
12YE/24,000FC	12YE/24,000FC	4	7	1	1			92.90	Extensive access into and within fuel tanks for detailed inspections including Airworthiness Limitation items.
24,000FC/12YE	24,000FC/12YE	77	11		6			129.59	Extensive access to cargo compartment, cabin interior, aircraft exterior panels, flight control and stabilizer structure.
ENG CNG	ENG CNG					4	4	2.4 EACH ENG	Engine, engine mount and nacelle structure at engine removal.
TOTAL TASKS		**118**	**23**	**1**	**8**	**4**	**4**		

787-8/9 ZONAL PROGRAMME MPD TASKS

Initial Threshold	Repeat Interval	Airframe Tasks All Types	787-8 9 Tasks	787-8 & -9 Tasks	787-9 & -10 Tasks	TRENT 1000 Tasks	GEnx Tasks	TOTAL Insp MH	Deep Access Requirements
6MO	6MO	6						1.60	
4,000FH	4,000FH					4	4	3.80	
6,000FH	6,000FH					10	10	15.00	Engine cowling and thrust reverser access
3YE	3YE	55				14	14	42.30	General panel removal across the fuselage and wings for inspections.
6YE	6YE	67	2					50.05	Paterial extensive access across the entire aircraft. Some tasks are L/N specific and/or list specific noted instructions to access conditions for inspections.
12YE	12YE	69	7		7			69.30	Passenger/ cargo/main deck/ flight deck/ wing and fuel tank extensive internal access requirements.
24YE	24YE	10	1		1			23.00	Internal GV inspections of passenger cabin and vertical stabilizer areas with panels and insulation blankets displaced as necessary.
TOTAL TASKS		**207**	**10**		**8**	**28**	**28**		

checks before the 12th check, which would be a combined A check and C check. As a maintenance cycle within the 787 MPD is referred to as 24YE, there would be about 96 A checks and eight base or C checks, that include four HMVs, in a full cycle. The 24YE would coincide with the highest current calendar inspections within the MPD.

A check interval

In reality, large differences in aircraft FH utilisation will affect the number of A checks in a cycle in the 36MO base check interval. An aircraft flying an average of 14FH per day will reach the larger grouping of 1,000FH in 2.3 months, while an aircraft flying an average of 10FH per day will reach 1000FH in 3.3 months. Therefore, airlines' A check schedules will relate to rates of utilisation.

If the 1,000FH multiple is to be used, groups, such as the 1,500FH tasks, could be de-escalated and brought forward to the 1,000FH interval. FC tasks will be performed at the equivalent FH interval depending on the FH:FC ratio, and slotted into the closest check. Calendar tasks will have to be performed at the most appropriate 1,000FH multiple in relation to utilisation *(see 787 MPD analysis & check planning - Aircraft Commerce, June/July 2016 for further A check breakdowns).*

C check interval

For C check planning assistance, the MPD provides operators with basic 'Phased' or 'Block' maintenance programme packaging examples, based on an average utilisation of 11FH per day and a ratio of 5.5 FH per FC.

For this article, and with reference to the industry general C check term usage, the 36MO (3YE) check is referred to as a C1, the 72MO (6YE) check as a C2, the 108MO (9YE) as a C3, and the 144MO (12YE) as a C4 check. The repeat of these checks with the addition of higher FH, FC and Calendar tasks would equate to a C5 at 180MO (15YE), C6 at 216MO (18YE), the C7 at 252MO (21YE), and the C8 at 288MO (24YE). Airline terminology may differ. The Guide Base Check MPD Inspection and Panel Access Hours are summarised *(see table, page 39).* This includes check pattern information for more details.

By summarising the systems, structures and zonal task content *(see tables, pages 38, 39 & 40)*, the extensive variations of thresholds and intervals that do not fall into an ideal block or phased pattern can be seen. This planning complexity means that, whatever the aircraft's utilisation, some tasks will be performed as standalone items or brought forward to a convenient time to avoid over-running their intervals. This must be managed by the operator's continued airworthiness maintenance organisation (CAMO).

Given that most of the larger 787 fleets' average annual utilisation is 4,500-5,000FH, with a daily flight utilisation of 12-14FH, the aircraft are likely to reach the FH guide intervals for base checks before they reach the calendar intervals. They also reach the structural check's calendar interval before they reach the FC interval, so it is likely that the intervals of the FH tasks in the Systems, Structures, and Zonal sections of the MPD will drive much of the base check input scheduling.

"At Monarch Airlines Engineering

787-8/9/10 BASE CHECK TASKS (EVERY 12,000FH OR 3YE) BASED ON AVERAGE FLEET UTILISATION

INITIAL THRESHOLD & REPEAT INTERVAL	AIRFRAME TASKS ALL TYPES	AIRFRAME TASK-8	AIRFRAME TASKS -8/-9	AIRFRAME TASKS -9	AIRFRAME TASKS -9/-10	AIRFRAME TASKS -10	TRENT 1000 TASKS	GEnx TASKS	TOTAL NO. OF TASKS	NUMBER OF INSP.MH (MPD)
To be repeated at intervals of 36MO/12,000FH (WCF)										
12000FH	22	4	1		1		4	6	38	28.48
12000FH/3560FC	1								1	2.00
12000FH/6000FC/3YE							14	14	28	2.8 Each
3YE	104	2					14	14	134	193.10
3YE/6000FC	1								1	0.25
6000FC/3YE	27					1	2	2	32	16.95
18000FH/3YE	1								1	1.00
OOP tasks to be included at nearest check										
4YE	2									0.40
8000FC/4YE		1								1.50
5YE	4									5.20
5YE/10000FC	1									0.90
16000FH	1									0.20
18000FH	2		1							3.00
To be repeated every 72MO/24,000FH										
6YE	87	2							89	69.40
6YE/12000FC	29	4			1				34	29.25
24000FH	31						5	5	41	41.26
OOP tasks to be included at nearest check										
78MO	1									1.00
7YE	7	2								15.80
8YE	1									0.33
16000FC/8YE	1									0.75
30000FH	1						2			0.90
5000FC	4						2	2		6.80
To be repeated every 108MO/36,000FH										
9YE	4	2							6	8.25
36000FH	6				1				7	4.70
OOP tasks to be included at nearest check										
40,000FH	1									8.00
10YE	8								8	7.50
To be repeated every 144MO/48,000FH										
12YE	93	8			7			1	109	104.50
12YE/24000FC	4	7		1	1				13	92.90
48000FH	11								11	11.10
24000FC/12YE	84	11			6				101	212.14
Tasks post 12YE up to 24YE										
150MO	1								1	1.00
10000FC							4			2.00
12000FC	1									1.00
16000FC	2									18.00
15YE	3									1.50
20YE	2									5.80
50000FC/20YE	1									8.00
24YE	10	1			1					23.00
Additional tasks										
ENG CNG/APU CNG	2						13	11		12.60
LIF LIMIT	3						22	16		HOURS AT
- ENG/APU & L/GEAR										SHOP VISIT
NOTE		8				1		2	14	9.40
SEE APX		3								1.40
SHP VST		1						4		2.00

Limited (MAEL), we are seeing that the C1 is generally falling due a few months before the three-year interval, with most operators bringing the check forward to avoid incurring any time penalties," explains David Doherty, head of commercial at MAEL. "The aircraft's operational profile usually allows for some downtime, during which a number of A check-type tasks and cabin repairs can be performed beforehand."

Individual task intervals in the MPD may be escalated upon approval by the local regulatory authority after in-service operation experience has been gained. This excludes AWL, CMR and SCI tasks. This would normally be set within the operator's approved maintenance programme (AMP), rather than used to escalate tasks to reach a C check on a one-off basis.

Systems tasks

The Systems section of the MPD contains scheduled maintenance tasks for aircraft systems, including those installed

on the powerplant and APU.

In the May 2018 MPD there are 563 Systems inspection tasks. Inspections cover 34 chapters of the ATA aircraft documentation number system, and are divided into over 80 different FH:FC and calendar groupings. All, apart from three groupings covering nine tasks, have the same initial threshold and repeat intervals. The exceptions are 2YE with a 1YE repeat interval, 1,000FC with a 600FC repeat interval, and 9,000FH/1,000FC with a 4,500FH/1,000FC repeat interval. Therefore, these reduced repeat interval system tasks do not have a large input on later base check inputs. This is summarised as systems and powerplant programme MPD tasks *(see table, page 38)* that provide an overview of all systems tasks.

Inspection thresholds range from 'Daily' tasks to 50,000FC/20YE. All Systems EZAP tasks appear as ATA Chapter 20 tasks, referred to as 'Standard Practices'. A large number of tasks in the Systems section that require the greatest access and preparation figures will be Chapter 20 tasks. These include the restoration by cleaning of all EWIS that are installed in the main deck and cargo bays, including utility areas where specified.

One method of gaining efficiencies in maintenance programmes is to reduce duplication in inspection tasks across the various sections of the MPD. For the 787 Systems section GVIs are satisfied by the Zonal inspection programme, so they do not have additional entries.

The main landing gear (MLG) and nose landing gear (NLG) overhauls are triggered by MPD inspection call-ups in the Systems section. These are planned for 12YE/24,000FC, subject to in-service data gathering.

Engine and APU overhaul inspection tasks, with the exception of life limited parts (LLPs), are controlled by their specific OEM maintenance programmes. LLPs have their MPD trigger within the Systems section of the MPD. The LLPs are replaced during engine overhaul, which involves the removal and replacement of the engine.

FH tasks

There are 176 FH-based tasks within systems. The 500FH to 48,000FH tasks will need to be grouped into line and base checks in accordance with each operator's flying schedule *(see table, page 38)*.

The 40 tasks from 200FH to 4,000FH, which will fall due before the first base check, contain aircraft system operational checks, and general fluid servicing and filter changes with minimal access requirements. These could be carried out during an A check.

The 31 tasks from 6,000FH to 8,000FH contain engine EZAP inspections, and further air and oil filter changes, with minimal access needed.

The 38 tasks from the 12,000FH group contain checks on the environmental system, aircraft static systems, passenger seats, flight control surface freeplay checks, and engine system components.

The four tasks from 16,000-18,000FH contain inspection requirements on the leading edge slat skew/loss system, operational checks of the rudder trim switch, and a functional check of the cabin speakers.

The 41 tasks in the 24,000FH group contain more extensive access requirements, because many of the functional checks required are off aircraft, like thrust reverser and flight control hydraulic fuses, numerous equipment cooling system checks and fuselage positive pressure relief valve functional checks. Some tasks have additional reference to CMR task intervals within the task description. This interval may be different to the MSG-3 listed interval, so is detailed to assist the maintenance planners.

The 10 tasks at 30,000-36,000FH contain only minor access requirements

GUIDE BASE CHECK MPD INSPECTION AND PANEL ACCESS HOURS - 787-8 WITH TRENT 1000 ENGINES*

BASE CHECK INTERVAL	GENERAL CHECK TITLE	CHECK NUMBER IN CYCLE OF 96 'A' AND 'C' CHECKS OVER 24 YEARS	CALENDAR INTERVAL - MONTHS	AIRFRAME MPD HRS	AVIONICS MPD HRS	ENGINE MPD HRS	TOTAL BASE INSP. HRS	PANEL ACCESS ONLY - MPD HRS	FURNISHING AND EQUIPMENT REM/REFIT
1st	C1	12th	36	287.29	12.55	12.84	312.68	75.66	Additional
2nd	C2	24th	72	434.52	16.55	13.64	464.71	121.40	Additional
3rd	C3	36th	108	293.74	18.55	12.84	325.13	76.12	Additional
4th	C4	48th	144	834.99	35.05	13.64	883.68	221.44	Additional
5th	C5	60th	180	296.09	14.05	19.04	329.18	75.66	Additional
6th	C6	72nd	216	441.30	22.55	13.64	477.49	121.42	Additional
7th	C7	84th	252	287.29	27.35	12.84	327.48	77.64	Additional
8th	C8	96th	288 (24YE)	858.74	35.05	13.64	907.43	226.61	Additional

*Pure MPD Man-hours only - no adjustment for skill level, aircraft handling, interior cabin furnishing and equipment removal/refit, or addition of customer cards and ADs.

for fuel filter changes (Trent 1000 engine), fire extinguishing system checks, hydraulic return line checks, and alternate control checks on the stabiliser trim.

The one task at 40,000FH is to restore off-wing the horizontal stabilizer trim actuator secondary load path for Transport Canada Civil Aviation (TCCA) aircraft only. For other operators the same inspection is at 50,000FC or 20YE.

The 11 tasks in the 48,000FH group are for GVI, operational checks (OPC) and functional checks (FNC) of systems valves and system override mechanisms.

FC tasks

There are just 33 FC-based tasks in the systems programme. Intervals range from 100FC to 16,000FC, and need to be grouped into line and base checks in accordance with each operator's flying schedule.

The 17 tasks from the 100FC to 1,000FC group contain light access system visual checks. For the GEnx engine there are multiple engine borescope inspection tasks, some of which refer to the AWL section of the engine manual for alternative reduced intervals, depending on the P/N of components installed.

The nine tasks from the 2,000-6,000FC group contain inspection and operational requirements of the battery system and thrust reverser manual operation.

The five tasks from the 10,000-12,000FC group contain the fan blade lubrication and coating restorations for the Trent 1000 fan blades, and head up display (HUD) desiccant changes.

The two tasks from the 16,000FC group are FNC tasks, inspecting the horizontal stabiliser trim actuator bushings and pins, and inspections of the inboard and outboard flap support joints for excessive wear.

Calendar tasks

There are 165 Systems tasks with calendar intervals. Of these, 15 have intervals of less than 24MO and include the minor but frequent inspections on wheels, brakes, and passenger safety equipment.

The 16 2YE, combined with 24MO interval tasks, of which three have a 1YE repeat interval, include light lube and water system servicing along with operational checks of aircraft systems.

The six 4-5YE tasks contain operational checks of aircraft lighting systems, along with minor tasks, such as weight checks of lavatory fire bottles and the discarding of flashlight and emergency lighting batteries.

The one 78MO is to discard the emergency locator transmitter (ELT) battery on specific P/N units. There is one 150MO task for ELT battery discard.

The nine tasks from the 7YE and seven tasks from the 8-9YE group mainly consist of L/HIRF inspections, and bonding jumper checks in areas of minor access requirements.

The eight tasks at 10YE require the discard of the various fire extinguishing system components and the overhaul flight deck door decompression panel mechanism.

The three 15YE and the two 20YE tasks list discarding the specific oxygen system components and entry-door emergency-assist pressure reservoir assemblies.

Tasks that can be grouped at base check level are the 3YE repeat (51 tasks), 6YE repeat (20 tasks) and 12YE repeat (26 tasks) inspections.

Most of the 3YE tasks are GVI, including EZAP of the APU compartment, nacelle areas, and wing leading and trailing edge inspections with the panels open. Other tasks in this group that require less access are inspections and operational checks of cabin safety equipment and listed furnishings.

Some of the major 3YE component restorations include the primary and secondary air-conditioning pack heat exchanges. The MPD notes that heat exchanger restoration, by cleaning off aircraft, is to be monitored by each airline to identify the most effective and economic maintenance interval, according to the fleet's environmental and ground operating time conditions.

The 6YE checks focus on aircraft and cabin safety equipment checks, along with cargo bay and electronic equipment bay condition checks. The latter will include cleanliness below floor panels, requiring the floor panels to be raised.

The 12YE tasks require functional checks of L/HIRF components, including current return network installations for bond degradation throughout the cargo bays, engine areas and wing trailing edges.

The 12YE tasks also contain the EZAP inspections or 'restoration' (the term used for cleaning combustible material from the components) of the cargo bays, flight compartment, areas under the main passenger compartment furnishings, and within the fuel tanks. Although the 12YE input may be referred to as a structural inspection input, EZAP inspections also require extensive access and man-hour (MH) monitoring.

Combination interval tasks

The 97 combination FC/FH/Calendar task intervals will come due at whichever comes first (WCF). All the tasks have to be scheduled into the maintenance cycle when due and have no major access requirements beyond removal refit of inspection access panels. This is apart from the seven 24,000FC/12YE TASKS for the restoration of the main and nose landing gears. MPD entries triggering the landing gear restorations will be reset within the aircraft's AMP by the installation of replacement gears.

The highest FC combination task 50,000FC/20YE requires the horizontal stabilizer trim actuator to be removed for off-aircraft inspection. While a significant amount of access is not required, the component itself is large and has to be removed from a confined space.

Detailing the larger groupings, the 11 tasks in 200-1,000FC and 2-6MO repeat interval include numerous lubrication tasks, such as the landing gears and cargo doors, and a GVI of cargo-handling systems.

The 20 tasks in the 6,000FC/3YE group contain more extensive lubrication tasks including shock strut servicing checks, inspections of the cargo bay, thrust reverser blocker doors assemblies.

The 28 tasks in the 12,000FH/6,000FC/3YE group all

The 787 maintenance check cycle covers a period of 24 years with 8 base checks at 36MO intervals and 4 heavy maintenance visits at 72MO intervals. The oldest aircraft have completed their second base checks.

require GVI, detailed visual inspections (DVIs) or operational checks of thrust reverser components on both engine types.

Other tasks

The systems section of the MPD contains 18 engine and APU detailed inspection tasks which are to be carried out while these major components and their mounts are removed for defect rectification or scheduled engine change. The engine mount inspections do have 5,000FC and 8,000FC threshold backstops to enforce a WCF requirement.

The 41 'life limit' and 'vendor recommended' (VR) tasks all cover lifed component and safety equipment that includes fire extinguishing squibs and oxygen cylinders. The major life-limited items will require the landing gears and engines to be removed for SVs.

The five tasks that have an SV listed as the interval are Trent 1000 oil system restoration and gearbox inspections.

The 25 'Note' interval items contain a mix of tasks, such as off-aircraft engine component restorations and operational checks of the slide/rafts. Task intervals are listed in the task description, or determined via referenced documentation, such as the AWL manual.

An addition to recent MPD revisions is the threshold interval reference to 'SEE APX', which appears for three tasks related to aircraft cabin safety equipment. This refers to the MPD's Appendix L, which lists items with multiple service limit intervals, depending on manufacturer and component P/N.

Structures tasks

The Structures section of the MPD contains GVI, DVI, special detailed inspections (SDI), and Non-Destructive Testing (NDT) inspections requirements for corrosion, accidental damage, composite delamination, and structural fatigue cracking.

The type of inspection listed is used by engineers to determine the full extent of the inspection that the OEM requires to be carried out in. For example, a GVI is within touching distance, unless otherwise listed (that is, upper lobe inspection as viewed from ground). DVI inspections may require inspection aids, such as magnifying lenses and mirrors. SDI tasks may require detailed cleaning, and substantial access and specialised tooling.

In the May 2018 MPD there are 158 structural inspection tasks. All threshold intervals have the same repeat interval over the seven different groupings of 6,000FC/3YE, 8,000FC/4YE, 12,000FC/6YE, 6YE/12,000FC, 12YE/24,000FC, 24,000/12YE, and 'ENG CNG' (engine change). These are summarised as the structures programme MPD tasks, which provides an overview of all structures tasks *(see table, page 39)*.

Inspections cover five ATA chapters: ATA 52: doors; ATA 53: fuselage; ATA 54: nacelles/pylons; ATA 55: stabilizers; and ATA 57: wings.

Fatigue-related supplemental inspections will enter the AWL documents, and then enter the MPD. When needed, the MPD states that one feasible supplemental inspection programme will use the Damage Tolerance Rating System (DTR). Many of the AWL supplemental inspection tasks on other Boeing aircraft types use a DTR check form system.

Damage tolerance is a property relating to a structure's ability to sustain defects safely until it can be repaired. To do this DTR check forms determine the inspections and repeat intervals necessary to provide adequate fatigue damage detection. This is done by defining a required DTR (a numerical value) that must be achieved.

As per standard MPDs, CPCP tasks appear more in the Structures section of the MPD. CPCP basic tasks' requirements are to preserve or restore corrosion preventive surface coatings and finishes. Prevention includes the steps necessary to make sure fluid drain holds are clear and faying sealant is in place and has not perished. This stops moisture from entering between joints.

FC/Calendar tasks

Like the Systems section tasks, the Structures combination interval tasks are to be carried out WCF.

There are 13 tasks at 6,000FC/3YE for the bulk, forward and aft cargo and passenger compartment doors, door surrounds, and door stop and latch pin fittings. These inspections focus on both the door and airframe structure that the door positions against. There is also an inspection of the vertical stabiliser front-spar-to-rear-spar root attach tension bolts.

The single 8,000FC/4YE task is for the SDI (with a borescope or videoscope) of the wing leading-edge slat six and seven drainage holes and ribs for earlier L/N specific aircraft.

The 27 tasks in the 12,000FC/6YE group focus on internal and external detailed inspections with removal of the access panel in the MLG, engine, nacelle, empennage, wing surge tanks and fuselage support structure.

There are two 6YE/12,000FC tasks that have the reverse interval listing to the paragraph above. This is for the external inspection of the tops of the over countersunk fasteners on the upper and lower wing surface. The task description contains detailed additional information on applicability and exact inspection area per aircraft L/N. This task is not derived via the MSG-3 analysis, however, and has been introduced into the maintenance programme as an AWL item, and added

The 787-10 has now entered service as of April 2018. Along with the 787-8 and 787-9, the airframe maintenance requirements of all three variants are covered by the one Maintenance Planning Document.

to the inspection programme due to flight safety analysis results.

There are 13 tasks in the 12YE/24,000FC group that are also AWL tasks for detailed inspections of sealing and fasteners, including high-tension bolts to the nacelles. Fuel tank access is required. Detailed description of the task and applicability is referenced in the description, including further additional reference document material, based on initial inspection findings.

The 94 tasks in the 24,000FC/12YE group create the large structural inspection content, with deep access to the passenger cabin, cargo bays, the vertical and horizontal stabiliser, and the wings. This involves displacing interior furnishings, and removing the ailerons and flaps. DVI and NDT inspection methods are used. Some of the tasks provide alternative method of compliance options which, if the right tooling is available, could reduce MH requirements. For example, a DVI of cargo compartment stringers at specific aircraft body stations and splice fittings could be performed from the outside of the fuselage by using NDT methods. This compliance option has the benefit of reducing access requirements and, therefore, overall cost.

Engine change tasks

There are eight MPD detailed inspection tasks (four for each engine type) related to pylon torque box areas and engine mounts (aft mount only) that have intervals at 'ENG CNG' (engine change). These tasks are carried out when the engine is removed for replacement or defect rectification and will involve NDT of removed parts.

Zonal tasks

Zonal inspections tasks consist of GVIs within a specific listed zone of the aircraft. Aircraft major zones and subzones are made up of a three-digit numbering system, referenced in the task description detail. The eight major zones cover lower fuselage, upper fuselage, empennage, engines and nacelles, left wing, right wing, landing gear, and passenger/cargo doors. The subzones will locate inspections to a specific area of the major zone.

All GVIs listed will be described as internal or external to determine from where the inspection is to be carried out. Zonal inspections contain EZAP requirements for areas that contain electrical wiring and have the potential for combustible materials being present. Areas of inspection include system components, electrical wiring and visible structure.

In the May 2018 MPD there are 281 Zonal inspection tasks. All initial thresholds have the same repeat intervals within seven different groupings of 6MO, 4,000FH, 6,000FH, 3YE, 6YE, 12YE and 24YE. These are summarised as the Zonal Programme MPD Tasks table *(see table, page 39)*.

Like the Structures section of the MPD, the Zonal section inspections cover limited ATA chapters. In this case it is only seven: ATA 32: landing gear; ATA 52: doors; ATA 53: fuselage; ATA 54: nacelles/pylons; ATA 55: stabilizers; ATA 57: wings; and ATA 71: powerplant.

FH tasks

The Zonal section FH tasks all relate to both GEnx and Trent1000 engine inspections. The eight 4,000FH tasks relate to inspections of nacelle areas that only require minor access. The 20 6,000FH tasks include thrust reversers and general engine inspections with further panels open.

Calendar tasks

The calendar-based tasks start with six 6MO tasks to inspect the main landing gear (MLG), and nose landing gears (NLG) with doors open. It is noted in the MPD that inspections are required with NLG and MLG doors open, but stands are not required.

The main body of the zonal section consists of the heavier zonal calendar-based tasks, both in total quantity and MH content. These are required at 3YE, 6YE, 12YE and 24YE initial intervals. These all have identical repeat intervals.

The 83 tasks in the 3YE group, which would ideally fall in line with the first base check, consist of internal and external GVIs over most of the aircraft fuselage, including doors, engine and engine nacelles, wheel wells and wing external surfaces. There are numerous access panels to remove/refit, but the removal of major structural items, such as interior furnishings or flight control surfaces, is not required.

The 69 tasks in the 6YE group cover increasing internal GVI, as well as external GVIs of the fuselage wing and empennage areas. The heavier access requirements are being introduced into the cargo bays and passenger compartment, with interior panel removals. Some inspections are L/N-specific. For example, the 6YE interval zonal inspection of the forward wing-to-body fairing area has separate task entries for aircraft L/Ns up to 125, and then from L/N 126.

The 83 tasks in the 12YE group include numerous passenger door, fuselage, wing and empennage inspection tasks, with the deeper inspection levels now reaching the internal floor and fuel tank structure. Throughout the rest of the aircraft there are extensive GVIs down to the structural level, which will require the removal of internal monuments, such as galleys and lavatories.

The 12 tasks in the 24YE group require extensive internal passenger cabin and stabiliser inspections with heavy

MPD guide intervals for line or A checks are 1,000FH, and C checks or base checks are 12,000FH/36MO. FC utilisation tasks will have to be monitored against these larger FH/Calendar grouping parameters.

access. As this grouping of tasks will also be carried out with the 12YE repeat tasks, some access requirements will have already been satisfied by other inspections.

Base checks

To get an idea of the C checks already carried out on the 787 fleet, there are 240 787-8s aged from 3YE to 5.9YE, all of which would have had their first C1 or 12,000FH/36MO checks and close to or undergoing their C2 checks, and 18 787-8s over 6YE which would have completed their first C2 (6YE) check.

For the 787-9 variant, there are 36 aircraft aged 3YE and over that would have completed their C1 checks. Since the oldest 787-9 is 4.7YE, the first C2 for a 787-9 is yet to be completed.

As with all Boeing MPDs, the three main sections of the MPD that list the tasks also list inspection MH requirements for planning and production department reference. These MH are based on skilled personnel familiar with the aircraft, and with access or area preparation already completed.

In the past it was common practice to multiply the base Boeing figures with a reality figure for a better reflection of estimated MH needed to complete the tasks within an MRO. An alternative is to independently evaluate each MPD task's MH figures, and to enter them into the airline's or MRO's Maintenance and Engineering (M&E) IT system. With new aircraft types, establishing a MH figure guide for check planning can often be a combination of both practices. "We use our own database based on the MH averages for each of the MPD tasks," explains Chris Dare, managing director at MAEL. "The data is not yet showing a 'regular' multiplication rate, but we are working with Boeing on standardising the MH for the MPD figures."

Additional information supporting planning and base maintenance activities for base checks is found within the Appendices of the MPD.

To assist production planning, Appendix E of the MPD contains aircraft dimensions and station diagrams. The station diagrams contain useful graphical representations of, for example, body station (BS) (circumferential frames), fuselage stringers (skin support structure), and engine nacelle numbering.

Zonal inspection task descriptions will often detail BS and stringer ranges that the inspection area covers. Any defect noted structurally on an aircraft can be referenced to a specific location on the aircraft by this numbering system.

To assist planning engineers, Appendix D contains a cross-reference list of MPD number to task card number, with reference also to the MRB report item number. MPD numbers detail the scheduled maintenance task threshold, repeat interval, task description, and access requirements. Task cards contain instructions to carry out requirements of the MPD inspection and reference further aircraft maintenance manual (AMM) sections to be used. This may result in one MPD task number being split into several task card numbers and cards for left- or right-handed systems or large inspection areas.

Task coding in the Appendix D table identifies any MPD-related task cards that should be carried out before, with, or after, if relevant. This helps optimise maintenance within each airline's AMP.

For both maintenance planning and production use, Appendix A has access data and zone diagrams. The access data contains panel number, location and MH open/close information. The zone diagrams illustrate the eight major zones of the aircraft in detail via a three-digit numbering system. The lower half of the fuselage is 100, the upper half of the fuselage is 200, the empennage is 300, powerplants and struts are 400, the left wing is 500, the right wing is 600, the landing gear and gear doors are 700, and the passenger/cargo compartment doors are 800. These eight major zones will run through the aircraft panel and door numbering system. For example, the right wing, zone 600, will have panels with three-digit numbers starting with a six. Two letters following the three-digit number will further pinpoint the panel location.

On a higher fleet planning level, Appendix B contains blocked or phased maintenance guide information. The sample check guide uses a 787-8 with Trent 1000 engines for base maintenance and HMV check planning assistance over a 24YE and 96,000FH period. Detail within the Appendix includes Boeing MH summaries, via trade (airframe, avionic, and engine) and access breakdowns. A check tasks, engine change, life limited component change, general aircraft handling and docking requirements are excluded. Out-of-phase (OOP) tasks are any FH/FC or calendar task that falls out of the major base check groupings. The base check tasks for all fleet variants are summarised *(see table, page 40)*.

Using Appendix B of the MPD, the following check information can be obtained. Figures are based on a 787-8 with Trent engines.

36MO (3YE) base check

The foundation of the C1 check will include the 12,000FH, 12,000FH/3,560FC, 12,000FH/6,000FC/3YE, 3YE, 3YE/6,000FC, 6,000FC/3YE, and 18,000FH/3YE tasks. By far the largest grouping of tasks is the 120 pure calendar-based 3YE tasks (787-8 with Trent engines). The C1 check equates to the 12th line or A check in the 96-check cycle, and are listed *(see table, page 40)*.

Appendix B of the MPD suggests a guide base MH figure of 312.68 for inspection all trades, and another 75.66MH for access. Inspection hours in this form are not factored to match each

Average FH and FC utilisation varies greatly between operators. As a guide figure from information available the average FH to FC utilisation equates to 6.65:1. Annual utilisations of most operators are 4,500-6,000FH.

MRO's reality rates or include aircraft handling and preparation. For reference, other Boeing MPD figures can often be multiplied by a factor of two to four.

Access with respect to Appendix B is for panel removal or door opening only. Cabin furnishing and equipment removal, flight control and major component removal, for example, will be listed under the task descriptions as a 'note'. Additionally, panels only applicable to one variant (the 787-10) will also be referenced as a 'note'. Appendix B guide MH and check cycles are detailed on the guide base check MPD inspection and panel access MH *(see table, page 42)*.

Added noted access for the 36MO check includes flap positioning, thrust-reverser cowl opening, and opening of the engine cowls.

The actual MH used for aircraft preparation, access and routine inspections will clearly be higher than the 390MH quoted in the MPD. In addition, there is the issue of customer-specific items, non-routine rectifications, and some possible ADs and SBs. The non-routine work as a result of MPD inspections will be low on the first C1 check. Normally at this early stage of an aircraft's life cycle non-routine content will consist of cabin interior defects and minor system discrepancies. Any large defect findings will more likely be a result of accidental damage to aircraft structural components.

MAEL, the industry leader in third-party 787 work in Europe, has provided its guide figures for in-service aircraft based on its check experience. "MPD figures range from 700MH to 900MH, with the C1 check totalling 1,200MH to 1,800MH, depending on the customer-driven additional tasks," explains Doherty. "We have carried out C1s in as little as five days, but on average they are taking seven days, based on the operator's additional requirements and cabin refurbishment programmes."

At this stage of the aircraft's maintenance cycle, the 4YE, 8,000FC/4YE, 5YE, 5YE/10,000FC, 16,000FH and 18,000FH inspection tasks are considered to be OOP and could all be brought forward to the C1 check. Alternatively, the tasks may be slotted into A checks, which is how they appear in Appendix B. This aspect of the check planning means the C1 check package will vary by operator and aircraft.

6YE base check

The foundation of the C2 check at a 72MO interval will include 6YE, 6YE/12,000FC and 24,000FH tasks, which includes the HMV check tasks. The largest grouping of tasks is the 89 pure calendar-based 6YE tasks. The C2 equates to the 24th check in the 96-check cycle. The C2 also includes the C1 tasks due on the repeat interval requirement.

Appendix B of the MPD suggests a guide base MH figure of 464.71 for inspection all trades, and 121.4MH for panel and door access. As mentioned in the 36MO base check section, these are raw, unaltered OEM MHs. These MPD labour estimates of about 585MH will clearly be escalated by a reality factor. The labour for preparation, access and routine inspections will then be added to by non-routine rectifications. The non-routine work for a C2 will be higher than for a C1 check. This is due in part to the larger content of structural and zonal inspection tasks, but also and their access requirements. When removing cabin furnishings and any interior/exterior access panel, inspections of the removed items along with the support structure and attachment hardware are automatically required. This results in additional defect findings that although predicted is considered non-routine. There will also be ADs and SBs, and customer items.

Added noted access for the 72MO check includes fuel tank entry. Although MHs for fuel tank access panels will be included in the supplied guide check figures, additional time for fuel tank draining, cleaning and venting will be needed. The dangerous working environment means that additional MH will be needed for externally positioned personnel to monitor the safety of fuel tank entrants.

For an in-service aircraft, MAEL has also provided its check experience guide figures as the first C2 checks enter their hangars. "The requirement heads up to 4,000-5,000MH as heavier tasks are introduced," explains Doherty. "Our previous checks have had heavy customer content, so it is difficult to give an average, as even the MPD call–offs vary depending on the equalised maintenance programmes between checks.

"In terms of downtime, we have seen TATs of 20-24 days for the C2, but again, these are driven by the elapsed times of some of the check additions rather than purely by MPD tasks," adds Doherty.

At this stage of the aircraft's maintenance cycle, 78MO, 7YE, 8YE, 16,000FC/8YE, 30,000FH and 5,000FC to 6,000FC are considered to be OOP tasks. They could all be de-escalated and brought forward to the C2 check, or slotted into A checks, depending on access requirements.

9YE base check

The foundation of the C3 check will include 9YE and 36,000FH tasks (six and seven tasks respectively) and the C1 check again. The C3 equates to the 36th line or A check in the 96-check cycle.

Appendix B of the MPD suggests a guide base MH figure of 325.13 for inspection all trades, and 76.12MH for panel and door access.

At this stage of the aircraft's maintenance cycle, the 10YE and 40,000FH tasks could be de-escalated and brought forward depending on access and inspection MH. Alternatively, the

Due to the reduction of duplicated inspection tasks within the MPD, base check total man-hour content can be dominated by cabin modification and refreshment programmes.

tasks may be planned into adjacent A checks to the check.

12YE base check

The foundation of the C4 check will be the 12YE, 12YE/24,000FC, 48,000FH, 24000FC/12YE tasks. The largest grouping of tasks is the 101 (for the 787-8 with Trent 1000) pure calendar-based 12YE tasks, with the 95 24,000FC/12YE tasks also a large grouping. The C4 equates to the 48th check in the 96-check cycle, and will include the lesser checks on repeat intervals. The check package will include the C1, C2 and two groups of HMV check tasks.

Appendix B of the MPD suggests a guide base MH figure of 883.68 for The actual MH used for aircraft preparation and routine inspections will clearly be higher than the 390MH quoted in the MPD. The actual MH used for aircraft preparation and routine inspections will clearly be higher than the 390MH quoted in the MPD. inspection all trades, and 221.44MH for panel and door access.

Added noted access for the 12YE check includes: insulation blanket displacement, and major assembly removals, such as waste tanks, interior flight deck consoles, and window liner furnishings. Deeper internal structural inspection access is required, for example, internally through the vertical stabilizer. Galley and lavatory removal will be indicated by the reference to 'remove all cabin equipment as necessary' in the task description.

The closest task grouping to be de-escalated and brought forward, depending on access and inspection hours, is one 150MO inspection for discarding an ELT battery. This task could be conveniently slotted into the nearest A check.

Higher FH & FC tasks

Tasks higher than the C4 interval of 12YE/48,000FH are the 8,500FC, 10,000FC, 12,000FC, 16,000FC, 15YE, 20YE, 50,000FC/20YE, and 24YE tasks. The largest task group is the 11 calendar-based 24YE tasks. All higher FH, FC and Calendar tasks will be slotted into the repeat of the 3YE, 6YE, 9YE, and 12YE inputs, or a convenient A check.

Of the two remaining HMVs in the check cycle, at 18YE and 24YE, the Appendix B 18YE base check total MH are of 477.49 for all inspections, and 121.42MH for panel and door access. The 18YE check or C6 equates to 72nd check in the 96-check cycle.

The Appendix B 24YE base check has 907.43 MH for all inspections, and 226.61MH for panel and door access. The 24YE check or C8 equates to the final check in the 96-check cycle.

Added noted access for the 24YE check includes further cabin and empennage internal equipment and furnishing removal across specific areas.

Since the aircraft has only been in service for seven years, additional fatigue-related inspections on a large scale are yet to be introduced into the main MPD body of maintenance. By the time the aircraft reach the 18YE and 24YE checks, the MPD may contain many higher FH, FC and Calendar inspection tasks.

Across the entire 96-check cycle, a guide inspection and panel/door access OEM figure of 8,701.77MH is given.

Additional tasks

Threshold parameters, such as ENG CNG/APU CNG (Engine and APU change), LIF LIMIT - ENG/APU & L/GEAR COMPONENTS, NOTE, SEE APX (Appendix), and SHP VST (shop visit) tasks will be monitored closely by the planning departments. There are 58 of these tasks that will slot into C checks as required.

ETOPS

To allow the aircraft to be flown with a single engine on a route up to 330 minutes away from a suitable airport to land, the 787 was designed to meet specific certification requirements on safety-critical systems. This certification is referred to as extended twin-engine operational performance standards (ETOPS). The additional maintenance and in-service requirements to maintain the ETOPS approval are found within a 787 configuration maintenance and procedures (CMP) document supplement, separate to the MPD. These procedures must be monitored during all A checks and base checks.

To avoid introduced errors within a critical system, or across more than one critical system, airline planning departments may stagger key MPD task requirements over several inputs. Production planners will ensure different personnel accomplish each task. For third-party MROs, the customer or airline procedures will have to be followed along with their own to identify and action critical system and ETOPS programme-related tasks.

Non-routine

Industry feedback from circulated questionnaires suggests that there are no common NR (defect rectification) issues identified with undertaking 787 maintenance checks, other than the engine issues for the Trent 1000 engines that require unscheduled SVs. More details on this topic are listed in the AD section.

Due to the high composite material construction of the aircraft fuselage, new repair methods and equipment for composite structural repairs processes will be required by the MROs. OEM support is available in this area.

"A number of repairs has been carried

The first 787s have been through their first C2 checks at about six years old. Data on the first C2 checks indicate labour used for the complete package are 4,000-5,000MH.

out by the specialist Boeing team in our hangar as damage is identified," explains Dare. "The current structural experience of our heavy maintenance teams is being supplemented as we develop our in-house capability on composite skins. A number of external suppliers is working with Boeing to develop quick application patch repairs that will assist in down-route AOG damage situations."

Major ADs

The latest release ADs for the 787 require a mix of immediate rectification action and general inspection requirements that may be aligned with the appropriate base check.

ADs requiring immediate action are AD 2018-09-05 and the earlier AD 2018-08-03. These affect the 787-8/-9 aircraft with Trent 1000 series engines installed. The ADs contain instructions for revising the aircraft's flight manual (AFM) limits for ETOPS operations down to 140 minutes from 330 minutes. This is to take effect after 300FC are accumulated on new or refurbished intermediate pressure compressor (IPC) assemblies.

The AD has been released due to concerns that, after an engine failure, the extended high thrust settings of the operating engine may cause it to fail within the current ETOPS parameters. This is mentioned as being a result of cumulative fatigue damage under certain temperature and altitude conditions of the IPC.

Both ADs are effective from April 2018. The AD only lists 1.0MH for the changes to the AFM which can initially be supported by placing a copy of the AD in the AFM. The larger impact of the AD, however, is on the operational costs of weight restrictions, extended flight routes and repetitive engine changes until a modification is developed. The AD has currently left airlines wet-leasing aircraft to fill slots, with some 787s forced into engineless storage. If the replacement engine is not prepared into a quick engine change (QEC) state with all bracketry and pipework installed, transfer of parts from the outgoing engine onto the in-going engine can take an aircraft out of service for up to two-and-a-half days.

Recent ADs of large MH content include AD 2018-11-13 for repetitive inspections on 787-8s for the disbond of specific upper wing stringers.

The inspections require ultrasonic testing of the listed areas, with corrective action required before further flight if disbond is found. The terminating preventative modification is to install disbond arrestment fasteners.

The AD also refers to an inclusion in the aircraft's maintenance programme to incorporate an inspection task AWL-57-13. Compliance of the inspection is within 24,000FC or within 12YE, WCF after the completed SB inspections from the listed AD.

The inspection requires 49MH, with the modification up to 352MH plus materials cost. The maintenance programme revision is only 1MH.

Post-production inspections are common for new-to-service aircraft types. AD 2016-26-06 for the 787-8 is for inspections of specific wing side of body upper stringer fittings, which may have been installed with faying sealant surface mismatch as a result of machining beyond a set tolerance. Replacement stringer fittings and fasteners are needed if discrepancies are found. Inspections are estimated at 144MH per aircraft, with repair due to fretting damage estimated at 9MHs. Compliance is before the accumulation of 18,000FC or 13 years after the effective date of the AD (February 2017).

Another post-production issue, AD 2017-01-02, is for 787-8 and -9 inspection of the trailing edge flap rotary actuators. It is noted that the actuators may have been incorrectly assembled during manufacture, causing accelerated wear. This AD is listed as taking only 1MH to complete. Compliance time is within 60 months after the effective date of the AD (February 2017). Repair is by replacement.

Everyday operational service patterns of the new aircraft types, such as the 787, can also trigger ADs to prevent unexpected system failures.

AD 2016-24-09 for the 787-8 and -9 requires repetitive cycling of power to the aircraft's three flight control modules (FCM). After 22 days of continuous power, it has been reported that the FCMs may simultaneously reset. Cycling power will address the sudden loss of all three FCMs at once. The action of cycling the aircraft power is to not exceed intervals of 21 days. The AD is listed as taking 1 MH but in practice can be carried out by normal 'power off' activities.

Summary

Although suffering from specific un-forecasted maintenance requirements, there is a growing list of orders and a high monthly production rate for the 787. This will create a large market of base check opportunities for MROs choosing to 'tool up' for the type.

As far as the scheduled maintenance MPD-based inspections programme is concerned, the first base checks through the MRO network have gone smoothly. As with many base checks of any civil aircraft type, focus of the input is often as much on refreshing the cabin and/or improving passenger comfort systems rather than the base MPD inspections themselves. These inclusions can dramatically increase MH requirements compared to base MPD inspection MH. AC