

The largest widebody aircraft types require both regular refurbishment of their interiors, and often a complete interior reconfiguration. The possible refurbishment routines and associated costs, and the workscope for complete interior configuration are examined for the largest widebodies.

The costs of large widebody interior refurbishment

The interior refurbishment of aircraft broadly falls into two areas: the regular maintenance of interior items; and the complete refurbishment or reconfiguration of the aircraft. Large widebodies, such as the 747-400, 777-300 and A340-600, undergo a higher degree of cabin reconfiguration more frequently than do smaller widebodies and narrowbodies. Cabin reconfigurations occur when an airline changes its branding, or improves its level of on-board service, for example changing from traditional first and business classes to a new business class with lie-flat seats.

Interior items

Interior maintenance can be divided into that which is mandatory, and that which is performed purely for marketing and cosmetic reasons. Interior items can also be broadly split between seller-furnished equipment (SFE) and buyer-furnished equipment (BFE).

Items included in the SFE category are standard parts selected by the aircraft manufacturer, and do not vary between operator. These include overhead and sidewall panels, overhead bins, passenger service units (PSUs), and toilets.

BFE items are those selected by the operator for their unique image and branding. These include seats, carpets, galleys and galley equipment, servicing areas, bulkheads, and in-flight entertainment (IFE) equipment.

Many SFE and BFE items are inspected, maintained and refurbished on a regular basis and at varying intervals. Only some items are replaced or changed

in the event of a cabin reconfiguration or the aircraft changing operators. These include seats, IFE equipment, broadband and in-flight telephone equipment, and galleys.

The refurbishment of aircraft interiors was traditionally combined with heavy airframe checks. This has changed, and a lot of interior refurbishment and upgrades are now performed separately to heavy airframe checks. The majority of large widebodies are operated by full service carriers, so high standards have to be maintained.

Cabin carpets

Although interior configurations will vary between airlines, a 747-400 cabin will have a carpet area of about 275 square metres and a 777-300 cabin will have a carpet area of about 250 square metres. Carpet in the aircraft will be used in the aisles and the seating areas. Servicing areas in doorways, galleys and toilets will use non-textile flooring (NTF) material.

All carpets on the aircraft will have to be cleaned and inspected on a frequent basis, and most airlines will vacuum clean them between all flights. Carpets in the aisles will require replacing about once every 12-15 months because of the high level of wear they experience, while carpets in the seating areas will be replaced at 24-30 month intervals, or even at longer intervals of up to four or five years.

The 747-400 and A340-600 both have a C check interval of 18 months, which often provides a convenient interval for replacing aisle carpets. The 777-300 has varying C check intervals

according to operator, but these are at either 12 or 24 months in most cases. A checks may also provide a convenient opportunity to replace aisle carpets, since the process does not require much downtime. The replacement of carpets in the seating areas requires the removal of seats, so most operators will wait for a heavy check to do this. This would be a D check in the case of a 747-400, which takes place about every five years; and a C4 or C8 check in the case of an A340-600. This takes place about once every five years. The timing of heavy checks in the 777 is less specific.

The aisles on a 747 use about 75 square metres of carpet, and about 200 man-hours (MH) to remove old carpet, and cut and fit new carpet. Labour rates vary, but at an illustrative labour rate of \$60 per MH, the labour used is equal to a cost of \$12,000. Carpet material costs about \$55 per square metre, so the total cost for this element is about \$16,000. On the basis that the aisle carpet is replaced about once every 15 months, equal to a C check interval, then this cost will be equal to a reserve of \$2.90 per FH.

The equivalent cost for replacing aisle carpets on the A340-600 will be about \$12,000, and will be equal to a reserve of \$2.30 per FH. The cost and reserve will be similar for a 777-300, which is a similar-sized aircraft to the A340-600.

Airlines replace seating area carpets at different intervals, but the average is about 45 months; equal to 17,000FH. About 200 square metres of carpet, costing \$11,000, are used in the seating area on a 747-400, and 180-190 square metres are used, at a cost of \$10,000, on the smaller A340-600 and 777-300.

REGULAR INTERIOR MAINTENANCE FOR 747-400, A340-600 & 777-300

Interior item	Timing	Interval FH	Cost \$	Reserve \$/FH
747-400				
Aisle carpets replacement	C check		16,000	2.9
Seat area carpets replacement	Every 45 months	17,000	44,000	2.6
Cleaning seat covers	C check		23,000	4.1
Replacing seat covers	Every 3-4 years		50,000	4.2
Seat cushions	Every 5 years		112,000	4.5-5.0
Seat frame maintenance	Every 5 years		115,000	4.6-5.1
Panels, bins & PSUs	D check	22,500	310,000	14.0
Galleys & toilets	D check	22,500	220,000	10.0
Servicing area NTF	D check	22,500	95,000	4.1
Total cost of regular interior maintenance				52.0
A340-600/777-300				
Aisle carpets replacement	C check	6,000	12,000	2.3
Seat area carpets replacement	Every 45 months	17,000	40,000	2.4
Cleaning seat covers			21,000	3.7
Replacing seat covers	Every 3-4 years		46,000	3.8
Seat cushions	Every 5 years		82,000	4.5-5.0
Seat frame maintenance	Every 5 years		105,000	4.6-5.1
Panels, bins & PSUs	Every 6 years	28,000	270,000	10.0
Galleys & toilets	C8/Every 8 years		190,000	5.5
Servicing area NTF	C8/Every 8 years		80,000	3.6
Total cost of regular interior maintenance				41.0

The labour used for removing old carpet and installing new material will be about 550MH for the 747-400, and 500MH for the A340-600 and 777-300. The total cost of labour and new carpet material will therefore be \$44,000 for the 747-400 and \$40,000 for the A340-600 and 777-300. Over a replacement interval of 17,000FH, these costs are equal to reserves of \$2.6 per FH for the 747, and \$2.4 per FH for the A340-600 and 777-300.

The total reserve for all carpet material on the 747 is therefore \$5.5 per FH, and for the A340-600 or 777-300 about \$4.7 per FH (*see table, this page*).

Passenger seats

Several elements concern the regular maintenance of passenger seats. Configurations vary between operators, but a typical layout of passenger accommodation (LOPA) for a 747-400 would be a total of about 372 seats, comprising: 12 in first class; 60 in business class; and 290-300 in economy. Aircraft configuration with lie-flat seats in a new style of a combined first and business class may have 75 seats, and again about 290-300 seats in economy class.

The LOPA for the smaller A340-600

and 777-300 is about 10 first-, 55 business- and 265 economy-class seats, with a total seat count of 330 seats. Seat counts for the A340-600 tend to be 20-30 seats fewer than the average for the 777-300. A two-class layout may comprise up to 70 lie-flat and 265 economy seats.

Regular seat refurbishment includes: cleaning and replacing seat covers; replacing seat cushions; inspecting seat frames and seatbelts; regular maintenance of accessories such as tray tables and seatback screens; and overhauling seat frames.

Seat covers can be made of fabric or leather. The frequency with which airlines choose to clean seat covers is a cosmetic issue, and depends on the nature of the operation. In many cases they can be removed for cleaning once every 15 months; which will be equal to 5,000-6,000FH for many long-haul aircraft. This is approximately equal to the actual interval for a C check on the 747-400 and A340-600. C check intervals are longer on the A340-600, so seat covers will have to be removed at another convenient maintenance event, such as an A check.

Removing and reinstalling a seat cover uses about 1MH of labour per seat. The cost of dry cleaning each seat cover is about \$3. The total cost for a shipset of

seats on the 747-400 is about \$23,000, equal to a reserve of \$4.1 per FH. The total cost for the A340-600 and 777-300 will be about \$21,000, and equal to \$3.7 per FH.

Seat covers can only be cleaned two or three times before they lose their fire resistant properties, so their replacement is mandatory. Some seat covers can last for three to four years before they have to be replaced. The cost of new seat covers is about \$180 per first-class seat, \$170 per business-class seat and \$130 per economy-class seat. A shipset of seat covers costs \$50,000 for a 747-400, and \$46,000 for an A340-600 or a 777-300. Including the labour used to replace old covers with new ones, the reserve for new seat covers is \$4.2 per FH for the 747-400, and \$3.8 per FH for the A340-600 or 777-300.

Seat cushions also lose their fire resistant properties so their replacement is mandatory too. There are three cushions in each seat, and the shipset should be replaced once every five years. A set of cushions costs about \$300 for a first-class seat, \$280 for a business-class seat, and \$240 for an economy seat. An entire shipset of cushions for the 747-400 therefore costs \$112,000, while a set for an A340-600 or 777-300 costs \$82,000. Reserves for cushion replacement are \$4.5-5.0 per FH.

Seat frame maintenance involves the general inspection of seat frames and the working condition of the reclining mechanism and other components, and the maintenance of tray tables and IFE screens and equipment. These inspections tend to be included in line, A or C checks. The MH and materials used for them are included as elements of these checks, as both routine and non-routine tasks.

Seat frames are typically overhauled once every five years. This requires the removal and later the reinstallation of seats, which uses 2-3MH per seat. A further 2-3MH is required per seat for the overhaul, and an allowance of \$5 per seat should be made for materials and consumables. This will be a total cost of about \$115,000 for a shipset of 747-400 seats, and \$105,000 for a shipset of A340-600 or 777-300 seats. Amortised over a five-year interval, the reserve for seat overhaul will be \$4.6-5.1 per FH.

The total cost of cleaning and replacing seat covers, replacing seat cushions and overhauling seat frames is about \$19 per FH for the 747-400, and \$17 per FH for the A340-600 and 777-300 (*see table, this page*).

Panels & bulkheads

Another group of items includes sidewall and ceiling panels, overhead bins, PSUs, passenger door linings, slide raft boxes, curtains and dado rails. These



have to be inspected at various intervals for working order, general condition, and appearance, while many are repaired on an on-condition basis.

PSUs include reading lights, and are inspected for proper working condition every few weeks or every A check, depending on cabin class, as part of the on-going airframe checks performed on aircraft.

PSUs are generally removed for restoration during heavy airframe checks. Overhead bins, and wall and ceiling panels have to be removed during heavy checks to allow structural inspections. It therefore makes sense to remove PSUs at the same time, and restore them during these checks. In the case of the 747-400, this is during the D check, which has an interval of about five years. This will be done at the C4 and C8 checks on the A340-600, which are performed every five to six years. The 777 has heavy checks at different intervals according to operator. Heavy checks are performed at intervals of five to eight years.

Ceiling and sidewall panels, and overhead bins will be checked for condition about once a year. The MH and material cost inputs for these are included in the on-going airframe checks. Like PSUs, they will be removed during heavy checks to allow structural inspections and their refurbishment. Some minor refurbishment can be done in situ on some of these items during lighter base checks.

A few other items such as passenger door linings, slide raft boxes and the base of cabin doors are also removed during heavy checks so they can be refurbished.

Curtains are also regularly cleaned and repaired on an on-condition basis, as are bulkheads and cabin dividers, which

will be removed during heavy checks for any refurbishment or redecoration.

Toilet and galley walls can also be removed during heavy checks for refurbishment.

Most items undergo some light refurbishment during heavy checks following their removal. The biggest element of this is the replacement of decorative foils on wall panels. This is usually required at removal, but will also be necessary during an interior re-branding and in-service improvement scheme.

The labour input for removing and installing toilet and galley walls on a 747- The labour for removing and reinstalling sidewall panels will be another 80-90MH. A 747-400 will have 140-145 overhead bins, whose removal and reinstallation will require 500-800MH. In addition, 40MH will be needed for the removal and reinstallation of PSUs, 35-40MH for door linings, and 10MH for slide raft boxes. The total will therefore be 1,800-2,000MH.

Refurbishment of toilet and galley walls will include replacing laminates and floor mats. This will use about 140MH for toilets and up to about 500MH for the galleys. Labour for refurbishing other items will be about 550MH for sidewall and ceiling panels, 250MH for door linings, 1,000-1,100MH for overhead bins, 100MH for PSUs, and 100MH for slide raft boxes. The total for the refurbishment will be 2,600-2,800MH.

A labour rate of \$60 per MH results in a labour cost of \$270,000-290,000. An additional \$30,000 should be allocated for materials and consumables, mainly for paints and decorative foils. The total cost will therefore be \$310,000.

Amortised over a D check interval of

The regular refurbishment of large widebody interiors should include all items, performed at varying intervals. Reserves for all items can equate to \$40-55 per FH for large widebody types.

about 22,500FH, this is equal to a reserve of \$14 per FH (see table, page 30).

The equivalent inputs for the A340-600 or 777-300 will be 4,000MH, at a total cost of \$270,000. The interval is likely to be slightly longer than the 747's, at six years or 28,000FH. The reserve will be equal to \$10 per FH (see table, page 30).

Galley & toilets

Galleys and toilets comprise one of the largest groups of items that require regular interior maintenance. Regular cleaning and functional checks are made during A and C checks, and the inputs for these are part of the labour and material costs of these checks. On-condition repairs and maintenance will also be carried out as findings and malfunctions are recorded in the aircraft's techlog during operation.

Galleys and toilets must be removed to allow access for structural inspections. This will take place at the D check in the case of the 747, and the C8 check for the A340-600. The interval will be close to eight years of operation for most 777-300s.

A 747-400 will typically have five or six galleys and up to 14 toilets. The smaller A340-600 and 777-300 will have three or four galleys and up to 12 toilets.

About 150MH are required to remove and reinstall each galley typical of those found on these large widebodies, while another 150-200MH are needed to refurbish each galley. Total labour for galley removal, refurbishment and installation will be 1,800MH; equal to a labour input cost of \$108,000. Up to \$20,000 should be allowed for materials and consumables, taking the total cost to \$130,000. A similar amount will be needed for the galleys on the smaller aircraft, although they are likely to have one galley fewer than the 747.

The labour used to remove, refurbish and reinstall each toilet unit is 50-100MH, depending on its age and condition. Total labour for toilets on the 747-400 is therefore 700-1,400MH. An allowance of \$500 should be made for materials and consumables for each toilet. This takes the total cost up to \$50,000-90,000 for the 14 toilets on the 747-400, and \$42,000-80,000 for the 12 toilets on the A340-600 or 777-300.

The reserve for the total cost of galley

COMPLETE REFURBISHMENT OF 747-400 & A340-600/777-300

Aircraft type	747-400		A340-600/777-300	
	MH	\$	MH	\$
Seller furnished equipment				
Overhead bins		2,000,000		1,700,000
Sidewall & ceiling panels		500,000		400,000
PSUs		600,000		500,000
Toilets		1,700,000		1,200,000
Total for SFE		4,800,000		3,800,000
Labour for installation:				
Overhead bins	600		440	
PSUs	120		90	
Sidewall & ceiling panels	300		90	
Toilets	250		220	
Total MH	1,300		900	
Buyer furnished equipment				
Materials:				
Carpet		12,000-20,000		12,000-20,000
Lie-flat seats		4,500,000		3,500,000
Economy class seats		1,500,000		1,300,000
IFE System		4,500,000		4,500,000
Galleys		1,800,000		1,500,000
Service areas & bulkheads		750,000		600,000
Total		13,000,000		11,400,000
Labour for installation:				
Carpet	700		500	
Lie-flat seats	3,500		3,000	
Economy class seats	300		240	
IFE system	2,500		2,500	
Galleys	900		800	
Total	7,900		7,000	
Total materials		18,000,000		15,300,000
Total labour	550,000		500,000	

and toilet refurbishment will be equivalent to \$10 per FH for the 747-400 (see table, page 30), and \$5.5 per FH for the A340-600 and 777-300. The cost is amortised over a longer interval for these smaller aircraft.

Other cabin structures that have to be removed, refurbished and reinstalled during heavy airframe checks are wardrobes, closets and cabin partitions. A few hundred MH and several hundred thousand dollars should be budgeted for this. The reserve for this will be about \$14.0 per FH for the 747-400, and \$10.0 per FH for the A340-600 and 777-300 (see table, page xx).

Servicing areas

The flooring material in the galleys and toilets, and in some cases in the areas

by the passenger doors, is NTF. Beneath the NTF there are another two layers of material: the first is mylar, a type of plastic; and below this is guiliner, which is impermeable to water and other liquids, and protects the aircraft from rust and corrosion. These three layers have to be lifted up during heavy checks so that structural inspections can be made. They are then replaced with new material.

About 100MH are used to remove old material and install new NTF and other flooring materials for each galley area in the aircraft cabin, and then apply sealing material between the flooring layers and the various walls. This is performed at heavy checks: at every D check on the 747-400 and every C8 check on the A340-600.

The cost of new material in each galley area is \$9,000. A smaller amount

of NTF material is used in each toilet, and some airlines use it at the passenger doors. Total labour for four or five galleys and 12-14 toilets will be 700MH for the 747, and 600MH for either of the smaller aircraft. An allowance of about \$50,000 for material should be made for the 747, and \$45,000 for the A340 or 777. This will take the total cost to about \$95,000 for the 747, and \$80,000 for the A340-600 and 777-300.

Amortised over heavy check intervals, the reserve for NTF replacement will be equivalent to \$4.1 per FH for the 747-400, and about \$3.6 per FH for the A340-600.

Summary

The total reserve for the regular refurbishment of all major interior items is about \$52 per FH for the 747-400, and \$41 per FH for the A340-600 and 777-300 (see table, page 30). The A340 and 777 benefit from longer heavy check intervals, which is when many of the interior items are removed, refurbished and reinstalled.

These costs are an integral part of A and base checks in most airlines and form an element of total reserves for airframe checks. This analysis identifies the costs and reserves for individual elements of interior refurbishment. The largest element relates to seats: cleaning and replacing seat covers; replacing seat cushions; and overhauling seat frames. The second largest element is accounted for by the refurbishment of panels, bulkheads, PSUs, door linings and other items. Reserves for refurbishing galleys and toilets are relatively small.

Cabin reconfiguration

As described, the large widebody types are the aircraft most likely to undergo some cabin reconfiguration during their operational lives.

The reasons for cabin reconfiguration include an upgrade to service standards that require improved seating, a change to galley layout and the installation of internet connections or a new IFE system.

Seating configuration changes are required either because the airline is launching a re-branding or marketing exercise, or because a new type of seating such as lie-flat seats is required.

Economy-class seats are unlikely to be changed on long-haul aircraft, unless the airline needs to incorporate a new IFE system. Changing a standard economy-class seat can utilise only about 1MH, while changing a first class or lie-flat seat can use up to about 50MH. This is because of their complexity and the wiring that has to be supplied for lighting, power and internet connections for computers, the IFE system, and power



for the moving parts of the seat.

A major reason for interior configuration changes in recent years has been migration from traditional three-class LOPAs to a new two-class LOPA, in which the first- and business-class cabins have been merged and fitted with lie-flat seats. This is often combined with the installation of new IFE systems. It can use 6,000MH to reconfigure the interior of a 747-400, and does not include any labour for installing an IFE system. It would be required to change from a three-class cabin to a two-class configuration where lie-flat seats were installed. It would also include the associated changes required to the PSUs in the overhead bins, the reconfiguration of one of the galleys, as well as the repositioning of one or two toilets. A final element would be the redecoration of sidewall panels with new decorative foils. This is an intensive job, since each panel has to be dealt with individually. The application of new foils is time-consuming, because it requires the use of a vacuum machine.

The associated cost of major materials and parts is related to seats. A single lie-flat seat can cost \$60,000. A shipset on a 747-400 or a 777-300 would therefore cost \$3.5-4.5 million, depending on the number of lie-flat seats required on the aircraft.

Individual economy-class seats with a hi-spec IFE system and power for laptop computers can cost up to \$5,000. A shipset of economy-class seats on a 747 can therefore cost about \$1.5 million, and \$1.3 million for a 777-300 or an A340-600.

A complete new wet galley can cost \$150,000-170,000, while the unit cost for a toilet is \$160,000.

A few other new items will also be

required: dado rails; closets or stowage cupboards; some lighting items; and cabin dividers. Up to \$1million should be allowed for these.

Estimates for the amount of labour required to install a new IFE system are 4,500MH.

On rare occasions a complete reconfiguration is needed. In addition to the changing of premium classes, a new image or service level may require the replacement of all seats on the aircraft with new items that include new seatback screens and power ports for laptops. If aircraft change operators, and a standard LOPA is required throughout the fleet, a complete reconfiguration of the aircraft's interior may be carried out. This can include completely changing all the seats, carpets, sidewall decoration, galleys and toilets.

Such a reconfiguration involves both SFE items and BFE items. SFE items are incorporated through a service bulletin (SB) issued by the aircraft manufacturer. The SB includes the reconfiguration design, ordering and integration processes, and the cost of the materials: the PSUs, overhead bins, sidewall and ceiling panels, and toilets.

The cost of the SFE for a 747-400 would include the following: about 145 overhead bins; a shipset of sidewall and ceiling panels; a PSU for each seat; and up to 14 toilets.

Each overhead bin has a list price of \$15,000. With 145 units on a 747-400, the total cost will be \$2 million, if they are required. A shipset of sidewall and ceiling panels will cost \$400,000-500,000, while \$600,000 will be required for PSUs in the economy cabin. A further \$1.7 million should be allowed for 14 toilets. The total cost for all the SFE

The complete interior configuration of an aircraft involves the purchase of SFE and BFE items. This can incur a cost as high as \$18 million for a 747-400, and up to about \$15 million for a type like the A340-600 and 777-300.

items, if they are required, will be \$4.8 million for a 747-400 (see table, page 34).

The cost for the equivalent SFE for an A340-600 or a 777-300 will be \$3.8 million (see table, page xx).

Labour inputs to install SFE items are 4MH for each overhead bin, 2MH for each panel, 1MH for each PSU and 15MH for each toilet. This totals about 1,300MH for a 747-400, and 900MH for an A340-600 and 777-300.

The BFE items include carpets, all seats, the IFE system and galleys. A shipset of seats will cost \$6.0 million for the 747-400, while a shipset for the A340-600 and 777-300 will cost \$4.8 million.

New carpet material will cost \$12,000-20,000 per aircraft. A shipset of new galleys can cost as much as \$1.8 million for the 747, and \$1.5 million for the A340-600 and 777-300. A new IFE system for this size of aircraft can cost about \$4.5 million. An additional allowance of \$0.5-1.0 million should be budgeted for service areas and bulkheads.

The total cost of BFE items with the IFE system on the 747-400 is \$13.0 million, and \$11.4 million for the A340-600 or 777-300.

The labour used to install the carpet will be up to 700MH. Labour for installing economy-class seats will only total about 300MH, while as many as 3,500MH can be used to install business class or lie-flat seats. About 100MH is required to install each galley. A total of up to 900MH can be used. The largest element of labour comes from the installation of the IFE system, which uses about 2,500MH. A total of 7,900MH can therefore be used to install all BFE items.

The total cost of SFE and BFE materials is therefore up to \$18 million for a 747-400, and \$15.3 million for an A340-600 or 777-300 (see table, page 34). The labour used for installation of these materials is about 9,000MH for the 747-400 and 8,000MH for the smaller types. This adds a further \$550,000-500,000 to the cost. **AC**

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