

The majority of regular refurbishment of widebody interiors is cosmetic maintenance, and dictated by airline policy. The items that are refurbished, their typical frequency of refurbishment, and the labour and material inputs are analysed.

# The costs of widebody interior refurbishment

**I**nterior refurbishment of widebodies involves regular aircraft maintenance and cabin reconfiguration. The cost is substantial, and is analysed below.

## Interior items

An aircraft's interior comprises many items, including: seats; carpets; overhead and sidewall panels; galleys; toilets; bulkheads; servicing areas in the vicinity of cabin doors and galleys; passenger service units (PSUs); and in-flight entertainment (IFE) equipment.

"Interior items and furnishings can be divided into buyer-furnished equipment (BFE) and seller-furnished equipment (SFE)," explains Roberto Rosell de Celis, interiors engineer at Iberia Maintenance. "BFE covers those items chosen and developed by the airline, such as carpets,

seats, IFE equipment and galleys. These are ordered by the airline from specialist manufacturers. SFE includes PSUs, sidewall and ceiling panels, overhead bins and toilets, which are all items that are specified by the aircraft manufacturer. Airlines can choose some of these items."

The maintenance of most these items is included in an aircraft's maintenance programme, so it is not mandatory. Certification requirements apply to seat cushions and textile materials inside the cabin, which are items that must be replaced on an on-condition basis. Seats also require regular safety inspections. An aircraft's maintenance programme does not, however, require seat covers to be regularly cleaned or replaced. Carpets, galleys and toilets must be removed during heavy checks so that structural inspections can be performed, which

provides the opportunity to repair and refurbish these items.

Most of the maintenance, refurbishment and replacement of interior items and equipment in an aircraft is performed for cosmetic and marketing purposes, so the frequency and depth are governed by airline policy. How much refurbishment is performed on each item in the interior therefore varies from airline to airline. Low-cost carriers, which have simpler cabin layouts, may maintain and refurbish interiors less frequently and thoroughly than full-service airlines. Few widebodies are operated in the low-cost mode, however, and most are operated on international services. Most airlines therefore require a high standard of cabin interior, and perform regular maintenance.

The interior of a passenger aircraft usually only needs to be reconfigured once or twice in its operational lifetime, for example when an airline chooses to rebrand, or reconfigure its interior layout for marketing reasons. Examples are when airlines do away with a traditional tri-class arrangement of first-, business- and economy-class cabins, and opt for a business-class cabin with lie-flat seats and a re-sized economy class, or when an aircraft changes operators, and the interior has to be changed to match the other aircraft in the fleet.

The cost of interior refurbishment for regular maintenance and for aircraft reconfiguration is analysed here, taking each major interior item into consideration.



*The regular refurbishment of widebody interiors includes panels, PSUs, toilets, galleys, seats, carpets, and non-textile floors.*

*Carpets have to be replaced at regular intervals due to wear by passengers. Most airlines replace carpets in aisles about once every C check, and in those in seating areas about once every three or four C checks.*

## Cabin carpets

The cabin carpet extends to the aisles between the passenger seats and the flooring areas of the passenger seats. The areas in the vicinity of the cabin doors, toilets and galleys have non-textile floor (NTF) material.

“The carpets in the aisles tend to have a higher rate of wear than carpets in the seating areas,” explains Ana Ricardo, cabin engineer A330, at TAP Maintenance & Engineering. “Carpets need cleaning at regular intervals, since they get dirty due to passenger traffic. They are usually cleaned during A and some line checks. The A330 has a maintenance programme of a base check cycle of eight C checks, with an interval between each of 18 months. The C4 and C8 checks, at six-year intervals, are the two heaviest checks. We replace aisle carpets at every C check, and so once every 15-18 months, depending on the actual timing of the check. The carpet in the seating areas is replaced at every C4 and C8 check, so every 5-6 years.

“Removing old, and installing new, carpets uses about 100 man-hours (MH) on the A330-200, and another 60MH are needed to cut the carpet to the right shape and size,” continues Ricardo. “The A330-200 uses 160 square metres (1,725 square feet) of carpet, which costs about Euro 40 per square metre (\$5 per square foot). A new carpet for an A330-200 will therefore cost Euro 6,500 (\$8,000).”

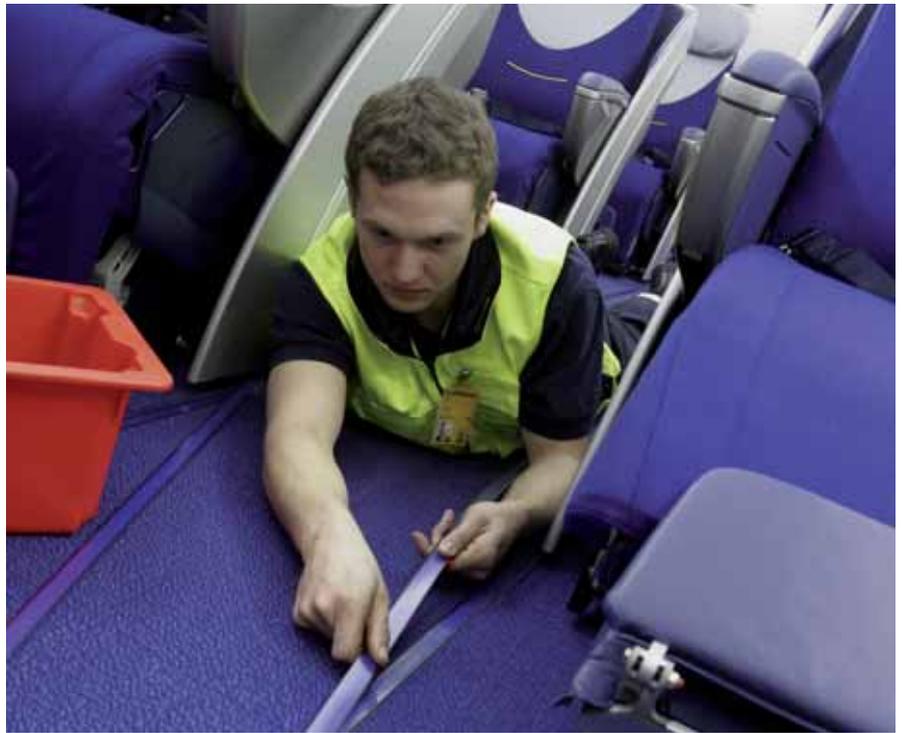
The labour used costs \$8,000 if the average labour rate is \$50 per MH. The total cost of replacing the carpet is therefore \$16,000 for an A330-200. This is equal to a reserve of \$0.80-1.00 per FH for an aircraft operating at 4,000FH per year (see table, page 40).

Carpet material for the aisle accounts for about 20% of the total area, so the cost of replacing the carpet for the aisles at every C check is Euro 1,300 (\$1,700). The total cost of replacing this would be \$3,000. If it is replaced at every C check this would be equal to a reserve of \$0.70 per FH (see table, page 40).

## Passenger seats

There are three elements of passenger seat maintenance: seat covers, seat cushions and seat frames.

Seat covers are cleaned at regular intervals, with the frequency determined by the rate of passenger use and airline



policy. Seat covers are then replaced at less frequent intervals, the life again being determined by airline marketing policy.

Seat cushions are certified according to inflammable properties included in the regulations, so their integrity must be observed.

Seat frames are maintained at regular intervals. Some of this maintenance relates to safety issues, so it is mandatory. The inspection of seat floor attachments, the operational check of the seat belts and the inspection of the seat structure is performed every 36 months according to the mandatory maintenance schedule. The restoration of the electronic restraint devices is done every 700 flight hours (FH) and seat airbag restoration is carried out every seven years from the manufacturing date.

There is also the issue of maintaining tray tables, seatback screens, and IFE equipment. Much of this maintenance is performed on an on-condition basis, as a result of reported problems with individual seats that arise during operation being recorded in the aircraft's technical log. These are repaired during line checks when convenient. Maintenance on seat frames is also done during C checks.

Besides maintenance of seat frames, there is the issue of seat replacement. Economy-class seats rarely need to be replaced during the life of an aircraft. Seats are replaced, however, when ones with seatback video screens and other IFE equipment have to be introduced, or when airlines upgrade their economy-class brands.

First- and business-class seats are more likely to be replaced at intervals of 5-10 years when airlines upgrade their

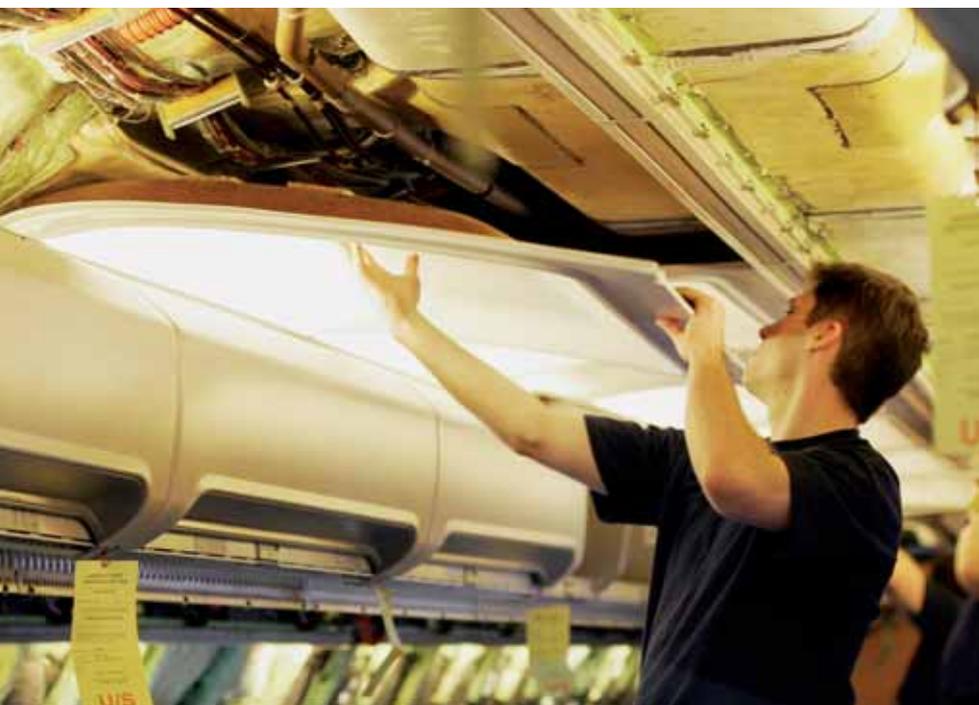
premium-class products.

“We manage the maintenance for Aer Lingus's A330-200s and -300s,” says Jean-Michel Lefevre, vice president of sales at Sabena Technics. “The aircraft are used on international services, and we dry clean the seat covers at the C check, every 15-18 months. The replacement of seat covers is treated as an on-condition issue.”

Ricardo explains the costs relating to seat covers, seat cushions and seat frames. “Leather or lighter textile seat covers are available. The flammability of seat cover material is an important consideration,” says Ricardo. “It takes about 300MH to remove and re-install covers on the 263 or 268 seats in the A330-200s.”

This would incur a cost of \$1,500, equal to about \$0.50 per FH if the covers were removed and re-installed at every C check. There would also be the cost of dry cleaning them. “It is only possible to clean the seat covers two or three times before they need to be replaced, because washing them more than this damages their inflammable properties,” explains Bernard Schoening, manager of cabin modification at Lufthansa Technik.

Seat covers are therefore replaced at every three C checks, or every four to five years. “The cost of new seat covers, for material and manpower for installation, is about \$700 for a double seat of business-class seats, and so \$8,000 for 24 seats in our A330-200s,” says Ricardo. “The cost for new seat covers for the 239-244 seats in economy class is about \$50,000 for the shipset. We replace our seat covers every second C check.” This total cost of \$60,000 is equal to a reserve of \$8 per FH for an aircraft operating at 4,000FH per year.



Seat cushions come in three parts: seatback, seat base and headrest cushions. “Seat base cushions lose their self-extinguishing properties every four years, while seatback and head cushions have to be replaced every six years,” explains Ricardo. “The whole shipset of cushions for all seats on the aircraft costs about \$64,000. New seat base cushions cost \$25,000 for the whole aircraft, while a whole shipset of new back and head cushions costs about \$39,000.” On the basis of four- and six-year replacement intervals, for the two groups of seat cushions, a reserve of about \$3 per FH should be used (see table, page 40).

The condition of seat frames is checked at regular intervals during airframe checks. “We check the business- and economy-class seats for proper condition and operation about every 15 days, so we check the trays, covers, bumpers, arms, belts, PSUs and screens,” says Rosell De Celis. “We make the same checks on the economy-class seats every four months. The seats are removed at heavy checks so that structural inspections can be made, every five or six years for the A340-300 and -600.”

Seats are rarely replaced, as described, but the cost of new seat sets is substantial, and depends on specification. Most airlines have seatback video screens in economy class. Economy-class seats are bought in pairs, tri-sets and quads. The average price per seat with seatback video screen, tray table and seatbelt is about \$3,000 per unit. A shipset of about 240 seats for an A330-200 will cost in the region of \$720,000. This increases in proportion to almost \$1.0 million for aircraft such as the 777-300 and 747-400 which can have up to 325 economy-class seats.

Business-class seats are supplied in pairs or tri-sets in most cases. Double seats have a unit cost of about \$65,000. The specification of business-class seats varies more widely than economy seating, however. Higher-specification seats with full lie-flat capability and elaborate IFE systems can cost up to \$50,000 each. A total shipset of 24 seats for an A330-200 therefore costs \$750,000-1,000,000. On larger widebodies there are typically 30-40 business-class seats, so a full shipset will cost \$1.0-1.6 million, depending on number and specification.

The complete shipset of seats for a smaller type like the A330-200 will therefore be \$1.5 million, rising to \$2.6 million for an aircraft like the 777-300 or 747-400.

## ■ Panels & bulkheads

The maintenance of sidewall panels, bulkheads, overhead bins and PSUs can be considered as one group. The maintenance for these items is treated on an on-condition basis by most airlines. “We check the proper condition and operation of business-class PSUs every 15 days, and those in economy class every four months,” says Rosell De Celis. “We then remove PSUs for restoration once every five years to ensure that the performance capabilities are at maximum levels. We check the proper condition and operation of sidewall and ceiling panels, and overhead bins once every 12 months. We then remove these items for restoration about once every five years on our widebodies. The overhead bins and sidewall and ceiling panels have to be removed during structural checks so that structural inspections can be made. The sidewall panels and ceiling panels are

*Repair, recovering or painting of ceiling panels is relatively easy and can be done by most maintenance providers. Applying new decorative foils to sidewall panels is more complex due to the contoured shapes, and requires specialist tooling.*

removed every 12 months to ensure their proper condition, and are totally restored every five years, when we take advantage of their removal to perform structural inspections of the aircraft body.”

TAP cleans and does minor refurbishment of these items in situ during C4 checks. This will consume a few hundred MH and some materials.

TAP then removes the sidewall and ceiling panels, the overhead bins, PSUs, toilet inner walls, galley walls, the cabin door linings, and slide raft boxes at the base of the cabin doors at every C8 check on its A330-200s. “It takes about 2,000MH to remove and re-install all these items at this check,” says Ricardo. “Another 1,800MH are needed to refurbish and paint or re-decorate these panels. The cost of the primers, paint and consumables is about \$20,000.”

A standard labour rate of \$50 per MH would take this to a total cost of \$220,000. Amortised over the base check cycle interval, it is equal to a reserve of about \$6 per FH.

These items are rarely replaced, unless they sustain extensive damage. The only complex part of the procedure is applying new decorative foils to the sidewall panels, which have contoured shapes due to the passenger windows. This therefore requires specialist tooling.

## ■ Galleys & toilets

Some of the maintenance for galleys and toilets is a function of airline policy. These so-called ‘monuments’ are normally cleaned and lightly refurbished during A and C checks to maintain appropriate appearance standards for passengers. They have to be removed during heavy checks so that structural inspections can be performed.

“The proper operation of both galleys and toilets is clearly important to maintain satisfactory levels of passenger service,” says Lefevre. “We deep clean galleys and toilets during A and C checks. We then service the internal parts, depending on the aircraft maintenance manual (AMM), usually during C checks. Moisture from spilt drinks can damage the metallic and composite parts of the monuments, which sometimes results in corrosion.”

Rosell De Celis explains Iberia’s policy for galleys and toilets. “Like the seats, panels and PSUs, we check the

## REGULAR INTERIOR MAINTENANCE A330-200

Interior item	Timing	Interval FH	Cost \$	Reserve \$/FH
Aisle carpets replacement	C check	4,000	3,000	0.70
Seat area carpets replacement	C4 check	16,000	16,000	\$0.80-1.00
Cleaning seat covers	C check	4,000	\$1,500	\$0.50
Replacing seat covers	Every 3 C checks	12,000	\$60,000	\$8.00
Seat base cushions	Every 4 years	16,000	\$25,000	\$1.55
Seatback & head cushions	Every 6 years	24,000	\$39,000	\$1.65
Panels, bins & PSUs	C8 check	36,000	\$220,000	\$6.00
Galleys & toilets	C8 check	36,000	\$55,000	\$1.60
Servicing area NTF	C8 check	36,000	\$115,000	\$3.00
<b>Total cost of regular interior maintenance</b>				<b>\$24.00</b>

function and operation of toilets in the business-class cabin every 15 days, and those in economy every four months. We then remove toilets for restoration tasks every five years in co-ordination with structural checks. We clean galley grills every four months, and check for proper condition of latches, doors and surfaces, and inspect the operation of plumbing and wiring every 18 months. We remove the galleys and toilets for restoration at structural checks, which is every five years on the A340-300 and -600."

The amount of maintenance required on galleys depends on their specification and complexity. The most basic galleys are 'dry', so they do not have plumbing, ovens, refrigeration or drinks machines, while the most complex ones have all these facilities. At least one galley on the aircraft will also have a trash compactor.

"We take the opportunity to refurbish galleys and toilets in the A330-200 at the C8 check because they are removed," says Ricardo. "Our A330-200s have five or six galleys, and eight or nine toilets, depending on cabin configuration. It takes about 500MH to remove and re-install the galleys, toilets and partitions on the aircraft. It then takes another 40MH to refurbish and decorate each galley, which totals about 250MH for the shipset on the aircraft. Materials for galley refurbishment cost \$5,000."

Another 200MH is used to refurbish the toilets, taking the total amount of labour to refurbish these two main items to 1,000MH.

The total cost for galley and toilet refurbishment is therefore about \$55,000. Amortised over the C8 check interval this is equal to a reserve of about \$1.60 per FH (see table, this page).

## Servicing areas

These are the servicing floor areas in the vicinity of the galleys, toilets and cabin doors. Instead of carpet, these are covered with NTF, a flooring material that allows spilt liquids to be mopped up. Underneath this is gulliner, a layer of glass fibre to protect the floor panels from damage and to stop corrosion from spilt water and other liquids, and underneath this is a layer of mylar. The gap between the NTF and cabin wall is sealed.

"It takes about 100MH to remove and install new flooring material in each service area," says Ricardo. "There are three of these areas on the A330-200, one for each pair of cabin doors, except the third door area which has carpet flooring. It therefore requires about 300MH to remove and install flooring material in the whole of the aircraft. The cost of this material for the three areas is about \$23,000." A standard labour rate of \$50 per MH takes the total cost to \$115,000. This is equal to a reserve of about \$3 per FH when amortised over an interval of the base check cycle, about 32,000-36,000FH.

## Summary

The total cost for the regular refurbishment of all major interior items is about \$24 per FH for the A330-200 (see table, this page). This cost will be proportionately greater for larger widebodies. This is low considering the revenue generated by a high standard of interior refurbishment. There are additional costs, however, that relate to regular cleaning, minor refurbishment and inspection of items such as seat

frames that take place on a continuous basis in line, A and base checks.

The cost of regular interior refurbishment compares to a reserve of \$130-145 per FH for base checks, which include interior work and refurbishment, for the A330-200/-300 (see A330-200/-300 maintenance analysis & budget, Aircraft Commerce, April/May 2008).

## Cabin reconfiguration

The complete reconfiguration of an aircraft's cabin is rare. Aircraft being acquired by new operators is the most common cause of some or all of the cabin's configuration being changed.

The seating configuration of economy classes rarely differs between carriers. For example, all Airbus widebodies are operated in an eight-abreast arrangement of two, four and two seats. Seat aisle widths therefore also rarely differ between operators. Similarly, the economy classes of most 767 operators comprise seven-abreast seating of two, three and two seats, with the same seat and aisle widths.

What does vary more between airlines is seat pitch, the area of the cabin used for economy class and therefore the number of economy-class seats. The standard of IFE equipment also varies between airlines. The number and standard of seats is likely to change when aircraft change operators.

There is some variance in the positioning and style of galleys and toilets at the middle and rear of the fuselage. The implications of this are that new toilets and galleys may have to be installed when aircraft change operators.

There is more variance in the configuration of first- and business-class cabins than in economy-class. Moreover, airlines purchasing used aircraft from other carriers will want to install new interiors in these cabins for marketing purposes.

TAP has been through the process of acquiring used aircraft and reconfiguring its interiors so that it has a uniform standard with its existing fleet. "We purchased three A330-223s from Swissair, and had to reconfigure them to the same interior standard as our own fleet of A330-202s," says Ricardo. "Our -202s have a configuration of 268 seats: 24 in business class and 244 in economy. The -223s had five fewer economy seats.

"The overall job was to change the configuration of the economy cabin to add more seats. We also had to modify the galley configurations, and had to install a lower-deck crew rest area in the underfloor compartment," continues Ricardo. "These three items consumed about 1,600MH. Changing the cabin configuration required about 950MH of this, but most of this was for the service

bulletin (SB) used to build a staircase down to the underfloor compartment.

"Then there was a list of material items which added a total of about \$2 million per aircraft," continues Ricardo. "The first of these was BFE for seats, which included wiring, IFE, seat belts and new seat covers. This was about \$60,000 per aircraft. Then there was BFE for galleys, which included coffee makers, refrigeration units, ovens, espresso machines and two trash compactors. There was also a modification kit for the galleys. The total for these items was about \$270,000 per aircraft. We also installed a complete shipset of 24 business-class seats at a cost of \$780,000, and also 64 new economy-class seats at a cost of about \$300,000. There were some small items that included two Dasell stowages at the aisle door and wall-mounted assemblies. These cost about \$30,000. One of the largest items was the lower-deck crew rest compartment, which has six beds. This cost about \$550,000. The modification of the galleys to our standard was possible. A complete new shipset of six galleys would cost about \$720,000." Taking the standard labour rate of \$50 then takes the total cost of labour and materials to about \$2.1 million.

Iberia gives an illustration of the total cost of completely refurbishing an aircraft's interior, and uses the A340-300 and A340-600 for this. "This takes a lot of preparation time. It takes several months for the design of different furnishings. An airline will issue their specifications to BFE manufacturers, and it can take up to 12 months to completely design lie-flat seats, for example," explains Rosell de Celis. "Even economy-class seats can take six months to design, galleys nine months and an IFE system up to about 10 months. Once the initial design process is completed then the materials can be ordered and the items constructed. This can take up to nine or 10 months for items like the galleys and IFE system.

"Time is also needed for the integration process," continues Rosell de Celis. "This is to issue SB numbers, make drawings and do the engineering work, all of which is necessary when adding in this new equipment. The integration process can start some time after the design process has started, when there will be sufficient design data. The integration process can then continue in parallel to the design and order processes. Overall, it can take up to about 12 months to obtain the IFE system, from making the initial specification through to completing the design, integration and delivery. Less time is needed for other items, but galleys and seats still need up to 10 months."

The SFE items are specified by the

## COMPLETE REFURBISHMENT OF A340-300 & A340-600

Aircraft type	A340-300		A340-600	
	MH	\$	MH	\$
<b>Seller-furnished equipment (SFE)</b>				
Cost of SB & materials		3,900,000		3,900,000
Labour for installation:				
PSUs	400		400	
Overhead bins	600		800	
Sidewall panels	40		40	
Toilets	180		200	
<b>Total</b>	<b>1,220</b>	<b>61,000</b>	<b>1,440</b>	<b>72,000</b>
<b>Buyer-furnished equipment (BFE)</b>				
Materials:				
Carpet		13,000		17,000
Business-class seats		1,600,000		2,000,000
Economy-class seats		900,000		1,200,000
IFE system		1,700,000		2,700,000
Galleys		1,000,000		1,500,000
<b>Total</b>		<b>5,100,000</b>		<b>6,900,000</b>
Labour:				
Carpet	200		200	
Business-class seats	250		300	
Economy-class seats	250		300	
IFE system	2,500		2,500	
Galleys	900		1,000	
<b>Total</b>	<b>4,100</b>	<b>205,000</b>	<b>4,300</b>	<b>215,000</b>
<b>Overall total</b>		<b>9,300,000</b>		<b>11,100,000</b>

aircraft manufacturer, and are issued via an SB. The design, ordering and integration process are all part of the SB. The cost of the SFE materials is included in the purchase price of the SB, and covers PSUs, sidewall and ceiling panels, overhead bins and toilets. Rosell de Celis says the cost for the SB for all these items is Euro 3.0 million (\$3.9 million) for the A340-300 and A340-600.

"The labour to install the BFE items and their purchase cost has to be considered in addition to this," says Rosell de Celis. "The A340-300 uses about \$13,000 of carpet material, and the A340-600 about \$17,000. The cost of business-class seats is about \$1.6 million for the A340-300 and \$2.0 million for the -600. Economy-class seats for the A340-300 cost about \$900,000, and the -600's shipset costs \$1.2 million. The IFE system is the most expensive item, and is \$1.7 million for the A340-300 and \$2.7 million for the A340-600. The A340-300 has nine galleys, and the total cost for these is about \$1.0 million. The A340-600 has 10 galleys, and the cost of a new shipset is about \$1.5 million."

The total cost for a complete shipset of new BFE items is therefore about \$5.1 million for the A340-300, and \$6.9 million for the A340-600.

The labour used to install these items totals 5,300-5,700MH for the aircraft (see table, this page). "About 200MH are used for installing the carpet, 250-300MH for the business-class seats and 250-300MH for the economy-class seats," says Rosell de Celis. "The PSUs take another 400MH, and the overhead bins use 8-10MH per unit, taking the total to 600MH for the A340-300 and 800MH for the A340-600. Sidewall and ceiling panels have the simplest installation, and only use about 40MH in total for all units on the aircraft. Each toilet uses about 20MH for installation, and each galley about 100MH."

Labour charged at \$50 per MH would therefore take the labour cost to \$265,000-290,000. When the cost of new items is added, the total cost for the BFE is therefore about \$5.1 million for the A340-300 and \$6.9 million for the A340-600.

When the cost of the SFE items and integration SB is added, the total cost is about \$9.3 million for the A340-300, and \$11.1 million for the A340-600 (see table, this page). 

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