

Landing gear repair and overhaul has become a specialist maintenance activity, requiring expensive tooling and a large number of gear shipsets. The gear overhaul process is analysed, and the industry's main gear overhaul shops are listed.

Landing gear overhaul suppliers survey

Landing gear is not normally top of the agenda when an aircraft's maintenance costs are discussed, but the component nevertheless forms an important element of total maintenance. The landing gear and braking systems of an aircraft can easily contribute a third of the non-engine-related component overhaul costs.

Overhauling a main landing gear shipset can cost in excess of \$750,000, according to research carried out by Aerostrategy, an aviation consultancy that has extensive experience in the maintenance, repair & overhaul (MRO) field. Aerostrategy's pricing figures are broadly in line with the views of the MRO providers that were questioned by *Aircraft Commerce*.

The combined cost of overhaul and the exchange fee for a shipset ranges from \$200,000 for older regional jets (RJs) to \$750,000 for current generation widebodies. In the case of RJs, the fees per shipset are about \$200,000 for old technology types, and \$150,000 for mature technology and current generation aircraft.

Shipset fees for narrowbodies are \$210,000-250,000 for varying vintages. Old and mature widebody types have shipset fees of \$450,000-500,000, and are in the region of \$750,000 for current generation aircraft.

Although the cost of landing gear overhaul for larger aircraft is the highest, the impact on total maintenance cost is often more important on smaller aircraft, such as RJs. Aircraft of this size are typically used for shorter sectors, which increases the ratio of landings per flight hour. Landing gear overhaul intervals are in calendar time and flight cycles (FCs). In a short FC-time style of operation, the landing gear and braking systems can be responsible for up to 40% of airframe-related maintenance costs.

The first step in clarifying and

controlling overhaul costs is to determine what constitutes a landing gear. Typically a main gear would include more than 15 major assemblies. This includes components such as: retraction jacks; uplock assemblies; actuator beams; torsion links; and drag struts. Configuration sheets provide a reference and help identify any missing parts when a gear is presented for overhaul. Replacing such missing parts is a factor in overhaul costs exceeding budgets. Nose gears are less complex and less expensive to overhaul, but the same principles of budgeting apply.

One area that needs to be considered when estimating the costs involved in landing gear overhaul is the impact of turnaround times. The overhaul process requires about 30 days for a narrowbody aircraft and up to 50 days for a widebody gear. The actual length of time required is one of the key factors in selecting an overhaul shop, and achieving shorter times is a key part of many providers' marketing efforts. The length of time that a landing gear is out of service for an overhaul is crucial in determining the number of spares that an airline will require to ensure there are sufficient shipsets for its active fleet.

The relatively long time between overhauls (TBOs) and the high capital cost of holding spare shipsets can make the holding of spares uneconomic for an airline, particularly one with smaller fleets. This has led to an increased tendency for overhaul shops to provide an exchange gear service. In such systems the operator is provided with a refurbished (or new) gear when one comes due for removal for overhaul. The removed gear is refurbished by the MRO and returned to its pool of spare units. The MRO of course charges an additional fee, in the order of \$30,000 for a 737 gear, for the exchange of gear shipsets. Larger airlines may therefore

find it economic to invest in their own spares.

The exchange system had come to dominate the market, but there are signs that some airlines are reverting to holding their own spares, particularly for narrowbody aircraft. For example, some sources suggest that operators own the majority of spare 737NG landing gears.

Overhaul process

Landing gear overhaul has some similarities with the engine market, not least in that a fully overhauled unit has practically the same life as a new one.

The overhaul process is complex. Incoming units are disassembled and individual parts are inspected, measured and assessed to determine what work needs to be performed and what needs to be replaced. Major parts can normally be reworked to bring them back into specified tolerances, but this requires specialist repairs and facilities.

The requirement for specialist facilities means that few airlines can justify an in-house capability and various industry surveys suggest that about 75% of landing gear overhauls are contracted out to original equipment manufacturers (OEMs) or third-party facilities.

Although the overhaul intervals of landing gears mean that shop visits are only required every eight to 10 years, some industry people suggest performing inspections after about five years to detect the onset of corrosion. It can make economic sense to carry out an early overhaul to avoid excessive scrapping of parts due to corrosion.

The market

As in many sectors of the MRO market, the role of the OEMs in the after-sales market has increased in recent years. The supply of landing gear for

LANDING GEAR CAPABILITIES

Name of provider	Aircraft covered	Exchange Service available	Approvals
AAR Aircraft/ Landing Services	707, 717, 727, 737, 747, 757, 767, 777, A300, A310, A319, A320, A321, A330, A340, DC-8, DC-9, DC-10, MD-10, MD-11, MD-80/90, CRJ, ERJ, EMB110, EMB120, ATR42, ATR72	Yes	FAA,EASA +7
AEM	Various narrowbody and commuter aircraft		FAA,EASA
Aero Precision Repair and Overhaul (A-PRO)	ATR42, ATR72, ERJ-135, ERJ-145	For some types	FAA,EASA
Aveos	737, 767, 777, A320 family, A330, A340, CRJ-100/200, E-170/-190	Yes	FAA +various
AMECO Beijing	737CL, 737NG, 747-200, 747-400, A320 family, 767	Yes	FAA,EASA +various
APPH Aviation Services	S340, S2000, J1, J32, J41, MD-11		FAA,EASA +various
A J Walter	Exchange/spares programmes	Yes	FAA,EASA +various
Avtrade	Exchange/spares programmes	Yes	FAA,EASA +various
CSA	737CL, 737NG	Yes	FAA,EASA +various
CSE Aviation	Shorts, Jetstream, Islander		FAA,EASA +various
Dallas Airmotive Delta Tech Ops	Saab 340, Jetstream41 737NG, 757, 767		FAA,EASA +various FAA,EASA +various
Finnair	A320, ATR42, ATR72	Yes	FAA,EASA
Goodrich Landing Gear	737NG, 737CL, 747, 757, 767, CRJ-700/900, Dash 8/Q400	Yes	FAA,EASA +various
ADAT (GAMCO)	767, A320		
HAECO	747		FAA,EASA +20
IAI Bedek	707, 717, 737CL, 737NG	Yes	FAA,EASA +various
Iberia	A340-300 (planned)	Yes	FAA,EASA +16
Japan Airlines	737, 747, 767, 777, DC-10, MD-11		FAA,EASA +various
Lufthansa Technik	737, 747, 757, 767, 777, 787 (in preparation), A300-600, A310, A319, A320, A321, A330, A340, A380, DC-9, MD-80, MD-90, DC10-10/30, MD-11, BAe146, Avro RJ, CRJ, ERJ	Yes	FAA,EASA +39
MAS Engineering	737CL	Yes	FAA,EASA +30
Messier Services	737NG, 777, A300, A310, A320 family, A330, A340, BAe146, CRJ, DHC-8, ATR42, ATR72	Yes	FAA,EASA +various
MyTechnic	737CL		FAA,EASA +various
Piedmont Aviation Component Services	ATR42, ATR72, DHC-8-100/200/300, CRJ, J31, J32, J41	Yes	FAA
SAA Technical	737-200, 737-800, 747-400	Yes	FAA,EASA +various
Saab Aviocomp	Various regional aircraft	Yes	FAA,EASA +various
Sabena Technics	737CL, A320 family, BAe146, E170, ERJ135/145, Casa 235, ATR42, ATR72, F28, F100, CRJ100/200, Dornier328	Yes (some types)	FAA,EASA +various
Singapore Precision Repair & Overhaul	DC-10, MD-11, MD-82, ATR42, ATR72, D0328, F.27, F50		FAA,EASA +various
Stork SP Aerospace	737, F.27, F.28, F50, F100	Yes	FAA,EASA +various
ST Aero	717, 737NG, A320 family, A330, A340, MD-80, MD-90, ATR42, ATR72, CRJ200, F50, D0328	Yes	FAA,EASA +various
TAP	737		FAA,EASA +7
Turkish Airlines Technic	727, 737CL, 737-800, A300B4, A310-200/-300, A320 family, A330, A340, RJ70, RJ100	Yes	FAA,EASA +18
United Services	777		FAA,EASA +4
TAP M&E Brazil (formerly VEM)	727, 737CL, 737NG, 747, 767, DC-10, MD-11, EMB120, ERJ145, ATR42	Yes	FAA,EASA +various

commercial aircraft is dominated by the US company Goodrich and Messier Services in Europe. Both these companies have a strong presence in the landing gear

overhaul business. Traditionally Goodrich has been the principal supplier for Boeing aircraft, while Messier has supplied the majority of Airbus products.

Goodrich's selection by Airbus to supply the A380 main landing gear was a significant departure from this trend, but in terms of MRO business there is as yet little impact.

Boeing has traditionally owned the design and manufacturing rights for the landing gear on its aircraft, and Goodrich has manufactured the gears and parts for the airframe manufacturer. Landing gear parts were therefore only available from Boeing. This situation, however, changed in late 2008 when Goodrich obtained a licence to manufacture and sell Boeing landing gear parts. The company markets the parts under the name GR-OEM parts. Bob Corbeil, director of business development landing gear aftermarket at Goodrich, believes that GR-OEM will help the company's competitive position in the aftermarket, not least because materials account for the major part of the cost of any landing gear overhaul. Corbeil adds: "While we are happy to supply these parts to anyone, including competitors, our partners will benefit from our ability to predict and provision material to support their future landing gear overhaul needs. Goodrich will have the data to provision for future requirements and our partners will be first in line to receive the respective parts, which is a significant benefit with major long-lead time components."

The OEMs are clearly well placed to attract after-sales business for their respective products, but there are a number of third-party MROs and airline technical divisions that compete for landing gear overhaul business. Economies of scale are important in the landing gear market as a large customer base makes it easier for a supplier to finance a pool of exchange gears.

A look at the potential market indicates why there is significant interest in the landing gear MRO sector. Aerostrategy forecasts that in 2009 the landing gear overhaul market will be worth close to \$560 million, and predicts that this will rise to over \$740 million by 2018. The consultancy suggests that there will be a dip through 2010 to 2013, however, with spend dropping to as low as \$465 million. This means that 2009 represents a significant peak. The consultancy also expects that the market will begin to rise again after 2013. Because the typical TBO of a landing gear is eight to 10 years, this demand pattern reflects to a large extent the pattern of aircraft deliveries from the corresponding aircraft delivery period.

The market is therefore driven by the fleet that was delivered around the turn of the century, when Airbus and Boeing produced about 815 aircraft. This also implies that the A320, 777 and 737NG will be prominent contributors to the requirement for landing gear overhaul, as

Landing gear repair and overhaul is a specialist activity, requiring specialised equipment and tooling. The long time between overhauls also adds to the need for a large turnover of shipset to justify having a landing gear overhaul shop.

will be the A330 and A340, albeit to a lesser extent. The time lag between aircraft delivery and the requirement for a landing gear overhaul lends predictability to the market, which some commentators suggest will insulate it from the current economic downturn.

Although this is a matter of some dispute, the OEMs and large third-party suppliers are bullish. Lufthansa Technik (LHT), along with its associated companies Ameco Beijing and Hawker Pacific, probably offers the most comprehensive coverage of aircraft types of any of the third-party respondents to our survey. With a capacity of about 800 shipsets per annum, LHT has a similar capacity to the OEMs such as Goodrich and Messier Services, and is therefore a barometer of the market. "The landing gear market is different from other MRO activity because we're working on fixed TBOs," says Klaus Koester, chief executive officer and president of Hawker Pacific Aerospace, a wholly-owned subsidiary of LHT.

Hawker Pacific estimates that revenue from overhauling commercial aircraft landing gears will increase by 10% in 2009. Although the Hawker subsidiary is sufficiently busy to be turning away some business, the diversity of the LHT group provides flexibility in capacity. A company spokesperson told *Aircraft Commerce* that while most of its landing gear business units are currently selling slots for 2010, the group was able to respond to some customer enquiries made at short notice.

ST Aerospace is another leading supplier in the market, with a capacity of about 200 shipsets per annum. The Singapore-based organisation also remains positive about the market and intends to continue investing in the sector. The company believes that one of the key factors in the business is the availability of exchange landing gears and spares. In this context, it has invested by buying more rotatables and spares, particularly for A320s and 737NGs.

Goodrich's Corbeil suggests that both the aircraft delivery cycles and general economic cycles have an impact on the landing gear MRO business. He believes that the sector is not immune from the general economic cycle, but thinks that Goodrich has minimised its likely impact on its own business by concentrating on newer aircraft types. "In a recession it is



the older types that are taken out of service first," he points out.

Although the landing gear overhaul market in the regional aircraft sector has many similarities to its widebody and narrowbody counterparts, there are some characteristics of typical regional aircraft operations that have a potential impact on the associated MRO business. Alan Haworth, director of sales & marketing at Piedmont Aviation Component Services, summarises the situation. "Most landing gears have a cycle limit between overhauls, with a calendar limit backstop. Aircraft and operators that have shorter stage lengths (typical of the regional business) are more likely to hit the cycle limit before the calendar limit. With reduced operations (as a result of the economic downturn) there may be a tendency for gears to remain on wing longer until reaching the calendar limit. This in turn could lead to a lull in removal activity, and therefore overhaul business." Haworth points out, however, that corporate and freight operators are generally limited by the calendar TBO, so in this sector activity should be unchanged.

The survey

Aircraft Commerce's global survey of landing gear MRO providers summarises the major aftermarket and technical support facilities available.

Although the landing gear market has some similarities with the engine overhaul market in that the OEMs have a large share of the aftermarket, *Aircraft Commerce's* initial research revealed a large number of independent suppliers.

Furthermore a number of respondents indicated that they were considering expanding their business by moving into additional aircraft types. The number of providers is, to some extent, misleading, however, as the capacity of many of the independent suppliers is only a fraction of that of the OEMs and the larger third-party suppliers.

Typically the smaller independent and airline MROs have a capacity of 20-30 shipsets per annum, according to the responses to the *Aircraft Commerce* survey. Nonetheless, the presence of independent suppliers does provide for increased competition, particularly in the narrowbody market where the costs of entry are lower than in the widebody sector. In the regional market there is also good competition, although some of the respondents pointed out that there are barriers to entry to the newer regional models, in particular the non-availability of spare gears.

Perhaps reflecting the high investment required to set up landing gear facilities, the market is characterised by a number of partnerships. In April ST Aerospace and Iberia Maintenance announced that a joint venture, Madrid Aerospace Services, had delivered its first overhauled landing gear.

A notable absentee from our survey is SR Technics. The closure of its Dublin facility, where much of its landing gear overhaul capacity is based, makes it unclear what capacity the company will offer in the future. **AC**

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