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# Optimising Landing Gear Maintenance

## With the stresses and loads landing gears are subjected to, effective maintenance is critical

By David Dundas

When you consider the extreme lateral, longitudinal and vertical loads an aircraft's landing gear is subjected to every time it lands and takes off, it is no surprise just how much maintenance is required and just how critical it is. If you take the Boeing 737 MAX as an example, the landing gear is certified to handle landing impact forces of up to 2.6g or sink rates of 600 fpm before a mandatory hard-landing inspection is required. Stationary wheels hit the runway at 120–150 knots, so they are instantly accelerated, inducing high torque on the axle and strut. During taxi, the gear handles dynamic loads, including stresses from turning and uneven runway surfaces while with takeoff rotation forces, during rotation, the main gear acts as the pivot point for the entire aircraft, sustaining high compressive loads and the gear, particularly the struts and attachments to the wing structure, experiences significant bending due to the aircraft's weight and acceleration. After take-off, hydraulic pressure (up to 3,000 psi) is used to overcome aerodynamic forces and lift the heavy gear assemblies into the fuselage.

In all the above, your key stress components are likely to be the oleo strut which compresses to absorb vertical energy on impact, side braces and jury struts which handle lateral stability, the trunnion pin which is a high-tensile stress point holding the gear to the wing structure, and the tension arm/scissor link which manages the rotation of the piston and torque loads. If you then imagine that low-cost carriers will operate a 737 MAX for up to 35 flights per week and you can begin to get a clearer picture of what is likely to be involved. Oh, did we mention about hard landings?...

With the level of maintenance required, it is no wonder MROs are constantly looking to optimise the whole landing gear maintenance set-up, and we decided to approach four leading operators to get a better picture of how they deal with this challenge.

**How should operators approach long-term landing gear maintenance planning across an aircraft's life?**

Operators should take a comprehensive, long term view of landing gear maintenance planning across the full life of the aircraft. This starts with establishing appropriate maintenance reserves to support the expected overhaul cycle, and ensuring that funding aligns with the operator's lifetime overhaul model. Andy Wheeler, Divisional Vice President & Managing Director, AEM / AMETEK MRO expands further. "Because landing gear shops often book up well in advance, overhaul slots should be secured early to avoid unplanned downtime or last-minute costs. Planning should also account for differences between first and second overhauls, as the scope, material demand

Andy Wheeler, Divisional Vice President & Managing Director, AEM/AMETEK MRO

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and cost can vary considerably. Operating conditions play a major role in determining actual maintenance intervals too. High-cycle operations, challenging environments, and exposure to corrosive conditions can all drive earlier or more extensive work. By regularly reviewing utilisation, reliability trends, and environmental factors, operators can refine their plans and maintain consistent fleet availability."

Karolis Jurkevičius, VP Landing Gear & Major Assets, APOC Aviation is firmly of the belief that many carriers don't fully understand the timescale involved for a landing gear shop visit. He explains: "Most airlines try to accommodate landing gear shop visits during heavy checks, expecting the gear to be repaired while the aircraft is already in base maintenance. This is the wrong approach. Landing gear shop visits typically have a much longer turnaround time (TAT) compared to base maintenance. When taking into account gear removal, shipment to the shop, overhaul TAT, return logistics, and re-installation, the total process can easily take 4–5 months for narrowbody aircraft and up to a year for some wide-bodies. Even though A330 overhaul capacity and parts supply are improving, current shop TATs are still a minimum of 120 days, as officially quoted by the majority of MROs. We also see that when operators face long landing gear TATs, they start looking for alternative solutions such as leasing, exchange, or outright purchase. However, this is often another incorrect assumption, as ready-to-go assets are rarely available. Most asset owners keep landing gear in stock unrepaired and uninspected, waiting for a customer order before committing to inspection or overhaul. The situation is even more challenging for widebody platforms such as the A330 or B777-300ER, where limited availability drives high lease, exchange, and purchase prices."

Raul Cruz-Alvarez, CEO & Accountable Manager, Landing Gear Technologies LLC puts the situation nice and succinctly when he says that: "... planning for landing gear maintenance has to be one of the easiest in the entire aircraft. If the aircraft accumulates 1 or 20,000 flight cycles they must be overhauled every 10 to 12 years depending on the aircraft. Landing gears are complex pieces of equipment and generally only come off for overhauls within that time period." Stephen Spender, Director of Sales - Landing Gear, Werner Aero certainly recommends not leaving things to the last minute. "Plan to maximise green time use and add flexibility, leaving it to the last minute only drives up cost and A/C down time. Work with an MRO with comparable assets as this helps to understand the operator's goal and demonstrate material and production planning for short- and long-term solutions," he advises.

**Where do you see the greatest opportunities for cost optimisation without compromising safety or compliance?**

Here, among a number of things, Karolis Jurkevičius has his focus on the choice of parts as being a key area to pare back costs. "The greatest opportunities for cost optimisation – without compromising safety or compliance – come from working with specialised asset managers such as APOC, who have invested in both landing gear asset pools and spare parts inventories. By actively managing repairs and material sourcing, costs can be significantly reduced. This includes encouraging MROs to use approved alternative parts and repairs instead of defaulting to OEM new material, where permitted. In addition, airlines should be open to using used serviceable material (USM) to replace scrapped parts, provided full traceability and regulatory compliance are maintained. Operators that rely on one-off repairs or attempt to source parts reactively – based solely on shop findings and short-term market availability – often face material shortages or inflated pricing. In contrast, contracting in advance with landing gear asset and parts owners allows operators to secure availability, control costs, and avoid exposure to

Raul Cruz-Alvarez, CEO & Accountable Manager, Landing Gear Technologies LLC

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volatile market conditions. Proactive asset pooling and repair management, rather than ad-hoc sourcing, is where the most sustainable cost optimisation can be achieved," he suggests.

Raul Cruz-Alvarez and Stephen Spender have differing views on this topic, with Cruz-Alvarez proposing that: "The easiest way to optimise cost is through strategic buying of spares and getting the team members to be more efficient in each process. Otherwise, a proper overhaul is strictly detail in each CMM." Spender, on the other hand, feels that: "Reliable partners (MRO's & material suppliers) with shared values that demonstrate product knowledge, commitment towards the same goals with a reliable and robust quality system," are a good option.

Andy Wheeler is of a similar mind to Karolis Jurkevičius in terms of the use, or rather lack of use, of USM. He tells us that: "There are several areas where operators can optimise landing gear maintenance costs without compromising safety or compliance. One of the most effective is to maximise the use of concessions and repairs rather than automatically replacing components with new. Many components can be safely restored to serviceable condition when supported by OEM-approved repairs like those provided by AEM/AMETEK MRO, which can significantly reduce overall overhaul costs. Using used serviceable materials (USM) is another cost-efficient option when appropriate and properly certified, particularly for high-value items with long lead times. Regular, high-quality inspections also play a key role. Identifying wear, corrosion, or minor issues early helps prevent them from developing into major findings at overhaul, improving both cost control and planning accuracy. A combination of smart repair decisions, strategic USM use and proactive inspections can deliver meaningful savings while keeping safety central."

Stephen Spender, Director of Sales - Landing Gear, Werner Aero

**How do parts availability, repair development, and OEM support affect turnaround times?**

Parts availability, repair development, and OEM support are key drivers of turnaround time (TAT) for landing gear overhauls. No MRO will fully guarantee overhaul TAT, as all contracts clearly state that turnaround times are subject to parts availability. Karolis Jurkevičius goes further when he points out that: "Recent experience with A321 overhauls and A330 enhanced overhauls has shown that long OEM lead times, even for relatively low-value parts, can significantly extend TAT. In cases where no used serviceable material is available on the secondary market, operators are forced to rely solely on OEM supply. This can result in overhauls being extended – sometimes up to a year – as repairs cannot be completed and landing gear cannot be fully assembled due to missing components. This highlights why early planning remains critical. While it cannot eliminate all risks, working with specialised asset managers such as APOC can help mitigate delays by maintaining parts availability and proactively managing repair solutions. Although not a full guarantee, this approach significantly reduces exposure to material shortages and unplanned TAT extensions." Meanwhile, Raul Cruz-Alvarez is quite blunt when it comes to this situation, making it clear that: "This is the biggest challenge we are facing today, the supply chain has yet to recover and after five years of hoping I personally don't see it happening anytime soon. My opinion is that OEMs have figured out that the industry will pay the extra charges for expedition fees and that is found money."

Andy Wheeler seems to be of the opinion that parts availability has the greatest effect on turnaround times, telling us that: "Parts availability, repair development, and OEM support all have a direct impact on turnaround time (TAT). Parts availability is often the biggest driver. If a component is on long lead time or suddenly becomes scarce, it can delay the entire overhaul. While post pandemic material constraints created real challenges, supply chains have stabilised more recently. Repair development can also extend TAT, especially when a new or updated repair is needed. Fast, responsive OEM support makes a big difference here, helping to keep the shop visit moving. Obsolescence on older platforms remains an ongoing issue, as sourcing alternatives or serviceable units can take longer. While these factors can influence TAT, proactive planning and realistic buffers help maintain reliable timelines for operators." Additionally, Stephen Spender's thinking is not that far detached from Wheeler's thoughts on the matter, suggesting that: "All outsourced support, whether OEM or any supplier needs to be reliable as when it is not, the MRO is put in a difficult situation to achieve TAT and on-time delivery. Parts availability and supply chain with lead time of 15, 30 or 45 days and in some cases no availability at all is a huge complexity for TAT and on time delivery. You can only pre plan so much around lead time on material. Repair development can help with TAT, as it gives the MRO in house capability and control of the repair time frame."

**How does landing gear maintenance status impact asset value and lease negotiations?**

Andy Wheeler tells us that AEM does not have extensive direct involvement in aircraft valuations or lease negotiations, but he is able to suggest that "...from our experience, landing gear maintenance status is an important consideration. Most lease agreements specify whether the gear must be overhauled at end of lease, typically based on the aircraft's age, utilisation, and whether it is likely to transition to another operator. While models vary, most lessors prefer the landing gear to be returned in overhauled condition to protect asset value and

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support onward remarketing. We have also seen this managed through tripartite agreements, where the lessor holds the reserves and funds the overhaul on the operator's behalf." Meanwhile, Stephen Spender at Werner Aero is quite clear in his thoughts. "Massively, the price difference between as removed, green time remaining and overhauled units can be hundreds of thousands of dollars. But it is always about managing risk, and who wants the risk?" he asks.

Karolis Jurkevičius at APOC Aviation definitely has concerns over costs when availability of landing gear for short-term lease is limited. He details that: "Landing gear maintenance status has a direct impact on both asset value and lease negotiations. The longer the turnaround time (TAT), the greater the immediate need for replacement landing gear assets. If no alternatives are planned in advance and operators still intend to reinstall their own landing gear during base maintenance, any parts shortages at the shop will extend TAT and can ultimately lead to redelivery failure. In such cases, operators are forced to seek alternative solutions in the market to support daily operations. For most aircraft types, the availability of landing gear for short-term lease is limited, which naturally drives lease rates upward. If no lease assets are available, operators must consider exchange or outright purchase options. Depending on the urgency of the requirement and the level of market availability, asset values can increase significantly." To conclude, Raul Cruz-Alvarez at Landing Gear Technologies LLC. makes a very valid comment when he says that: "This is a tricky question as it really depends on the leasing company if the aircraft will fly again or if it will be parted out. Generally, there are maintenance reserves to cover the overhaul if the lease was properly negotiated."

**What common issues arise at lease return related to landing gear condition or documentation?**

Karolis Jurkevičius sees that one of the most common issues relates to landing gear documentation, which is increasingly being assessed not only from a technical perspective but also from a commercial and regulatory standpoint. He goes on to suggest that: "From a technical point of view, lessors and operators are right to focus on compliance, however, this is only part of the picture. The true value of a landing gear lies in its paperwork (PPW). Commercial traceability is just as important as technical records. In today's environment, this has become even more critical due to global sanctions and regulatory restrictions, where certain countries, operators, or counterparties may be subject to limitations. As a result, it is essential to ensure full historical traceability before accepting landing gear into a pool or releasing it to a buyer or lessee. At APOC, we apply the highest PPW and quality standards across all landing gear assets. This approach ensures that every asset delivered to our clients meets not only technical and regulatory requirements but also the highest commercial and compliance standards, allowing us to provide reliable assets and consistent service to all customers."

Andy wheeler feels that at lease return, the most common issues tend to relate to documentation rather than the physical condition of the landing gear. He further advises that: "Lessors typically expect full back-to-birth traceability, including non incident statements and complete records for all life limited and major components. Although maintaining these records is the operator's responsibility, AEM/AMETEK MRO does occasionally receive requests where documents are missing or incomplete. We assist where possible, but gaps in traceability can become a sticking point in the return process." On the other hand, Raul Cruz-Alvarez points out that: "Our experience has been the documentation, if life limited parts are changed on the line or while undergoing routine maintenance and not properly documented that is high dollar parts will need to be replaced just due to documentation," while to round things off, Stephen Spender sees the answer as being "Back-to-birth issues of installed life-limited parts – it can have a large commercial impact. In general, though, the agreement is clear on the return expectations, and mostly the lessor will enforce the agreement including penalties."

Karolis Jurkevičius, VP Landing Gear & Major Assets, APOC Aviation

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