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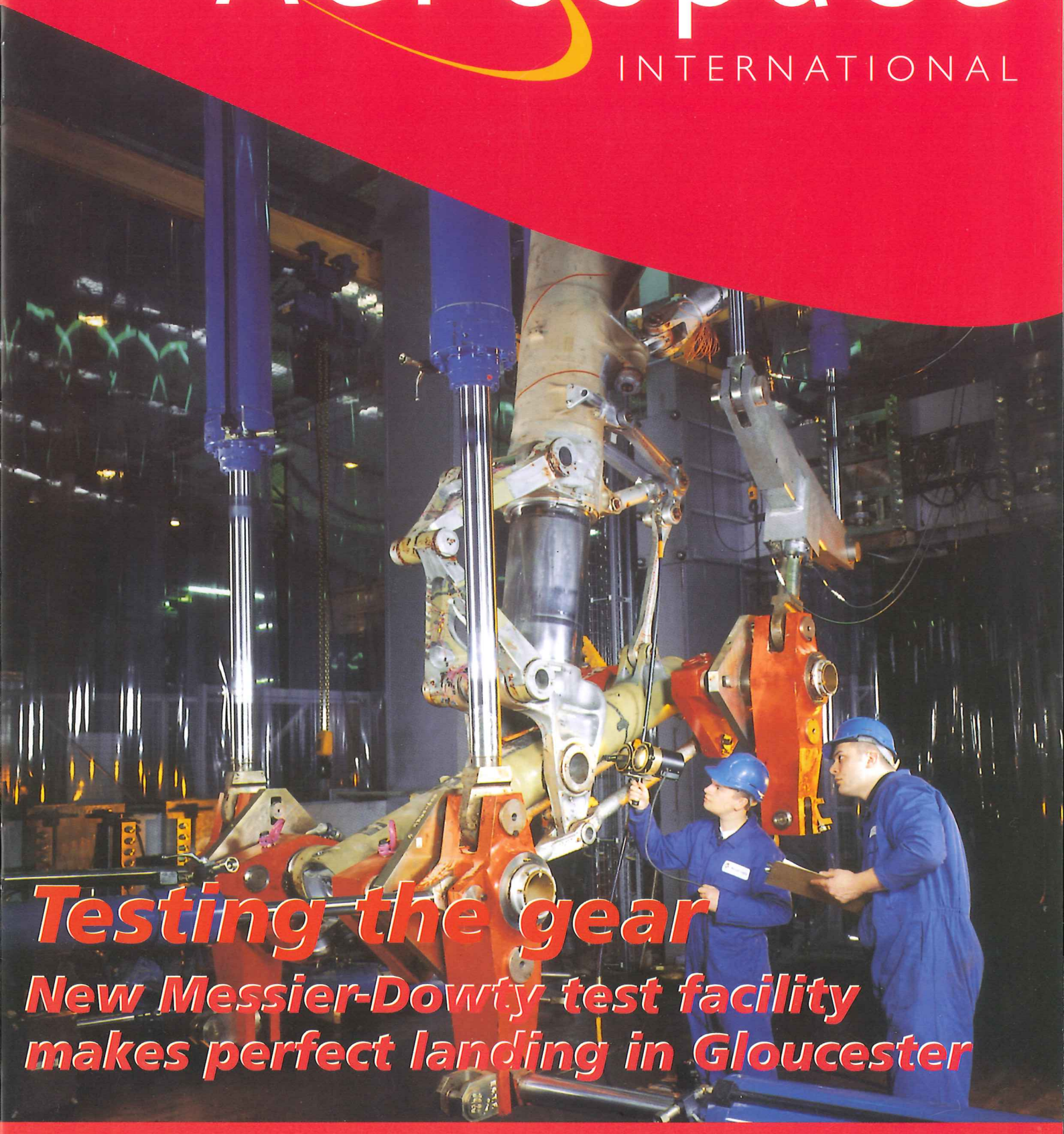
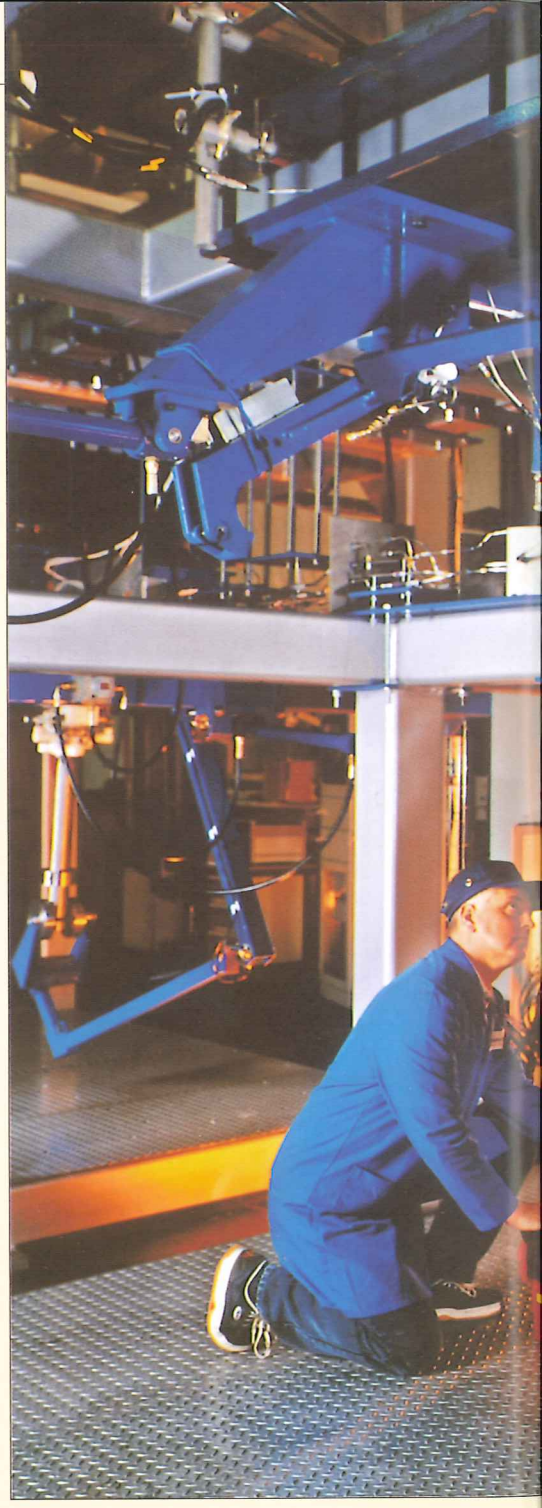


Testing the gear

New Messier-Dowty test facility makes perfect landing in Gloucester

TESTING THE GEAR

Messier-Dowty is opening a major new landing gear test facility at its UK Gloucester plant. **RICHARD GARDNER** reports.



Landing gear, like so much else on a modern airliner, probably never even enters the consciousness of the average airline passenger. For many, the reassuring contact with the runway after a typical commercial flight marks merely the satisfactory conclusion of one phase of a journey and the start of another. Even after a more robust landing, perhaps as a result of strong crosswinds or wind shear, the shock-absorbing quality of an aircraft's landing gear usually causes little more than momentary concern as the aircraft slows down and passengers gather their belongings. For the military pilot, the confirmation of 'three greens' comes as a routine anti-climax after a demanding sortie. For every single flight, however, the reliable operation of the landing gear at take-off and landing is absolutely fundamental to safe operation. It is one of the most vital systems in any aircraft and its design, development, manufacture and maintenance requires extremely demanding high standards at every stage of activity.

Later this month, Snecma Group's Messier-Dowty is opening a greatly expanded test facility at its UK Gloucester plant. This will be the most comprehensive specialist landing gear test facility anywhere in the world, and is part of a long term investment programme intended to monitor and anticipate landing gear performance well ahead of in-service customer use.

Strong heritage

The design and production of aircraft landing gear in Gloucestershire started in the 1930s when George Dowty began building shock-absorbing wheels and, later, fully retractable landing gear for commercial and military aircraft. The coming of WW2 led to a vast expansion in landing gear design and production as Britain's aircraft industry strained to meet the needs of new military requirements for all sizes of aircraft. An essential part of this expansion was the creation of test rigs to speed the development and approval of new landing gear designs and components.

As aircraft increased in size and capability, Dowty expanded its specialist knowledge and skilled workforce to build more complex landing gear that could carry greater payloads from a variety of runway surfaces in a multitude of weather conditions. This expansion and design evolution has been continuous into recent times when, as Messier-Dowty, it joined with French group, Snecma, to become the world's largest landing gear company, with major facilities in Europe, the USA, Canada and Asia.

Today, more than 16,000 aircraft make over 30,000 landings every 24 hours on Messier-Dowty landing gear. With more than 30 airframe customers and 750 commercial and military operators, landings on Messier-Dowty gear take place, on average, every three seconds around the world. Sales during 2001 were worth around Euro 610m. With a workforce of 2,900, on seven sites, the company is now divided into three business units: Airbus, Boeing and Military and Regional and Business. The business units are highly customer focused with close two-way relationships ensuring strong working bonds throughout the lifetime of a programme. Within the commercial aircraft market, the company is the lead supplier of landing gear to Airbus, providing systems for all the current in-service range. Also, it supplies and services landing gear on over

Above: The test rig for the KAI/Lockheed Martin T50 landing gear system. All aspects of the operation of the gear can be replicated at Cheltenham on the test rigs, including retraction and extraction. *Photo: Michael Hall.*

half the world's regional and business aircraft, including Bombardier's Global Express and Continental, and the entire Dassault Falcon family. As well as the landing gear used on the latest Airbus A340-600, Messier-Dowty is developing the new nose gear for the Airbus A380, destined to be the world's largest commercial airliner.

In military aviation, Messier-Dowty landing gear is aboard a huge number of existing aircraft, as well as in production for the new generation of combat types including the Boeing F/A-18E/F, Eurofighter Typhoon, Dassault Mirage and Rafale. Another new programme currently in production is the gear for the BAE Systems Nimrod MRA4.

Further programmes include Korea's T50 Golden Eagle trainer and many rotary wing aircraft including the Boeing V-22 Osprey and Eurocopter Tiger helicopter.

Combined resources

The creation of Messier-Dowty in 1995 brought together two test facilities in Europe, one in France and a larger one at Gloucester, together with another facility at the company's Toronto site. With the growth in Airbus and other programmes a new focus was required in Europe to provide a more capable test centre for future aerospace programmes. The older test buildings at Gloucester had been in use since the 1930s and were in urgent need of expansion and modernisation. John Griffin, test engineering manager, told *Aerospace International* that the major challenge of expanding the test facilities was compounded by the need to maintain concurrent tests throughout any re-build

Below: M-D landing gear fitted to the A340-600.

TESTING THE GEAR

This view, taken in 2001, shows the frame of the new building being erected around the original test department hangar.

programme. Disruption to intensive test programmes had to be avoided at all costs.

The solution was quite ingenious, yet simple in concept. After a five-month detailed preparation phase, a 52-week building programme would begin. The existing test rigs would remain *in situ* within the original test department building while a completely new, and larger, structure would be erected around it. As work progressed, the original inner shell would gradually be removed and additional test rigs and power supplies installed, with other new offices, a clean room, control room and workshops added around the central test rig area. Work started in late April 2001, and will be officially opened this month.

New facility

There is a team of 50 people working at the new Gloucester facility including professional engineers, control engineers and a range of specialist and multi-role technicians. With their high experience levels, the team can tackle any aspect of a development or test programme. The new facility has been purpose-designed to provide the rugged physical tests likely to be required for a new design of landing gear, together with advanced data recording and analysis systems. The results can be examined in detail in the control room, networked elsewhere within the test centre and in the not too distant future, to other Messier-Dowty plants and customers thousands of miles distant.

Within the main test area there are several test rigs catering for different sizes of commercial or military landing gear systems. Each rig is flush-mounted to ease access and maintenance and sits within a massive steel frame which contains all the power and hydraulic supplies as well as actuators which replicate the actual forces acting upon the landing gear under test. The hydraulic and electrical supplies are contained in underground ducts which have easy access but are safely removed from working areas. Screens and safety cages protect personnel when tests are underway and have been designed to contain any surplus energy and materials that might break free in the unlikely event of a pipe or component failing during a load test. The forces present during such tests can be considerable. In strength and fatigue tests, the landing gear is subjected to loads that are well in excess of what is likely to be experienced in real aircraft service. Loads that approximate to a fully loaded A340, for example, can be applied in pre-determined sequences to represent extended periods of operational use.

The test cycles are designed to examine how well the gear stands up to the strains of regular use at landing, take off, retraction, extension and taxiing. Sideways forces replicate pressure on main wheel bogies as aircraft turn during ground operations. Sometimes these side forces can be very considerable. The test rig actuators apply appropriate force at the axle points and other key structural locations, producing the conditions needed for strain gauges to monitor the effect within the landing gear components and main structure. Other hydraulic devices produce strong vertical forces to compress the gear.

The largest rig weighs 250 tonnes, is 10m in height and has a 30m² template with a loading capability of 1,000 tonnes force. The landing gear under test is suspended from the upper bedplate on dedicated fixtures that simulate aircraft attachment points. A huge new overhead crane has been installed to aid the movement of landing gear within the facility.

A large test programme may see, typically, a landing gear test last some two years, completing 60,000 landings, with up to 100 different actions being monitored.

Systems test rig

Experience gained from the design and operation of systems rigs at the Toronto facility has been used to help create a new systems test facility at Gloucester. Though not quite becoming an 'iron bird' simulator, the rigs can be linked together, as is currently underway testing the landing gear for the new KAI/Lockheed Martin T50 advanced trainer, so that simulated door movements can be tested alongside fully operating landing gear. As many completed landign gear components as possible can now be tested together. All the associated electrical cables and hydraulic piping can be installed in a representative configuration, and changes made when found to be necessary.

This is proving to be a highly valuable and cost effective development tool and

Photo: Michael Hall.

already design improvements have emerged as a result of careful testing and examination of how the gear will work in service. Discovering such changes at this stage of development, ahead of flight testing of the prototype, can save much time and money, and help to reduce overall development costs for a programme.

Photo-elastic testing

Landing gear structure destined for testing can have a photo-elastic coating applied which is actually moulded on to the part. After it is mounted into a rig, and a load is applied (typically 30% of maxiumum load), the changes to the material can be recorded using a special photo-elastic lamp. Through polarization, the colour pattern changes, indicating where stresses are concentrated. Results can be compared to other models and this can be supplemented by up to 600 strain gauges mounted on a typical landing gear test model.

Seal testing

In a seals cell a series of loads can be applied to replicate the forces acting on the shock absorbing seals and associated components. The company works closely with suppliers to test seals under all conditions, including ultra high and ultra low temperatures. Different compounds used in the manufacture of seals can be tested and evaluated and development work has included looking at how future seals can perform 20,000 landings between changes. These tests are conducted in close co-operation with the aircraft manufacturers and airlines and also involve other R&D agencies, such as France's CEAT.

Control room

On the first floor of the facility are located the design offices and a central control room which is linked by fibre optic cable to the rigs. The test data is fed back via the ethernet to this computer-filled room where it can be distributed to a number of monitors, or networked to other locations, including customers' engineering departments. Direct data acquisition enables fatigue test information to be made available immediately and advanced data filter software through the Fokker Control System produces an excellent tool for analysis. The customer can tap into test programme progress at any stage.

This facility is now closely integrated within Messier-Dowty's international organisation and, as a consequence, there is a high degree of synergy between the different business units. Real-time data links enable CAD information, for example, to flow freely where required from design office to development or production site. The destination is immaterial. It can be across an ocean or in the next building. Experience and capability can be matched precisely to ensure that, regardless of the nature of the problem, the solution can be sought from the most appropriate centre of excellence within the group.

Risk reduction

The business of developing new landing gear systems is getting more sophisticated all the time but, with advances in data acquisition technology and CAD innovation, the total timespan required to complete development programmes is steadily reducing. These new methodologies also bring great risk reduction benefits.

There are many more aspects to testing gear than might at first be imagined. Apart from the testing of complete landing gear systems, which includes energy absorption, static strength, stiffness, fatigue and frequency response and structural damping tests, there are more specialised tests. These include retraction/lowering and freefall tests, environmental (including lightning) tests, crashworthiness and tests of associated equipment, such as the unlock and retraction actuators, bogie pitch trimmers and electrical harnesses. Yet more element tests include those applicable to gland seals, shortening mechanisms, retraction brackets, shock absorbing static pistons and sidestays. Vulnerability to wheel damage and tyre bursts and the examination of the bonding between various joints are also covered.

According to John Roberts, vp Airbus and Military Engineering at Messier-Dowty, Gloucester, a key requirement in any test programme is the ability to have the capacity to carry out the programme as thoroughly as possible but, at the same time, incorporating measures to carry out the task with minimum delay. Messier-Dowty's customers include all the major aircraft manufacturers and airlines, and most of the world's air forces. To meet the highly demanding needs of these organisations, the information available on the performance of its landing gear must stay ahead of any in-service use. In this context, as John Roberts points out, the tests continue as long as the aircraft are likely to remain in service. Even where aircraft types go out of production there is often a potential 30-year lifespan remaining for which full service support is going to be needed.

Having the right test equipment is a key component in the challenge to remain a long-term global player. Only the largest companies can afford to invest in development facilities on this scale, yet to retain a competitive edge it is essential. The new Messier-Dowty test facility at Gloucester is an impressive symbol of a confident future. Another significant symbol is the company's decision to pursue an innovative research and development initiative dubbed 'the quiet landing gear programme'. As roughly one third of a large civil aircraft's approach noise is generated by the wind resistance on the landing gear, this promises to offer significant noise reduction benefits in future years.

New applications as well as retrofit options are currently being studied. This includes the adoption of ovoid tube components and lightweight shields. Much more testing and evaluation has to be undertaken before the practicalities can be agreed. The environmental gains and economics resulting from the adoption of such changes will have to be balanced and ultimately the customers will have to decide what they wish to do. One thing is certain, the new UK test facilities will help to maintain Messier-Dowty as a world class landing gear innovator and supplier for the foreseeable future. ◆


AIR FRA


GROUPE
AIR FRANCE

Who else could land 30,000 tons in Gloucestershire without disturbing the local residents?

Only the world's leading landing gear company can take such a weighty task in its stride.

Messier-Dowty is a truly global organisation, with bases in Europe, North America and Asia.

At the same time, we are a major investor in the UK aerospace industry.

Hence our latest enterprise: a state-of-the-art test centre for landing gear, built at our base near Gloucester. Our extensive range of test cells is capable of handling landing gear for all types and sizes of aircraft, from Eurofighter to Airbus.

The new facility represents an important investment for the Snecma Group, and reinforces our commitment to UK aerospace.

As for the neighbours, they'll barely know we're there.

Messier-Dowty
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