Testing for take-off.
IABG Aeronautics

Testing for take-off.

Airbus A350 XWB: EF 2 and EW structural tests
Aeronautics

As a strategic partner of the international aeronautics industry, IABG performs strength, fatigue and functional tests for the entire aircraft as well as for individual assemblies and structural components. During our test series, the test items must withstand several thousands of flights before they are finally released for regular flight operations. This is the case for passenger jets as well as for general aviation and military aircraft.

Our services have been called upon for all Airbus programmes, from the very first Airbus project to the present day. We also carried out a comprehensive series of tests for the Airbus A380 wide-body aircraft – to date the largest full-scale fatigue test on an airframe in the history of our company. In recent projects we fatigue tested the entire airframe of the military transporter A400M and carried out life span extension tests with the A320. The structural fatigue tests for the Airbus A350 and the Bombardier C-Series are currently in process.

Such trust is warranted by highest quality standards, unique know-how, innovative test technology, speed, flexibility and commitment to schedules. These are the strengths that have made us Europe’s leading provider of aerospace testing and quality assurance services.

While our main focus is on structural testing, we offer a wide variety of testing services for aeronautics customers.

Our aeronautics service portfolio includes:

- Experimental testing (structural tests, functional tests, product qualification, flight tests)
- Development of functional and system test benches
- Structural monitoring, inspection and analysis
- Functional Safety and Operational Safety
- Provision of the test infrastructure

Tests are carried out at our locations in Ottobrunn, Dresden and Erding in test halls encompassing an area of more than 18,000 m², including a modern infrastructure and central supply of hydraulic fluid, compressed air and cooling water as well as a specific controller technology enabling a new magnitude of test speed.
Comprehensive experimental testing service from material sample to full-scale airframe tests
Experimental testing

Structural tests

Structural tests are indispensable for the development and certification of aircraft to guarantee efficient and safe in-service operation. Our services cover all levels of the test pyramid. We test and analyse entire aircraft structures and subsystems as well as individual components, parts and material samples, in particular their fatigue and strength characteristics.

Test items range from all categories of civilian aircraft to military fighter jets. Besides experimental testing facilities and computer simulations, we offer our customers a unique combination of experiment and analysis – a service we have been offering for more than 50 years.

- Fatigue tests
  - Fatigue tests on complete airframes, subsystems and components
  - Investigations into damage tolerance characteristics, crack initiation and propagation
- Static load tests
  - Static load tests of complete airframes, subsystems, components and parts, including effects of thermal constraints
  - Determination of deformations, stiffness, fracture strength and fracture behaviour
- Residual strength tests
- Other structural tests regarding
  - Aging characteristics
  - Corrosion
  - Wear
Experimental testing | Functional tests

Functional test on landing gear
Experimental testing

Functional tests

Impact tests
We have various impact test facilities that support a multitude of applications with customer-specific projectiles.

Our services include:
- Impact tests / bird strike tests in accordance with international standards or customer requirements
- Hail impact tests with projectiles of different calibres
- Impact tests in accordance with FAA, EASA, ASTM, UIC 651 etc.
- Projectile velocities of up to approx. 450 m/s
- Various test projectiles (metal, stone, gelatine, ice, blades, electric components etc.)
- Virtually no limitations for the test component size

Landing gear tests
Our test facilities have all the equipment needed to meet the qualification requirements for landing gear.

Our services include:
- Static tests
- Calibration tests
- Fatigue tests
- Drop tests for development and qualification purposes on measurement table or rotating drum
- Brake and tyre burst tests
Aircraft engine in EMC chamber

Experimental testing • Product qualification • Flight tests
Experimental testing

Product qualification

The high standards that technical products are held to regarding reliability, robustness, durability and compliance with statutory provisions require sophisticated test procedures. Not only is it necessary to confirm the functionality of these aircraft, but it is also essential to evaluate the behaviour of a product while subjected to environmental influences during the real product life cycle. Our teams of experienced experts and our powerful, modern facilities can perform any environmental test for a wide range of applications.

All tests comply with national and international testing standards, e.g. MIL-STD 810, RTCA/DO-160:
- Temperature, Humidity, Splash, Waterproofness
- Altitude
- Sand & Dust
- Icing
- Pressure changes
- Vibration
- Windmilling
- Shock
- Acoustic Noise
- EMC

Flight tests

For many years, our test and engineering departments have collaborated closely with customers to ensure that all of their specific flight test requirements are met:
- Test and campaign support at IABG test sites in Oberpfaffenhofen and Granada – and worldwide
- Assistance with test planning and execution, data evaluation and reporting for development and certification (of civilian and military aircraft) provided by flight test engineers
- Definition and manufacture of flight test measuring systems and avionics databus interfaces
- Encoder selection and instrumentation incl. related planning tasks, telemetry, experimental radio, data processing and data display on board and on the ground
- Specialised hardware, e.g. for icing, flutter tests, aircraft performance and Pitot-static
- Software for test management, test planning and requirement tracking
Development of functional and system test benches

Fieldbus-based measuring data acquisition during airframe fatigue test
Development of functional and system test benches

IABG designs and implements highly complex functional and development test benches for aircraft systems, tailored to customers’ specifications. Customers benefit from our comprehensive experience with mechanical, hydraulic, pneumatic and electric/electronic subsystems as well as our know-how on real-time simulation and control unit tests. We take care of the technical implementation of the test benches as well as their integration into the customer’s testing environment. Our core competencies include the utility management, technical planning and general contracting services required for setting up test facilities and centres.

Our service portfolio

- **Feasibility studies**
  The launch of a complex test bench is generally preceded by a model-based feasibility study. We analyse the task, develop and evaluate different solutions and accompany their implementation if requested. As part of the feasibility study, we offer consulting and/or take care of drafting specifications, scope of work and invitations to tender.

- **Planning and configuration**
  We draft the detailed configuration as well as the entire manufacturing and assembly documentation for a test bench.

- **Consultation and analysis**
  Our team analyses existing testing environments, identifies potential areas for optimisation and plans respective modification and modernisation measures.

- **Construction supervision, project management**
  Our experts manage the installation, implementation and acceptance of your test bench on site.

- **Test bench modernisation**
  We bring your test benches up to the latest state of the art, using standard products as well as our own powerful control and automation systems.

- **Test bench implementation**
  As your general contractor, we assume responsibility for the implementation of the test bench and set it up on site, ready for you to use.

- **Metrological services**
  Benefit from IABG’s many years of experience and knowledge in metrology and associated fields. Our expertise enables us to understand your challenges and meet the requirements of any given task. A comprehensive palette of sensors and measuring data acquisition systems permit us to react quickly and flexibly to all sorts of measuring requirements. Our services include sensor application (force, torque, pressure, temperature, displacement, acceleration, strains etc.), flight test instrumentation, optical deformation and strain measurement, photogrammetry, measuring data evaluation and calibration.
Structural monitoring to optimise the projectable maintenance

Through-life monitoring and continuous observation of the loads and strains on aircraft ensure a higher level of safety, reliability and enhance availability. Comparing real-life strains with verification qualification results provides valuable input on the determination of an aircraft’s service life consumption. We have many years of experience in structural monitoring to optimise condition-oriented maintenance.

Structural health monitoring (SHM)

Efficient and permanent monitoring of structural integrity:
- Strain data acquisition using sensor technology
- Flight parameter acquisition via the Onboard-Life-Monitoring-System (OLMOS)
- Correlation of measured structural loads with flight parameters
- Software-driven determination of service life consumption using in-service and test load spectra

Fatigue management

Database-driven control of service life-relevant material sustainment measures (LEDA)
- Weakness identification and analysis
- Leveraging of know-how gained from comprehensive measurement programmes to individual aircraft (operational load measurement)
- Use of modern technologies for the in-flight acquisition of flight and structural load parameters (flight load measurement)
- Comparison of operation and qualification strains

Creation and realisation of concepts for the inspection as well as repairs/modifications
- Analytical condition inspection and usage-dependent measures
- Special inspections
- Teardown inspections
Structural inspection

Ensuring the structural integrity of an aircraft requires specific structural analyses and adapted structural inspections (visual, NDT). IABG provides expert advice concerning suitable measures for sustaining structural integrity and provide qualified technical personnel to perform structural inspections.

Structural inspections

- Non-destructive tests (NDT) with state-of-the-art equipment (UT, PAUT, ET, PT, MT – Levels 2 and 3 – as well as visual inspection incl. video endoscopy)
- Destructive inspections (e.g. teardown inspections)
- Use of dedicated inspection procedures for composite materials such as CFRP, GLARE, etc.
- Application of optical systems to establish a geometrical database (ARAMIS, PONTOS) and to detect plastic deformations, buckling etc.
- Preparation of inspection programmes and instructions

Damage documentation

- Development and use of a location-independent damage documentation platform (DamDoc)
- Definition and implementation of customer-specific interfaces (VNC)
- Interaction with software-based customer platforms for structural inspection programmes

Structural analysis

Structural components can be analysed in our own materials testing laboratory (accredited in compliance with DIN EN ISO 17025). We conduct the tests in combination with structural strength calculations and damage analyses.

Material investigations

- Determination of material properties
- Material qualification
- Further development of test methods and repair procedures
- Characterisation of composite materials

Strength tests, calculations, method development

- Identification of static, cyclic and fracture-mechanical properties in sample tests, including effects of thermal constraints
- Establishment and parameterisation of material models
- Evaluation of operational loads
- Calculation of local strains and damage distribution
- Optimisation of components with respect to fatigue strength
- Development and optimisation of calculation and verification methods
- Fatigue strength verification

Certification advice

Our experienced employees provide the following support in connection with the certification of new aircraft:

- Consulting, certification-related technical evaluation and analysis of airframe, propulsion system, aircraft performance, avionics, software safety and IT security
- Consulting and assistance with project planning, test management, certification methodology and procedures
- Technical and scientific advice on structural issues in connection with the development and operation of aircraft
- Evaluation of structural issues in connection with the certification and qualification of aircraft
- EASA-qualified entity (EASA.2012.DE.01EiABG.01)
## Functional Safety and Operational Safety

### Safety process consulting
IABG applies its competence regarding standards and processes to the analysis, tailoring and optimisation of your development lifecycle to ensure that your safety processes conform to the current state-of-the-art. IABG combines cross-industry experience from many projects with cost-efficient approaches, such as the V-Model (developed in cooperation with IABG), Agile Development, CMMI, Automotive SPICE and Lean Management. We guide you from the concept development through to certification, start of production and beyond. We provide matured and methodical approaches, such as our Safety Process Check, which identifies necessary remedial actions under consideration of both technical aspects and human factors. We give particular consideration in the application of our approaches to their cost-effectiveness.

### Audits to maintain compliance with industry standards
IABG has many years of experience regarding the Audit and Assessment of processes, products and compliance with standards. We accompany you throughout the development process, in order to prepare you efficiently, timely and successfully for an audit or assessment according to the relevant safety standards, including ARP4761, ARP4754, RTCA/DO-254 and RTCA/DO-178.

### Verification and validation of safety-critical hardware and software
We provide specific aviation-expertise for the verification and validation of safety-critical hardware and software in accordance with RTCA/DO-254 and RTCA/DO-178B/C. In addition, we support tool qualification according to RTCA/DO-330.

### Safety engineering and outsourcing partner
We provide safety engineering and outsourcing services throughout the entire product lifecycle, for example, performing a Hazard Analysis and Risk Assessment. Our customers benefit from our competence in applying methods and tools to increase the efficiency of safety-relevant projects.

### IABG

| Safety Academy | Audits and Assessments | Process Consulting | Safety Engineering & Outsourcing Partner |

### CUSTOMER

| Conception & Planning | Development | Review & Qualification | Production | Supply & Operation | Decommissioning |
Provision of the test infrastructure  Our test halls and test sites
Provision of the test infrastructure

Our test halls and test sites

Tests are carried out at our locations in Ottobrunn, Dresden and Erding in test halls encompassing an area of more than 18,000 m², including a modern infrastructure and central supply of hydraulic fluid, compressed air and cooling water.

The test halls also provide equipment for simulating environment-related properties, e.g. temperature, climate, dust and corrosion, as well as for conducting fatigue strength tests. Material tests as well as failure and damage analyses are handled by the materials testing laboratory.

Test hall in Ottobrunn
- Area: 5,600 m²
- Height: 15 m
- Lift capacity: ≤ 20 t

Test hall #1 in Dresden
- Area: 5,000 m²
- Height: 26 m
- Lift capacity: ≤ 2 x 20 t

Test hall #2 in Dresden
- Area: 1,800 m²
- Height: 17 m
- Lift capacity: ≤ 20 t

Test hall in Erding
- Area: 5,000 m²
- Height: 25 m
- Lift capacity: ≤ 30 t

Hydraulic fluid supply

Hydraulic fluid supply: Stationary systems
- Ottobrunn 3,741 l/min at 280 bar (4,060 psi)
- Dresden 1 6,000 l/min at 280 bar (4,060 psi)
- Dresden 2 2,100 l/min at 280 bar (4,060 psi)

Hydraulic fluid supply: Mobile systems
- 2,100 l/min at 280 bar (4,060 psi)

Compressed air supply
- Ottobrunn 40 m³/min at 7.5 bar (mobile)
- Dresden 1 270 m³/min at 7.5 bar
- Dresden 2 100 m³/min at 3.5 bar
- Mobile 120 m³/min at 7.5 bar

Test equipment
- Control and monitoring systems: More than 700 channels
- Measuring data acquisition systems: Approx. 15,000 channels
- Sensor technology: Load sensors, pressure sensors, travel sensors etc.

Hydraulic actuators
- Number of actuators available: > 900
- Nominal load: 10 – 10,000 kN
- Stroke: 100 – 7,000 mm

All test halls are fully equipped with anchor rails for bearing loads and anchoring test frames.
Provision of the test infrastructure

Mobile test infrastructure • Functional test benches

Component test using modular test system
Provision of the test infrastructure

Mobile test infrastructure

Due to a rising demand for non-stationary and scalable test facilities, we have designed and realised an innovative, mobile and modular infrastructure for our aeronautics customers which has already been successfully implemented at our location in Erding.

The infrastructure consists of modules for electric power, hydraulic fluid and pneumatic supply as well as cooling and heat recovery. The load bearing strong floor and the lightweight hall construction are also modular, scalable and easy to transport.

Functional test benches

Modular test system: Service portfolio

The modular test system is especially ideal for structural and functional tests on aerospace components. The modular architecture ensures fast and cost-effective test set-up and preparation.

- Simultaneous installation of several single tests on the fixing plate
- Individual and fast integration of test components
- Independent execution of tests using fixed control units with 2 x 20 and 2 x 4 free control channels
- State-of-the-art measuring system with optional online monitoring of selected measurement channels

Large drop facility: Service portfolio

- Drop and landing tests
- Roll tests, fatigue tests, slide tests, brake tests, tyre burst tests
- Driving over baffle plates and bumps

Test bench: Technical specifications

- Drum
  - Maximum circumferential velocity: 400 km/h
  - Drum diameter: 4.0 m
  - Drum width: 1.5 m
  - Drum driver power: 130 kW (4Q drive / drive and brake)
- Drum surface: Blank steel or friction surface
- Maximum drum load:
  - Vertical: 560 kN
  - Axial: 200 kN
  - Tangential: 400 kN
- Mass moment of inertia for drum: 29,500 kgm²
- Drop mass: 14,000 kg maximum
- Drop height: 8 m maximum
- Fall velocity:
  - with counterweight: 7 m/s maximum
  - without counterweight: 11 m/s maximum
Selected references

Structural tests for airframes
- Entire Airbus family (A300 to most recent Airbus A350 XWB)
- Bombardier (C-Series)
- Commuter aircraft (PC-12)
- General aviation aircraft (Extra 400, Grob G180)
- Trainer aircraft (Pilatus PC-21)
- Military aircraft (Airbus A400M, Tornado, F104G Starfighter, Eurofighter Typhoon, Swiss F/A-18 at RUAG)

Structural tests for components
- Airbus A380: Engine pylon attachment, spoiler, vertical tail plane component and windmilling tests
- Pilatus PC-21, AW 189, C-Series: Airframe tests (static, fatigue, drop tests)
- Tornado: Main landing gear door
- Airbus A400M: Barrier net
- Various engine components
- Impact testing for leading aircraft manufacturers and suppliers

Functional and system test benches
Load application systems for primary and secondary flight control systems
- Test benches for testing entire high-lift systems
- Functional test benches for landing gear

Structural analysis
- NDT inspections under test and in-service conditions (Airbus family, Tornado)
- Damage documentation (DamDoc) for airframe fatigue test
- (Airbus A400M, Airbus A320, Airbus A380, Airbus A340-600)
- Structural damage analysis on in-service aircraft (e.g. Tornado)
- Technical/scientific advice on structural issues during the development and operation of aircraft (e.g. Eurofighter Typhoon)

Structural monitoring
Through-life monitoring of PA200 Tornado, C-160 Transall, Eurofighter Typhoon, AlphaJet, F-4F Phantom, BR-1150 Breguet Atlantic, Mig 29

Flight tests
- Saab Gripen: Hot-and-high test, Saab 2000: Test in Granada
- RUAG Dornier 228NG: Measuring system, telemetry
- CH53 G: New autopilot amplifier (measuring system, data evaluation, reporting)
- NH90: Whole-body vibration exposure tests (measuring system, instrumentation, data evaluation)
- Airbus S.A.S. A320 airborne icing tanker: Consulting, feasibility study
- Airbus A400M: Supplemental verification for national certification and qualification