Eurofighter final assembly in Manching

TYPHOON FACTORY

Text and photos: Alexis von Croy

Final assembly of the production series Eurofighter is in full swing at the four European plants in Getafe, Turin, Warton and Manching. Planet AeroSpace visited the assembly line for the European high-performance fighter in Manching, Germany.

FROM TAKEOFF to 35,000 feet and Mach 1.5 in less than two and a half minutes. From 200 knots to supersonic speed in only 30 seconds. A payload of up to 7.5 metric tons – with full tanks – and an operational runway length as short as 300 metres: the sensational flight capabilities of the Eurofighter Typhoon are beyond anything an amateur pilot can even begin to imagine. After a Eurofighter test flight, or so rumour at the assembly plant would have it, air traffic controllers following the almost vertical climb on their radar screens have been known to ask which rocket launch they had just witnessed. With its relatively low weight, powerful engines and sophisticated flight controls, the Eurofighter delivers superior performance across its entire flight envelope. It is still extremely agile even at supersonic speeds – unlike the American F-16, for one.

A Typhoon pilot lacks nothing that modern technology can provide. Operation by direct voice input (DVI), 'carefree handling' (a system for automatic observation of structural and aerodynamic limits) including a 're-orientation button' (automatic return-to-level flight from any conceivable attitude if the pilot becomes disoriented), a very advanced autopilot incorporating a 'flight director' and 'autothrottle' that allows Airbus-style fully automatic approaches in all weather conditions, and the electronic defensive aids subsystem (DASS) are but a few of the many highlights of a near-overflow technology package that can easily stand comparison with the latest US products – as even a former US Air Force chief readily admits. The Eurofighter was designed from the outset for interoperability, and its multi-information distribution system (MIDS) gives it network enhanced capabilities (NEC).

The Typhoon's landing flaps and slats extend automatically at the right time, and even trimming requires no effort on the part of the pilot. The only remaining manual operation is to extend the landing-gear for touchdown. The aircraft has an advanced digital fly-by-wire (FBW) flight control system comprising control units in a quad-redundant configuration, and the entire avionics system is networked via digital or optical databuses. The flight controls are configured according to the 'HOTAS' (Hands on Throttle and Stick) principle, with 12 control elements on the control stick and another 12 on the thrust lever. Inertial navigation by laser gyro, satellite and radio navigation, the ground proximity warning system (GPWRS), a radar altimeter and the sophisticated CAPTOR airborne radar, which can identify and pursue multiple targets simultaneously, are all standard equipment. Further highlights include three multifunction colour displays (MFCD) (six in the two-seater version), an advanced head-up display (HUD), and a pilot's helmet with a helmet-mounted sight (HMS) that projects key flight information onto the visor via two high resolution CRTs. Taken in conjunction with the ingenious networking of onboard sensors ('sensor fusion'), all these features help to reduce the pilot's workload and provide him with an up-to-the-minute overview of the situation at all times. The aircraft can also be equipped with a forward-looking infrared (FLIR) sensor (except for the German air force).

Over 70 percent of the aircraft shell is made of carbon-fibre-reinforced composite materials (CFC), which account for large sections of the fuselage and skin and of the delta wing's ribs, frames and skin. The remainder of the aircraft is made of aluminium, titanium and plastics. CFC accounts for 55 percent of the total weight. The two canards, for instance, are made primarily of titanium. The Eurofighter's lightweight construction gives it an impressive advantage over many of its competitors and is the prime reason for its large payload capacity and outstanding performance.

Capable of in-flight switching from fighter to fighter-bomber, this European combat aircraft sets new standards in terms of weaponry too: it has a 27mm cannon that weighs only 100kg with a maximum firing rate of 1700 rounds per minute , and 13 external stations, housing precision-controlled guided missiles with a variety of sensors, as well as extra fuel tanks. The Typhoon can carry a total payload of 7500 kilograms on these stations. The pilot 'manages' the weapons with the aid of the armament control system (ACS), which ensures the correct choice of weapon for the target identified. It is supported in this task by the attack and identification system (AIS).

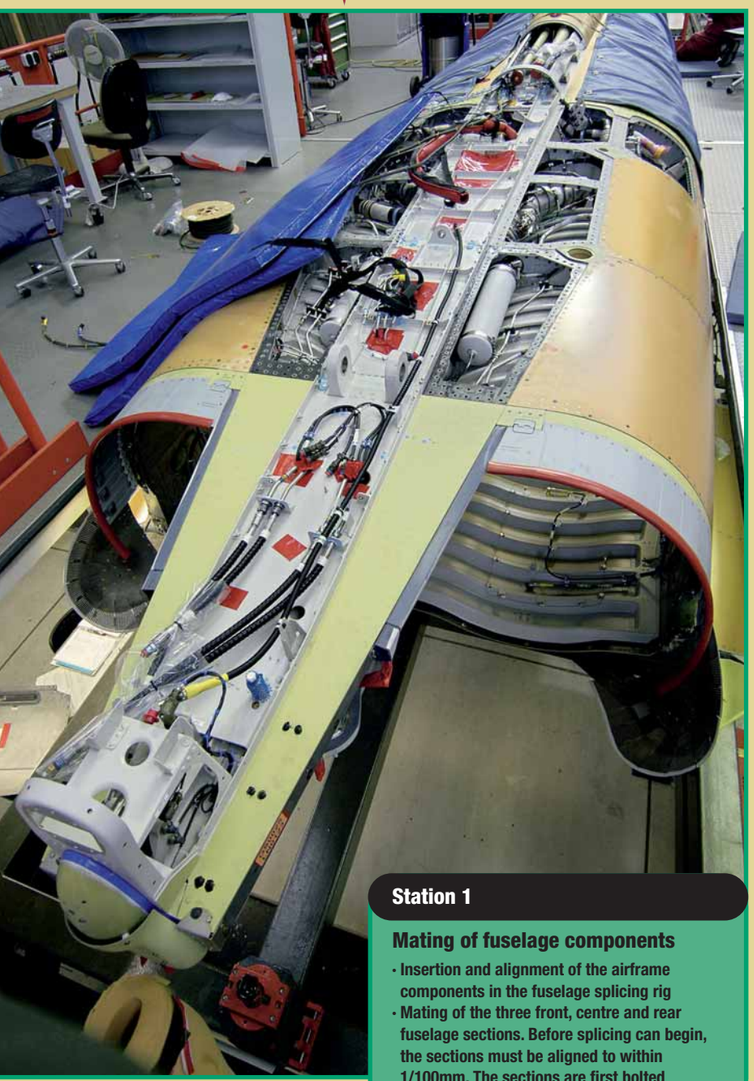
Pilot safety is also a prime consideration. The Martin-Baker zero-zero ejection seat can save the pilot and co-pilot's lives – whether on the ground or at an altitude of 15 km – at speeds of up to nearly 1200 km per hour.

SCARCELY less impressive than the aircraft itself is the production of the high-tech fighter at the four European sites, and the logistics this involves.

As orders stand at present, a total of 638 Eurofighters in three tranches will be rolled out of the Alenia, BAE Systems and EADS assembly plants. Up to January 2006, 74 machines (including five instrumented production aircraft) had been delivered to the British, German, Spanish and Italian air forces. Including the seven prototypes and two airframes for static load tests, a total of 83 aircraft have been built so far. Although only 12 years have elapsed since the first DA 1 (Development Aircraft 1) prototype made its

Preparatory Station

- Delivery of the main assemblies, already fitted out and tested by the four partner companies
- The transport equipment is dismantled and the components are prepared for fuselage splicing.

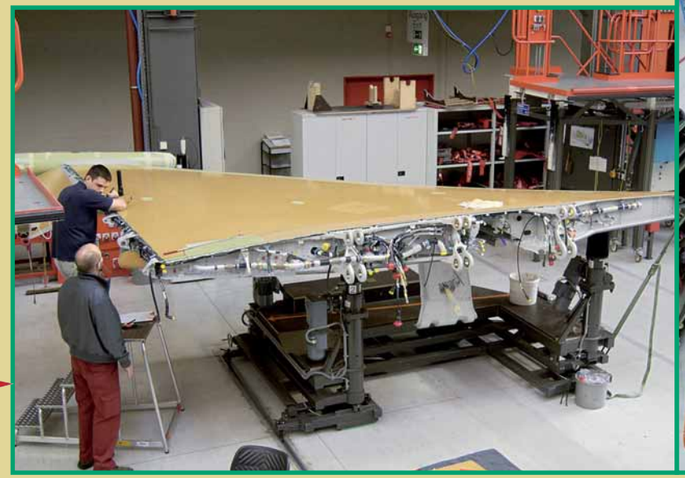


In the foreground: the tail fin mountings and the hydraulic pipes below them.

Station 1

Mating of fuselage components

- Insertion and alignment of the airframe components in the fuselage splicing rig
- Mating of the three front, centre and rear fuselage sections. Before splicing can begin, the sections must be aligned to within 1/100mm. The sections are first bolted together, then joined smoothly using about 800 fasteners (metal parts and special rivets).



The port wing, built by Alenia in Italy. The starboard wing is supplied by EADS CASA of Spain.

Station 2 from above: The wings and landing gear have been attached. You can see the voluminous airbrake, which is manufactured by BAE Systems along with the dorsal spine.

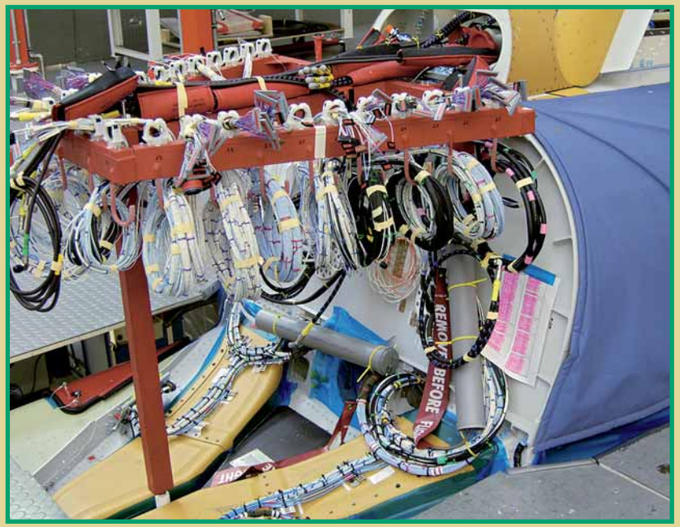
maiden flight in Manching in 1994, the Eurofighter can meanwhile boast of an order-book which outstrips that of any comparable aircraft programme anywhere in the world. Two single-seat Eurofighters now protect Italian airspace. Based at Grosseto in Tuscany since December, they are at all times ready to scramble.

After Steinhoff fighter squadron JG 73 in Laage near Rostock, JG 74 at Neuburg on the Danube will be the second German air force unit to switch to the Eurofighter. The JG 74 pilots began retraining at JG 73 in January. Pilots in Coningsby and Morón de la Frontera have also been retrained. Between them, the four Eurofighter units had logged nearly 6000 flight hours by the end of 2005. Adding to this the more than 4000 hours of test flights performed means that the Eurofighter has already spent over 10,000 hours in the air.

Station 2

Attachment of main components and integration of all systems

- Attachment of wings, fins, slats, canards and main landing gear
- Installation of actuators for flaperons, rudder and canards
- Integration of all systems: electrical system, hydraulic system, fuel system, environmental control system (ECS) and secondary power supply system (SPS)



The centre fuselage sections delivered from Augsburg are outfitted on a dedicated assembly line also located in Manching. The auxiliary frame (orange) holds the cables that will later be laid through the front fuselage and the cockpit.

September saw delivery of the first Eurofighters built to the enhanced standard 'Block 2B', and international type acceptance for the new version was secured on schedule in December. Among the key components of 'Block 2B' is an update to the flight control software, which not only makes the aircraft considerably more agile but also significantly reduces the pilots' workload in operations such as in-flight refuelling. Four 'Block 2B' aircraft had been delivered by the end of 2005.

The Eurofighter is unique not only in terms of its technology but also in the sophisticated logistics that enables such a complex system to be manufactured concurrently at four separate European plants. Some 150,000 people, working for more than 400 high-tech companies all over Europe, are involved in this new-generation combat aircraft programme, currently the most extensive in the world.

The further the programme advances and the more positive the experience of the armed forces with the Eurofighter system, the greater are the prospects of exporting the aircraft. Austria has already ordered 18 machines, Greece has announced its intention to purchase the European fighter, and Norway has signed a co-operation agreement with the Eurofighter consortium for advanced development of the aircraft. Saudi Arabia, too, plans to replace its Tornado ADVs and other aircraft with the Eurofighter. Other countries such as Turkey have also shown interest.

To build the Eurofighter, the primary contractors (EADS, Alenia and BAE Systems) have invested heavily in state-of-the-art infrastructure and production facilities at their plants in Manching, Getafe, Turin and Warton. The same can be said of the associated multinational consortia, Eurojet Turbo GmbH (responsible for development and production of the EJ200 engine) and Euroradar (which produces the CAPTOR airborne radar).

Planet AeroSpace visited the Eurofighter production line in Manching, as being representative of the other plants. Technicians here assemble Germany's Eurofighters and put them through their paces after final assembly. The technical maturity of the production version is steadily increasing under the watchful eye of the Bundeswehr inspection department.

Production of the Eurofighter is unique in that final assembly plants exist in all four member countries. Although this may at first sight appear to increase production costs, in practice it gives the partners the flexibility to organise construction of the aircraft in accordance with their own national requirements. What all four countries share is the 'just-in-time' approach, meaning that only parts immediately needed for production are kept in stock. In addition, they all implement highly developed 'lean production' procedures that significantly reduce the time taken to build the aircraft and help save production costs. All 148 aircraft in the first tranche are either under construction or have already been delivered. Production of the second batch is now under way.

Find what you always wanted to know about the final assembly process in our step-by-step description on the following pages.

Station 3

Automatic wiring test

- Computerised automatic test of all aircraft wiring for electrical continuity, electrical strength and insulation.
- Inspection of high-frequency cables

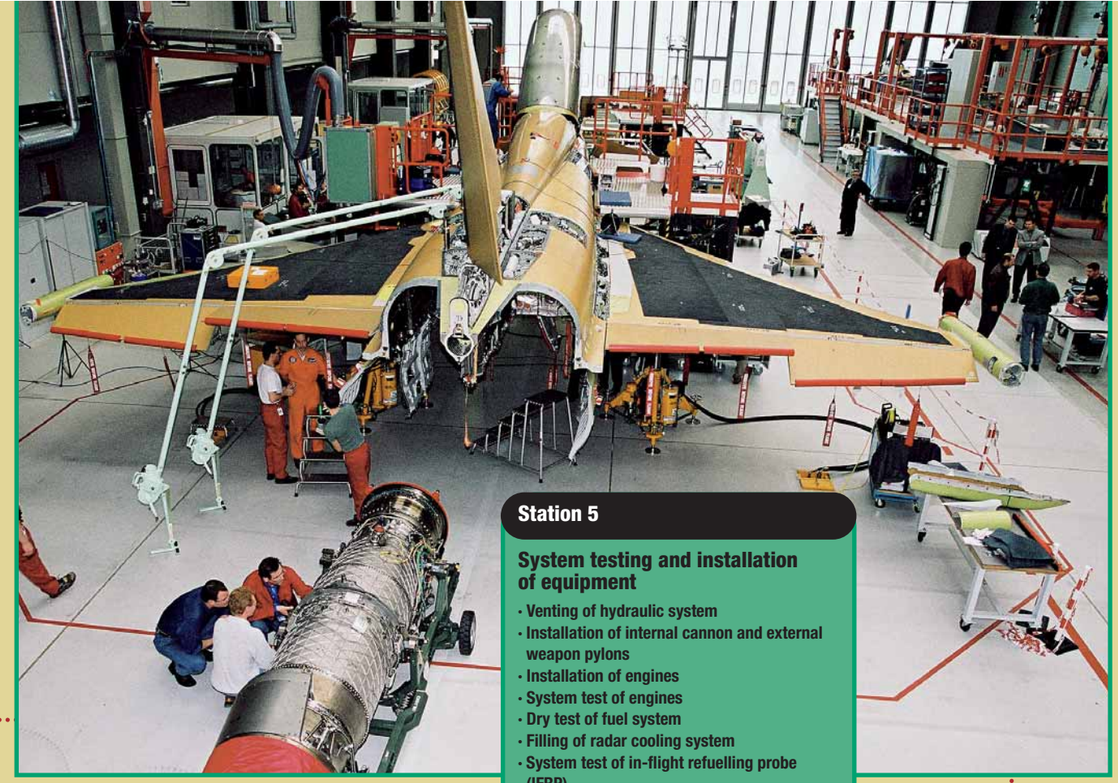
The Eurofighter fuselage contains 30 kilometres of cabling. The red boxes in the avionics bays (left) are dummies used for cabling tests.

Station 4

Installation of equipment and basic-systems check

- Installation of system computers
- Installation of missile ejection launchers (MEL)
- Attachment and functional test of canopy
- Installation of auxiliary power unit (APU)
- Test of hydraulic system and check for leaks
- System test of fibre-optic cables and conventional data buses
- Landing-gear system test and adjustment
- Environmental control system (ECS) test and check for leaks
- System test of cockpit operating elements and display instruments

The 'firewall' between the two engines is made of titanium. The rear fuselage section is built by Alenia and BAE Systems.



One of the two EJ200 engines being installed at Station 5, where the flight control system is also tested.

Station 5

System testing and installation of equipment

- Venting of hydraulic system
- Installation of internal cannon and external weapon pylons
- Installation of engines
- System test of engines
- Dry test of fuel system
- Filling of radar cooling system
- System test of in-flight refuelling probe (IFRP)
- System test of flight control system
- System test of arrester-hook and parachute
- System test of cockpit ladder and canopy

Four nations – one aircraft

The partner companies in the Eurofighter consortium each build major components and assemble aircraft at the seven European plants in Samlesbury and **Warton*** (UK), Augsburg, Lemwerder and **Manching** (Germany), Foggia and **Caselle** near Turin (Italy), and **Getafe** near Madrid (Spain).

Alenia (I)
- Port wing
- Outboard flaperons
- Rear fuselage sections

BAE systems (GB)
- Front fuselage and canards
- Dorsal spine and airbrake
- Canopy
- Tail fin
- Inboard flaperons
- Rear fuselage section

EADS (D)
- Main centre fuselage (including flight control, target identification and auto-attack systems, sensor fusion, hydraulics)

EADS CASA (E)
- Starboard wing
- Leading-edge slats

***Bold type:** final assembly site

Station 6

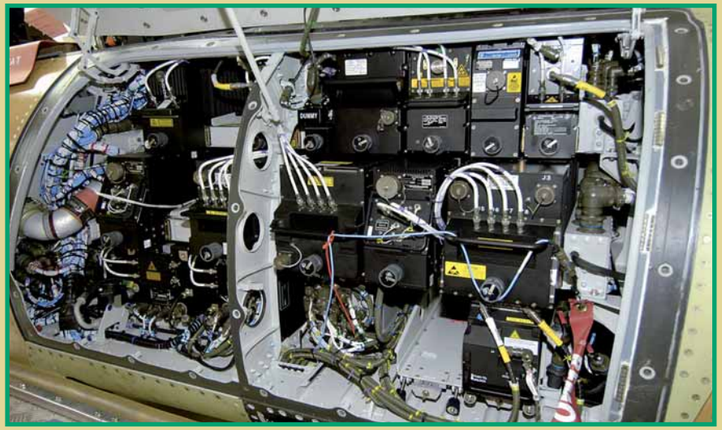
Radar system test. The radome is enclosed in a radar absorber to shield the technicians.

Station 6

System testing

- Radio and communications system test
- Radar system test
- Defensive aids subsystem (DASS) test
- Attack and identification system (AIS) test
- Armament control system (ACS) test
- Cannon control check
- Pilots' liquid conditioning system (LCS) test
- External and internal lighting system test
- Harmonisation of weapons stations and targeting devices

The Eurofighter's high-tech cockpit, featuring three multifunction colour displays and the head-up display (top). Bottom: The fully installed avionics are put through their paces at Station 6.



Station 14

- Attachment of external tanks
- Fuel management system functional test
- Water sprinkling test
- Removal of extra tanks

Station 15

Engine test run and system tests

- Installation of ejection seat and pyrotechnics for canopy jettison mechanism
- Weight and CG test
- Preparation for engine and APU test run
- Power supply check
- Engine and APU test run
- All systems check with engines on full power

The work of Station 15 includes installing the Martin-Baker ejection seat before the first flight. The canards, made mainly of titanium, are built by BAE Systems.

Station 15A

- Station 15A is located in a separate area of the final assembly hall. Special safety measures are required during the electronic defence systems test, when the aircraft is exposed to intense electromagnetic radiation.
- EMC tests (selected machines only)

Images: Alexis v. Croy, Eurofighter (1)

Final checks are carried out prior to the aircraft's delivery to the German air force.

Station 21

Installation of customised equipment

- Preparations for delivery to the air force
- Pre-flight check
- Delivery flight

Station 19

- Painting and application of in-service markings
- EMC tests (selected machines only)

Station 16

Acceptance flights

- Flight preparation
- Pre-flight check
- Acceptance flights
- Elimination of any defects
- Special tests

ONCE the aircraft have reached Station 6 and had their radar systems tested, they enter a specially equipped separate building for the ESM/ECM test, in which the radar warning receiver (RWR) and radar jammer are tested. Since these tests can pose a serious health hazard due to the high levels of electromagnetic radiation produced, particularly stringent safety measures have to be implemented in this area of the final assembly line to protect the test personnel.

After these tests comes 'roll-out', in which the aircraft is transferred from the assembly hall to the systems and flight testing area. First of all the fuel system (including the spare tanks) is tested in the 'fuel hall', and shortly afterwards the engines undergo functional tests in the soundproof hangars designed specifically for this purpose. Next, the Martin-Baker ejection seat and the pyrotechnic cartridges for seat firing and canopy jettison are installed. (This is not performed during final assembly for safety reasons.) Finally the pilot's life support systems (air conditioning and oxygen supply) and the basic avionics, flight control and fuel systems are all checked with the auxiliary power units or main engines running.

On completion of all these tests, the aircraft is delivered to the paintshop where it receives its in-service colour scheme. Finally it undergoes flight acceptance tests to ensure it is ready for take-off.

The aircraft are usually ready for delivery after two or three production flight acceptance tests (PFAT), each lasting between one and one and a half hours. Most of them are flown by the six test pilots employed at the plant, but a few are flown by German air force pilots. Nine training aircraft and 11 single-seat machines had been assembled and had achieved flight acceptance in Manching by the end of 2005. However, more remains to be done before the aircraft can be delivered to the customer. Failure corrective action must be taken to eliminate any remaining defects, however small, and a special team of German air force test pilots is present for the final preflight check.

The Typhoons are normally delivered to their operational units by air force pilots – a coveted task even for these seasoned servicemen.