= Panavia Tornado =

The Panavia Tornado is a family of twin @-@ engine , variable @-@ sweep wing multirole combat aircraft , which was jointly developed and manufactured by Italy , the United Kingdom , and West Germany . There are three primary Tornado variants : the Tornado IDS (interdictor / strike) fighter @-@ bomber , the suppression of enemy air defences Tornado ECR (electronic combat / reconnaissance) and the Tornado ADV (air defence variant) interceptor aircraft .

The Tornado was developed and built by Panavia Aircraft GmbH , a tri @-@ national consortium consisting of British Aerospace (previously British Aircraft Corporation) , MBB of West Germany , and Aeritalia of Italy . It first flew on 14 August 1974 and was introduced into service in 1979 ? 1980 . Due to its multirole nature , it was able to replace several different fleets of aircraft in the adopting air forces . The Royal Saudi Air Force (RSAF) became the only export operator of the Tornado in addition to the three original partner nations . A tri @-@ nation training and evaluation unit operating from RAF Cottesmore , the Tri @-@ National Tornado Training Establishment , maintained a level of international co @-@ operation beyond the production stage .

The Tornado was used by the Royal Air Force (RAF) , Italian Air Force and RSAF during the 1991 Gulf War , in which the Tornado conducted many low @-@ altitude penetrating strike missions . The Tornados of various operators were also used in conflicts in the former Yugoslavia during the Bosnian War and Kosovo War , the Iraq War , Libya during the Libyan civil war , as well as smaller roles in Afghanistan , Yemen , and Syria . Including all variants , 992 aircraft were built .

= = Development = =

= = = Origins = = =

During the 1960s , aeronautical designers looked to variable @-@ geometry wing designs to gain the manoeuvrability and efficient cruise of straight wings with the speed of swept wing designs . The United Kingdom had cancelled the procurement of the TSR @-@ 2 and subsequent F @-@ 111K aircraft , and was still looking for a replacement for its Avro Vulcan and Blackburn Buccaneer strike aircraft . Britain and France had initiated the AFVG (Anglo French Variable Geometry) project in 1965 , but this had ended with French withdrawal in 1967 . Britain continued to develop a variable @-@ geometry aircraft similar to the proposed AFVG , and sought new partners to achieve this .

In 1968 , West Germany , the Netherlands , Belgium , Italy and Canada formed a working group to examine replacements for the Lockheed F @-@ 104 Starfighter , initially called the Multi Role Aircraft (MRA) , later renamed as the Multi Role Combat Aircraft (MRCA) . The participating nations all had ageing fleets that required replacing ; but , as the requirements were so diverse , it was decided to develop a single aircraft that could perform a variety of missions that were previously undertaken by a fleet of different aircraft . Britain joined the MRCA group in 1968 , represented by Air Vice @-@ Marshal Michael Giddings , and a memorandum of agreement was drafted between Britain , West Germany , and Italy in May 1969 .

By the end of 1968 , the prospective purchases from the six countries amounted to 1 @,@ 500 aircraft . Canada and Belgium had departed before any long @-@ term commitments had been made to the programme ; Canada had found the project politically unpalatable ; there was a perception in political circles that much of the manufacturing and specifications were focused on Western Europe . France had made a favourable offer to Belgium on the Dassault Mirage 5 , which created doubt as to whether the MRCA would be worthwhile from Belgium 's operational perspective .

= = = Panavia Aircraft GmbH = = =

On 26 March 1969 , four partner nations ? United Kingdom , Germany , Italy and the Netherlands , agreed to form a multinational company , Panavia Aircraft GmbH , to develop and manufacture the

MRCA . The project 's aim was to produce an aircraft capable of undertaking missions in the tactical strike , reconnaissance , air defence , and maritime roles ; thus allowing the MRCA to replace several different aircraft then in use by the partner nations . Various concepts , including alternative fixed @-@ wing and single @-@ engine designs , were studied while defining the aircraft . The Netherlands pulled out of the project in 1970 , citing that the aircraft was too complicated and technical for the RNLAF 's preferences , which had sought a simpler aircraft with outstanding manoeuvrability . An additional blow was struck by the German requirement reduced from an initial 600 aircraft to 324 in 1972 .

When the agreement was finalised , the United Kingdom and West Germany each had a 42 @.@ 5 % stake of the workload , with the remaining 15 % going to Italy ; this division of the production work was heavily influenced by international political bargaining . The front fuselage and tail assembly was assigned to BAC (now BAE Systems) in the United Kingdom ; the centre fuselage to MBB (now EADS) in West Germany ; and the wings to Aeritalia (now Alenia Aeronautica) in Italy . Similarly , tri @-@ national worksharing was used for engines , general and avionic equipment . A separate multinational company , Turbo @-@ Union , was formed in June 1970 to develop and build the RB199 engines for the aircraft , with ownership similarly split 40 % Rolls @-@ Royce , 40 % MTU , and 20 % FIAT .

At the conclusion of the project definition phase in May 1970 , the concepts were reduced to two designs ; a single seat Panavia 100 which West Germany initially preferred , and the twin @-@ seat Panavia 200 which the RAF preferred (this would become the Tornado) . The aircraft was briefly called the Panavia Panther , and the project soon coalesced towards the two @-@ seat option . In September 1971 , the three governments signed an Intention to Proceed (ITP) document , at which point the aircraft was intended solely for the low @-@ level strike mission , where it was viewed as a viable threat to Soviet defences in that role . It was at this point that Britain 's Chief of the Defence Staff announced " two @-@ thirds of the fighting front line will be composed of this single , basic aircraft type " .

= = = Prototypes and testing = = =

The first of more than a dozen Tornado prototypes took flight on 14 August 1974 at Manching , Germany ; the pilot , Paul Millett stated of the occasion : " Aircraft handling was delightful ... the actual flight went so smoothly that I did begin to wonder whether this was not yet another simulation " . Flight testing led to the need for minor modifications . Airflow disturbances were responded to by re @-@ profiling the engine intakes and the fuselage to minimise surging and buffeting experienced at supersonic speeds . Testing revealed that a nose @-@ wheel steering augmentation system , connecting with the yaw damper , was necessary to counteract the destabilising effect produced by deploying the thrust reverser during landing rollouts . In August 1976 , Soviet espionage activities were exposed trying to obtain information on the aircraft .

Two prototypes were lost in accidents , both of which had been primarily caused by poor piloting decisions and errors leading to two ground collision incidents ; a third Tornado prototype was seriously damaged by an incident involving pilot @-@ induced pitch oscillation . During the type 's development , aircraft designers of the era were beginning to incorporate features such as more sophisticated stability augmentation systems and autopilots . Aircraft such as the Tornado and the General Dynamics F @-@ 16 Fighting Falcon made use of these new technologies . Failure testing of the Tornado 's triplex analogue command and stability augmentation system (CSAS) was conducted on a series of realistic flight control rigs ; the variable @-@ sweep wings in combination with varying , and frequently very heavy , payloads complicated the clearance process .

= = = Production = = =

The contract for the Batch 1 aircraft was signed on 29 July 1976 . The first aircraft were delivered to the RAF and German Air Force on 5 and 6 June 1979 respectively . The first Italian Tornado was delivered on 25 September 1981 . On 29 January 1981 , the Tri @-@ national Tornado Training

Establishment (TTTE) officially opened at RAF Cottesmore , remaining active in training pilots from all operating nations until 31 March 1999 . The 500th Tornado to be produced was delivered to West Germany on 19 December 1987 .

Export customers were sought after West Germany withdrew its objections to exporting the aircraft ; Saudi Arabia was the only export customer of the Tornado . The agreement to purchase the Tornado was part of the controversial Al @-@ Yamamah arms deal between BAE Systems and the Saudi government . Oman had committed to purchasing Tornados and the equipment to operate them for a total value of £ 250 million in the late 1980s , but cancelled the order in 1990 due to financial difficulties .

During the 1970s , Australia considered joining the MRCA programme to find a replacement for their ageing Dassault Mirage IIIs ; ultimately the McDonnell Douglas F / A @-@ 18 Hornet was selected to meet the requirement . Canada similarly opted for the F / A @-@ 18 after considering the Tornado . Japan considered the Tornado in the 1980s , along with the General Dynamics F @-@ 16 Fighting Falcon and F / A @-@ 18 ; before selecting the Mitsubishi F @-@ 2 , a domestically produced design based on the F @-@ 16 . In the 1990s , both Taiwan and South Korea expressed interest in acquiring a small number of Tornado ECR aircraft . In 2001 , EADS proposed a Tornado ECR variant with a greater electronic warfare capability for Australia .

Production came to an end in 1998 ; the last batch of aircraft being produced going to the Royal Saudi Air Force , who had ordered a total of 96 IDS Tornados . In June 2011 , it was announced that the RAF 's Tornado fleet had flown collectively over one million flying hours . Aviation author John Lake noted that : " The Trinational Panavia Consortium produced just short of 1 @,@ 000 Tornados , making it one of the most successful postwar bomber programs " . In 2008 , AirForces Monthly said of the Tornado : " For more than a quarter of a century ... the most important military aircraft in Western Europe . "

= = Design = =

= = = Overview = = =

The Panavia Tornado is a multirole , twin @-@ engined aircraft designed to excel at low @-@ level penetration of enemy defences . The mission envisaged during the Cold War was the delivery of conventional and nuclear ordnance on the invading forces of the Warsaw Pact countries of Eastern Europe ; this dictated several significant features of the design . Variable wing geometry , allowing for minimal drag during the critical low @-@ level dash towards a well @-@ prepared enemy , had been desired from the project 's start . Advanced navigation and flight computers , including the then @-@ innovative fly @-@ by @-@ wire system , greatly reduced the workload of the pilot during low @-@ level flight and eased control of the aircraft . For long range bombing missions , the Tornado has a retractable refuelling probe .

As a multirole aircraft , the Tornado is capable of undertaking more mission profiles than the anticipated strike mission ; various operators replaced multiple aircraft types with the Tornado as a common type ? the use of dedicated single role aircraft for specialist purposes such as battlefield reconnaissance , maritime patrol duties , or dedicated electronic countermeasures (ECM) were phased out ? either by standard Tornados or modified variants , such as the Tornado ECR . The most extensive modification from the base Tornado design was the Tornado ADV , which was stretched and armed with long range anti @-@ aircraft missiles to serve in the interceptor role .

The Tornado operators have chosen to undertake various life extension and upgrade programmes to keep their Tornado fleets as viable frontline aircraft for the foreseeable future . The RAF and RSAF have upgraded their Tornados to the GR4 standard to increase combat effectiveness , while German Tornados have been undergoing periodic upgrades under the multi @-@ stage ASSTA (Avionics System Software Tornado in Ada) programme . With these upgrades , as of 2011 , it is projected that the Tornado shall be in service until 2025 , more than 50 years after the first prototype took flight .

= = = Variable @-@ sweep wing = = =

In order for the Tornado to perform well as a low @-@ level supersonic strike aircraft , it was considered necessary for it to possess good high @-@ speed and low @-@ speed flight characteristics . To achieve high @-@ speed performance , a swept or delta wing is typically adopted , but these wing designs are inefficient at low speeds . To operate at both high and low speeds with great effectiveness , the Tornado uses a variable @-@ sweep wing . This approach had been adopted by earlier aircraft , such as the American General Dynamics F @-@ 111 Aardvark strike fighter , and the Soviet Mikoyan @-@ Gurevich MiG @-@ 23 fighter . The F @-@ 111 has many similarities with the smaller Tornado ; however , the Tornado differs in being a multi @-@ role aircraft with more advanced onboard systems and avionics .

The level of wing sweep , the angle of the wings in relation to the fuselage , can be altered in flight at the pilot 's control . The variable wing can adopt any sweep angle between 25 degrees and 67 degrees , with a corresponding speed range for each angle ; some Tornado ADVs were outfitted with an automatic wing @-@ sweep system to reduce pilot workload . When the wings are swept back , the exposed wing area is lowered and drag is significantly decreased , which is conducive to performing high @-@ speed low @-@ level flight . The weapons pylons pivot with the angle of the variable @-@ sweep wings so that the stores point in the direction of flight and do not hinder any wing positions .

In development , significant attention was given to the Tornado 's short @-@ field take @-@ off and landing (STOL) performance . Germany , in particular , encouraged this design aspect . For shorter take @-@ off and landing distances , the Tornado can sweep its wings forwards to the 25 @-@ degree position , and deploy its full @-@ span flaps and leading edge slats to allow the aircraft to fly at slower speeds . These features , in combination with the thrust reverser @-@ equipped engines , give the Tornado excellent low @-@ speed handling and landing characteristics .

= = = Avionics = = =

The Tornado features a tandem @-@ seat cockpit , crewed by a pilot and a navigator / weapons officer ; both electromechanical and electro @-@ optical controls are used to fly the aircraft and manage its systems . An array of dials and switches are mounted on either side of a centrally placed CRT monitor , controlling the navigational , communications , and weapons @-@ control computers . BAE Systems developed the Tornado Advanced Radar Display Information System (TARDIS) , a 32 @.@ 5 @-@ centimetre (12 @.@ 8 in) multi @-@ function display , to replace the rear cockpit 's Combined Radar and Projected Map Display ; the RAF began installing TARDIS on the GR4 fleet in 2004 .

The primary flight controls of the Tornado are a fly @-@ by @-@ wire hybrid , consisting of an analogue quadruplex Command and Stability Augmentation System (CSAS) connected to a digital Autopilot & Flight Director System (AFDS) ; in addition a level of mechanical reversion capacity was retained to safeguard against potential failure . To enhance pilot awareness , artificial feel was built into the flight controls , such as the centrally located stick ; because of the Tornado 's variable wings enabling the aircraft to drastically alter its flight envelope , the artificial responses adjust automatically to wing profile changes and other changes to flight attitude . As a large variety of munitions and stores can be outfitted , the resulting changes to the aircraft 's flight dynamics are routinely compensated for by the flight stability system .

The Tornado incorporates a combined navigation / attack Doppler radar that simultaneously scans for targets and conducts fully automated terrain @-@ following for low @-@ level flight operations ; being readily able to conduct all @-@ weather hands @-@ off low @-@ level flight was considered one of the core advantages of the Tornado . The Tornado ADV has a different radar system to other variants , designated AI.24 Foxhunter , as it is designed for air defence operations ; it is capable of continuously keeping track of up to 20 targets at ranges of up to 160 kilometres (100 mi) . The Tornado was one of the earliest aircraft to fitted with a digital data bus for data transmission . A link

16 JTIDS integration on the F3 variant enabled the exchange of radar and other sensory information with nearby friendly aircraft .

Some Tornado variants carry different avionics and equipment , depending on their mission . The Tornado ECR is devoted to Suppression of Enemy Air Defences (SEAD) missions , operated by Germany and Italy . The Tornado ECR is equipped with an emitter @-@ locator system (ELS) to spot radar use . German ECRs have a Honeywell infrared imaging system for reconnaissance flights . RAF and RSAF Tornados have the Laser Range Finder and Marked Target Seekers (LRMTS) for targeting laser @-@ guided munitions . In 1991 , the RAF introduced TIALD , allowing Tornado GR1s to laser @-@ designate their own targets .

The GR1A and GR4A were equipped with TIRRS (Tornado Infrared Reconnaissance System) , consisting of one SLIR (Sideways Looking Infra Red) sensor on each side of the fuselage forward of the engine intakes to capture oblique images , and a single IRLS (InfrarRed LineScan) sensor mounted on the fuselage 's underside to provide vertical images . TIRRS recorded images on six S @-@ VHS video tapes . The newer RAPTOR reconnaissance pod has replaced the built @-@ in TIRRS system .

= = = Armament and equipment = = =

The Tornado is cleared to carry the majority of air @-@ launched weapons in the NATO inventory , including various unguided and laser @-@ guided bombs , anti @-@ ship and anti @-@ radiation missiles , as well as specialised weapons such as anti @-@ personnel mines and anti @-@ runway munitions . To improve survivability in combat , the Tornado is equipped with onboard countermeasures , ranging from flare and chaff dispensers to electronic countermeasure pods that can be mounted under the wings . Underwing fuel tanks and a buddy store aerial refuelling system that allows one Tornado to refuel another are available to extend the aircraft 's range .

In the decades since the Tornado 's introduction , all of the Tornado operators have undertaken various upgrade and modification programmes to allow recently introduced weapons to be used by their squadrons . Amongst the new armaments that the Tornado has been adapted to deploy are the enhanced Paveway and Joint Direct Attack Munition bombs , and modern cruise missiles such as the Taurus and Storm Shadow missiles ; these upgrades have increased the Tornado 's capabilities and combat accuracy . Precision weapons such as cruise missiles have replaced older munitions such as cluster bombs .

Strike variants have a limited air @-@ to @-@ air capability with AIM @-@ 9 Sidewinder or AIM @-@ 132 ASRAAM air @-@ to @-@ air missiles (AAMs) ; additionally the Tornado ADV is outfitted with beyond visual range AAMs such as the Skyflash and AIM @-@ 120 AMRAAM missiles . The Tornado is armed with two 27 mm (1 @.@ 063 in) Mauser BK @-@ 27 revolver cannon internally mounted underneath the fuselage ; the Tornado ADV was only armed with one cannon . When the RAF GR1 aircraft were converted to GR4 , the FLIR sensor replaced the left hand cannon , leaving only one ; the GR1A reconnaissance variant gave up both its guns to make space for the sideways looking infra @-@ red sensors . The Mauser BK @-@ 27 was developed specifically for the Tornado , but has since been used on several other European fighters , such as the Dassault / Dornier Alpha Jet , Saab JAS 39 Gripen , and Eurofighter Typhoon .

The Tornado is capable of delivering air @-@ launched nuclear weapons . In 1979 , Britain considered replacing its Polaris submarines with either the Trident submarines or alternatively the Tornado as the main bearer of its nuclear deterrent . Although the UK proceeded with Trident , several Tornado squadrons based in Germany were assigned to SACEUR to deter a major Soviet offensive with both conventional and nuclear weapons , namely the WE.177 nuclear bomb , which was retired in 1998 . German and Italian Tornados are capable of delivering US B61 nuclear bombs , which are made available through NATO .

= = = Engine = = =

Britain considered the selection of Rolls @-@ Royce to develop the advanced engine for the MRCA

to be essential , and was strongly opposed to adopting an engine from an American manufacturer , to the point where the UK might have withdrawn over the issue . In September 1969 , Rolls @-@ Royce 's RB 199 engine was selected to power the MRCA . One advantage over the US competition was that a technology transfer between the partner nations had been agreed ; the engine was to be developed and manufactured by a joint company , Turbo @-@ Union . The programme was delayed by Rolls @-@ Royce 's entry into receivership in 1971 ; the nature of the multinational collaboration process helped avoid major disruption of the Tornado programme . Research from the supersonic airliner Concorde contributed to the development and final design of the RB.199 and of the engine control units .

To provide the desired performance , several features were used in the RB.199. To operate efficiently across a wide range of conditions and speeds up to Mach 2 , the RB.199 and several other engines make use of variable intake ramps to control the air flow . The hydraulic system is pressurised by syphoning power from both or either operational engine ; the hydraulics are completely contained within the airframe rather than integrating with the engine to improve safety and maintainability . In case of double @-@ engine , or double @-@ generator , failure , the Tornado has a single @-@ use battery capable of operating the fuel pump and hydraulics for up to 13 minutes .

Relatively rare amongst fighter aircraft , the RB.199 is fitted with thrust reversers to decrease the distance required to safely land . To fully deploy the thrust reverser during landings , the yaw damper is connected to the steering of the nosewheel to provide greater stability .

In August 1974 , the first RB.199 powered flight of a prototype Tornado occurred ; the engine completed its qualification tests in late 1978 . The final production standard engine met both reliability and performance standards , though the development cost had been higher than predicted , in part due to the ambitious performance requirements . At the time of the Tornado 's introduction to service , the turbine blades of the engine suffered from a shorter life span than desired , which was rectified by the implementation of design revisions upon early @-@ production engines . Several uprated engines were developed and used on both the majority of Tornado ADVs and Germany 's Tornado ECRs . The DECU (Digital Engine Control Unit) is the current engine control unit for RB 199 engines superseding the analogue MECU (Main Engine Control Unit) also known as CUE .

= = = Upgrades = = =

Being designed for low @-@ level operations , the Tornado required modification to perform in medium level operations that the RAF adopted in the 1990s . The RAF 's GR1 fleet was extensively re @-@ manufactured as Tornado GR4s . Upgrades on Tornado GR4s included a Forward looking infrared , a wide @-@ angle HUD (Head @-@ up display) , improved cockpit displays , NVG (Night vision devices) capabilities , new avionics , and a Global Positioning System receiver . The upgrade eased the integration of new weapons and sensors which were purchased in parallel , including the Storm Shadow cruise missile , the Brimstone anti @-@ tank missile , Paveway III laser @-@ guided bombs and the RAPTOR reconnaissance pod was integrated . The first flight of a Tornado GR4 was on 4 April 1997 , on 31 October 1997 the RAF accepted the first delivery and deliveries were completed in 2003 . In 2005 , the RSAF opted to have their Tornado IDSs undergo a series of upgrades to become equivalent to the RAF 's GR4 configuration . On 21 December 2007 BAE signed a £ 210m contract for CUSP , the Capability Upgrade Strategy (Pilot) . This project would see RAF GR4 / 4A improved in two phases , starting with the integration of the Paveway IV bomb and a communications upgrade , followed by a new tactical datalink in Phase B.

Beginning in 2000 , German IDS and ECR Tornados received the ASSTA 1 (Avionics System Software Tornado in Ada) upgrade . ASSTA 1 involved a replacement weapons computer , new GPS and Laser Inertial navigation systems . The new computer allowed the integration of the HARM III , HARM 0 Block IV / V and TAURUS KEPD 350 missiles , the Rafael Litening II Laser Designator Pod and GBU @-@ 24 Paveway III laser @-@ guided bombs . The ASSTA 2 upgrade began in 2005 , primarily consisting of several new digital avionics systems , a new ECM suite and provision

for the Taurus cruise missile ; these upgrades are to be only applied to 85 Tornados (20 ECRs and 65 IDSs) , as the Tornado is in the process of being replaced by the Eurofighter Typhoon . The ASSTA 3 upgrade programme , started in 2008 , will introduce support for the laser @-@ targeted Joint Direct Attack Munition along with further software changes .

= = = = Test platform for 3 @-@ D printed parts = = = =

BAE Systems announced that , in December 2013 , the company had test flown a Tornado equipped with parts that were made with 3D printing equipment . The parts included a protective cover for the radio , a landing @-@ gear guard and air @-@ intake door support struts . The test demonstrated the feasibility of making replacement parts quickly and cheaply at the air base hosting the Tornado . The company claims that , with some of the parts costing less than £ 100 per piece to manufacture , 3D printing has already resulted in savings of more than £ 300 @,@ 000 and will offer further potential cost savings of more than £ 1 @.@ 2 million between now and 2017 .

= = Operational history = =

= = = German Air Force (Luftwaffe) = = =

The first Tornado prototype made its first flight on 14 August 1974 from Manching airbase , in what was then West Germany . Deliveries of production Tornados began on 27 July 1979 . The total number of Tornados delivered to the German Air Force numbered 247 , including 35 ECR variants . Originally Tornados equipped five fighter @-@ bomber wings (Geschwader) , with one tactical conversion unit and four front line wings , replacing the Lockheed F @-@ 104 Starfighter . When one of the two Tornado wings of the German Navy was disbanded in 1994 , its aircraft were used to re @-@ equip a Luftwaffe 's reconnaissance wing formerly equipped with RF @-@ 4E Phantoms .

As many as 15 German Tornados undertook combat operations as a part of NATO 's campaign during the Bosnian War ; this was the first combat operation for the Luftwaffe since World War II . The Tornados , operating from in Piacenza , Italy , flew reconnaissance missions to survey damage inflicted by previous strikes and to scout targets for other aircraft to strike . These reconnaissance missions were reportedly responsible for a significant improvement in target selection throughout the campaign .

In 1999 , German and Italian Tornados participated in Operation Allied Force , NATO 's military operation against the Federal Republic of Yugoslavia during the Kosovo War . The ECR aircraft would escort various allies ' aircraft while carrying several AGM @-@ 88 HARM missiles to counter attempted use of radar against the allied aircraft . During the Kosovo hostilities , Germany 's IDS Tornados would routinely conduct reconnaissance flights to identify both enemy ground forces and civilian refugees within Yugoslavia .

In June 2007 , a pair of Luftwaffe Tornado were controversially used to fly reconnaissance flights over an anti @-@ globalisation demonstration during the 33rd G8 summit in Heiligendamm . Following the mission , the German Defence Ministry admitted one aircraft had broken the minimum flying altitude and that mistakes were made in the handling of security of the summit .

In 2007 , a detachment of six Tornados of the Aufklärungsgeschwader 51 " Immelmann " (51st reconnaissance wing) were deployed to Mazar @-@ i @-@ Sharif , Northern Afghanistan , to support NATO forces . The decision to send Tornados to Afghanistan was a controversial decision , including one political party launching an unsuccessful legal bid to block the deployment as unconstitutional . In support of the Afghanistan mission , improvements in the Tornado 's reconnaissance equipment were accelerated ; improving the Tornado 's ability to detect hidden improvised explosive devices (IEDs) . The German Tornados were withdrawn from Afghanistan in November 2010 .

Defence cuts announced in March 2003 resulted in the decision to retire 90 Tornados from Luftwaffe service . This led to a reduction in its Tornado strength to four wings by September 2005 .

On 13 January 2004 , the then German Defence Minister Peter Struck announced further major changes to the German armed forces . A major part of this announcement is the plan to cut the German fighter fleet from 426 in early 2004 to 265 by 2015 . The German Tornado force is to be reduced to 85 , with the type expected to remain in service with the Luftwaffe until 2020 . The aircraft being retained have been undergoing a service life extension programme . Currently , the Luftwaffe operates Tornados with Tactical Wings Taktisches Luftwaffengeschwader 33 in Cochem / Büchel , Rhineland @-@ Palatinate and with Taktisches Luftwaffengeschwader 51 " Immelmann " in Jagel , Schleswig @-@ Holstein . Aircrew training takes place at Fliegerisches Ausbildungszentrum der Luftwaffe , based on Holloman Air Force Base in New Mexico , US .

= = = German Navy (Marineflieger) = = =

In addition to the order made by the Luftwaffe , the German Navy 's Marineflieger also received 112 of the IDS variant in the anti @-@ shipping and marine reconnaissance roles , again replacing the Starfighter . These equipped two wings , each with a nominal strength of 48 aircraft . The principal anti @-@ ship weapon was the AS.34 Kormoran anti @-@ ship missile , which were initially supplemented by unguided bombs and BL755 cluster munitions , and later by AGM @-@ 88 HARM anti @-@ radar missiles . Pods fitted with panoramic optical cameras and an infrared line scan were carried for the reconnaissance mission .

The end of the Cold War and the signing of the CFE Treaty gave rise to a requirement for Germany to reduce the size of its armed forces , including the number of combat aircraft . To meet this need , one of the Marineflieger 's Tornado wings was disbanded on 1 January 1994 ; its aircraft replaced the Phantoms of a Luftwaffe reconnaissance wing . The second wing was enlarged and continued in the anti @-@ shipping , reconnaissance and anti @-@ radar roles until it was disbanded in 2005 with its aircraft and duties passed on to the Luftwaffe .

= = = Italian Air Force (Aeronautica Militare) = = =

The first Italian prototype made its maiden flight on 5 December 1975 from Turin , Italy . The Aeronautica Militare received a total of 100 Tornado IDS . 16 IDSs were subsequently converted to the ECR configuration ; the first Italian Tornado ECR was delivered on 27 February 1998 . As a stop @-@ gap measure for 10 years , the Aeronautica Militare additionally operated 24 Tornado ADVs in the air defence role , which were leased from the RAF to cover the service gap between the retirement of the Lockheed F @-@ 104 Starfighter and the introduction of the Eurofighter Typhoon .

In 2000 , with major delays hampering the Eurofighter , the Aeronautica Militare began a search for another interim fighter . While the Tornado itself was considered , any long term extension to the lease would have involved upgrade to RAF CSP standard and thus was not considered cost effective . In February 2001 , Italy announced its arrangement to lease 35 F @-@ 16s from the United States . The Aeronautica Militare returned its Tornado ADVs to the RAF , with the final aircraft arriving at RAF Saint Athan on 7 December 2004 . One aircraft was retained for static display purposes .

Italian Tornados , along with RAF Tornados , took part in the first Gulf War in 1991 . Operation Locusta saw eight Tornado IDS interdictors deployed from Gioia del Colle , Italy , to Al Dhafra , Abu Dhabi , as a part of Italy 's contribution to the coalition . During the conflict , one aircraft was lost to Iraqi anti @-@ aircraft fire , the pilots ejected safely and were captured by Iraqi forces .

A total of 22 Italian Tornados were deployed in the NATO @-@ organised Operation Allied Force over Kosovo in 1999 , the IDS variant was used in the bombing role while the ECR variants patrolled the combat region , acting to suppress enemy anti @-@ aircraft radars , firing 115 AGM @-@ 88 HARM missiles . In response to anticipated violence during the 2010 Afghanistan elections , Italy , along with several other nations , increased its military commitment in Afghanistan , dispatching four IDS Tornados to the region .

Italian Tornado IDS and ECR aircraft participated in the enforcement of a UN no @-@ fly zone during the 2011 military intervention in Libya . Various coalition aircraft operated from bases in Italy ,

including RAF Tornados . Italian military aircraft delivered a combined 710 guided bombs and missiles during the strikes against Libyan targets . Of these Aeronautica Militare Tornados and AMX fighter @-@ bombers released 550 guided bombs and missiles , and Italian Navy AV @-@ 8Bs delivered 160 guided bombs . Italian Tornados launched 20 to 30 Storm Shadow cruise missiles with the rest consisting of Paveway and JDAM guided bombs .

In July 2002 , Italy signed a contract with the Tornado Management Agency (NETMA) and Panavia for the upgrading of 18 IDSs , the first of which was received in 2003 . The upgrade introduced improved navigation systems (integrated GPS and laser INS) and the ability to carry new weapons , including the Storm Shadow cruise missile , Joint Direct Attack Munition and Paveway III laser @-@ guided bombs .

Italy has opted to extend the Tornado 's service life at the expense of alternative ground @-@ attack aircraft such as the AMX International AMX ; in 2010 a major upgrade and life extension program was initiated , which will provide new digital displays , Link 16 communications capability , night @-@ vision goggles compatibility , and several other upgrades . In the long term , it is planned to replace the Tornado IDS / ECR fleet in Italian service with the Lockheed Martin F @-@ 35 Lightning II , with the final Italian Tornado scheduled to be phased out in 2025 .

On 14 November 2014 , Italy announced it was sending four Tornado aircraft with 135 support staff to Ahmed Al Jaber Air Base in Kuwait in participation of coalition operations against the Islamic State . The four aircraft will be used for reconnaissance missions only .

= = = Royal Air Force = = =

Nicknamed the " Tonka " by the British , the Tornado made its combat debut as part of the British contribution to the Gulf War in 1991 . Operation Granby saw nearly 60 RAF GR1s deploy to air bases at Muharraq in Bahrain and Tabuk and Dhahran in Saudi Arabia . Several Tornado ADVs were deployed to provide air cover , the threat of their long range missiles being a significant deterrent to Iraqi pilots , who would deliberately avoid combat when approached .

Early on in the conflict , the GR1s targeted military airfields across Iraq , deploying a mixture of 450 kg (1 @,@ 000 lb) unguided bombs in loft @-@ bombing attacks and specialised JP233 runway denial weapons . Six RAF Tornados were lost in the conflict , four were lost while delivering unguided bombs , one was lost after delivering JP233 , and one trying to deliver laser @-@ guided bombs . On 17 January 1991 , the first Tornado to be lost was shot down by an Iraqi SA @-@ 16 missile following a failed low @-@ level bombing run . On 19 January , another RAF Tornado was shot down during an intensive raid on Tallil Air Base . The impact of the Tornado strikes upon Iraqi air fields is difficult to determine .

In an emergency deployment , the UK sent out a detachment of Blackburn Buccaneer aircraft equipped with the Pave Spike laser designator , allowing Tornado GR1s to drop precision guided weapons . A further crash programme in support of the sudden military action saw multiple GR1s outfitted with the TIALD laser designation system ; author Claus @-@ Christian Szejnmann declared that the TIALD pod enabled the GR1 to " achieve probably the most accurate bombing in the RAF 's history " . Although laser designation proved effective in the Gulf War , only 23 TIALD pods were purchased by 2000 ; shortages hindered combat operations over Kosovo .

Following the initial phase of the war , the GR1s switched to medium level strike missions , typical targets for these strikes included munition depots and oil refining facilities . Only the reconnaissance Tornado GR1As continued to operate at the low @-@ altitude high @-@ speed profile throughout the war , the GR1A emerged unscathed despite the inherent danger posed by missions such as conducting pre @-@ attack reconnaissance . In the war 's aftermath , Britain maintained a military presence in the Gulf , around half a dozen GR1s were based at Ali Al Salem airbase in Kuwait for operations over the southern no fly zone as part of Operation Southern Watch ; another half a dozen GR1s participated in missions over Northern Iraq in Operation Provide Comfort .

In March 1993 , a Mid @-@ Life Upgrade (MLU) project of the Tornado was launched to upgrade the GR1 / GR1A to GR4 / GR4A standard . The Tornado GR4 made its operational debut in Operation Southern Watch ; patrolling Iraq 's southern airspace from bases in Kuwait . Both Tornado

GR1s and GR4s based at Ali Al Salem , Kuwait , took part in coalition strikes at Iraq 's military infrastructure during Operation Desert Fox in 1998 . In December 1998 , an Iraqi anti @-@ aircraft battery fired six to eight missiles at a patrolling Tornado , the battery was later attacked in retaliation , no aircraft were lost during the incident . It was reported that during Desert Fox RAF Tornados had successfully destroyed 75 % of allotted targets , and out of the 36 missions planned , 28 had been successfully completed .

The GR1 participated in the Kosovo War in 1999 . The Tornados initially operated from RAF Bruggen , Germany ; they later moved to Solenzara Air Base , Corsica . Experience from fighting in Kosovo led to the RAF procuring AGM @-@ 65 Maverick missiles and Enhanced Paveway smart bombs for the Tornado fleet . Following the Kosovo War , the GR1 was phased out as more aircraft were upgraded to GR4 standard . The final GR1 was upgraded and returned to the RAF on 10 June 2003 .

The GR4 was heavily used in Operation Telic , the British contribution to the 2003 invasion of Iraq . RAF Tornados flew in the opening phase of the war , flying alongside American strike aircraft to rapidly attack key installations . Following an emphasis on minimising casualties , Tornados of No. 617 Squadron deployed the new Storm Shadow precision cruise missile for the first time in the Iraq conflict ; while 25 % of the UK 's air @-@ launched weapons in Kosovo were precision @-@ guided , four years later in Iraq this ratio increased to 85 % .

On 23 March 2003 , a Tornado GR4 was shot down over Iraq by friendly fire from a US Patriot missile battery , killing both crew members . In July 2003 , a US board of inquiry exonerated the battery 's operators , observing the Tornado 's " lack of functioning IFF (Identification Friend or Foe) " as a factor in the incident . Problems with Patriot were also suggested as a factor , multiple incidents of mis @-@ identification of friendly aircraft have occurred , including the fatal shootdown of a US Navy McDonnell Douglas F / A @-@ 18 Hornet a few weeks after the loss of the Tornado . Britain withdrew the last of its Tornados from Iraq in June 2009 .

In early 2009 , several GR4s arrived at Kandahar airfield , Afghanistan to replace the Harrier GR7 / 9 aircraft deployed there since November 2004 . In 2009 , Paveway IV guided bombs were brought into service on the RAF 's Tornados , having been previously used in Afghanistan by the Harrier II fleet . In Summer 2010 , extra Tornados were dispatched to Kandahar for the duration of the 2010 Afghan election . British Tornados ended their operations in Afghanistan in November 2014 . They flew over 5 @,@ 000 pairs sorties over 33 @,@ 500 hours , including 600 " shows of force " to deter Taliban attacks . During more than 70 engagements , some 140 Brimstone missiles and Paveway IV bombs were deployed in total (roughly half each) and over 3 @,@ 000 27 mm cannon shells were fired .

Prior to the 2010 Strategic Defence and Security Review (SDSR) ' s publication , the retirement of the entire Tornado fleet was under consideration , savings of £ 7 @.@ 5 billion were anticipated . The SDSR announced the Tornado would be retained at the expense of the Harrier II , although Tornado numbers are to decline in transition to the Eurofighter Typhoon , and later on , the F @-@ 35 Lightning II .

On 18 March 2011 , British Prime Minister David Cameron announced the deployment of Tornados and Typhoons to enforce a no @-@ fly zone in Libya . In March 2011 , several Tornados flew 3 @,@ 000 @-@ mile (4 @,@ 800 km) strike missions against targets inside Libya in what were , according to Defence Secretary Liam Fox , " the longest range bombing mission conducted by the RAF since the Falklands conflict " . A variety of weapons were used in operations over Libya , including Laser @-@ guided bombs and Brimstone missiles . 59 RAF aircraft are receiving the CUSP avionics upgrade which achieved Initial Service Date (ISD) in March 2013 and the type will be withdrawn from RAF service on 31 March 2019 .

On 11 August 2014 , a Cabinet Office Briefing Room (COBR) emergency meeting concluded that the RAF would deploy Tornado GR4s to RAF Akrotiri , Cyprus in support of refugees sheltering from Islamic State militants in the Mount Sinjar region of Iraq . The decision came three days after the United States began conducting air attacks against the Islamic State . Tornados were pre @-@ positioned to use their surveillance capabilities to gather situational awareness to help with humanitarian efforts . On 29 September 2014 , three days after Parliament approved of airstrikes

against Islamic State forces inside Iraq , two Tornados conducted their first armed reconnaissance mission over the country , in conjunction with other coalition aircraft , and were cleared to conduct airstrikes if needed . Britain 's first airstrike was conducted the next day , when two Tornados hit a heavy weapons post and an armored vehicle in the process of supporting Kurdish forces in northwest Iraq . By 1 March 2015 , eight RAF Tornados had been deployed to Akrotiri and conducted 159 airstrikes against IS targets in Iraq .

On the 2 December 2015 , the British Parliament voted to begin air strikes in Syria as well as Iraq , to combat the growing threat of ISIS . Tornados began their bombing that evening .

= = = Royal Saudi Air Force = = =

On 25 September 1985 , the UK and Saudi Arabia signed the Al Yamamah I contract including , amongst other things , the sale of 48 IDS and 24 ADV model Tornados . The first flight of a RSAF Tornado IDS was on 26 March 1986 , and the first Saudi ADV was delivered on 9 February 1989 . Saudi Tornados undertook operations during the Gulf War . In June 1993 the Al Yamamah II contract was signed , the main element of which was 48 additional IDSs .

Following experience with both the Tornado and the McDonnell Douglas F @-@ 15E Strike Eagle , the RSAF discontinued low @-@ level mission training in the F @-@ 15E in light of the Tornado 's superior low @-@ altitude flight performance . In addition , 10 of the Saudi Tornados were outfitted with equipment for performing reconnaissance missions . The 22 Tornado ADVs were replaced by the Eurofighter Typhoon ; the retired aircraft were being purchased back by the UK as of 2007 .

By 2007 , both the Sea Eagle anti @-@ ship missile and the ALARM anti @-@ radiation missile that previously equipped the RSAF 's Tornados had been withdrawn from service . As of 2010 , Saudi Arabia has signed several contracts for new weapon systems to be fitted to their Tornado and Typhoon fleets , such as the short range air @-@ to @-@ air IRIS @-@ T missile , and the Brimstone and Storm Shadow cruise missiles .

In September 2006 , the Saudi government signed a contract worth £ 2 @.@ 5 billion (US $ 4 @.@ 7 billion) with BAE Systems to upgrade up to 80 RSAF Tornado IDS aircraft to keep them in service until 2020 . RSAF Tornado 6612 was returned to BAE Systems Warton in December 2006 for upgrade under the " Tornado Sustainment Programme " (TSP) , which will " equip the IDS fleet with a range of new precision @-@ guided weapons and enhanced targeting equipment , in many cases common with those systems already fielded by the UK 's Tornado GR4s . " In December 2007 , the first RSAF aircraft to complete modernisation was returned to Saudi Arabia .

Starting from the first week of November 2009 , Saudi Air Force Tornados , along with Saudi F @-@ 15s performed air raids during the Shia insurgency in north Yemen . It was the first time since Operation Desert Storm in 1991 that the Royal Saudi Air Force participated in a military operation over hostile territory .

= = Variants = =

= = = Tornado IDS = = =

Tornado GR1

RAF IDS variants were initially designated the Tornado GR1 with later modified aircraft designated Tornado GR1A , Tornado GR1B , Tornado GR4 and Tornado GR4A . The first of 228 GR1s was delivered on 5 June 1979 , and the type entered service in the early 1980s . A total of 142 aircraft were upgraded to GR4 standard from 1997 to 2003 .

Tornado GR1B

The Tornado GR1B was a specialised anti @-@ shipping variant of the GR1 . A total of 26 were converted , which were based at RAF Lossiemouth , Scotland , replacing the Blackburn Buccaneer . Each aircraft was equipped to carry up to four Sea Eagle anti @-@ ship missiles . At first the GR1B lacked the radar capability to track shipping , instead relying on the missile 's seeker for target

acquisition , later updates allowed target data to be fed from aircraft to missile .

Tornado GR4

In 1984 , the UK Ministry of Defence began studies for a GR1 Mid @-@ Life Update (MLU) . The update to GR4 standard , approved in 1994 , would improve capability in the medium @-@ altitude role based on lessons learned from the GR1 's performance in the 1991 Gulf War . British Aerospace (later BAE Systems) upgraded 142 Tornado GR1s to GR4 standard , beginning in 1996 and finished in 2003 . 59 RAF aircraft are receiving the CUSP avionics package which integrates the Paveway IV bomb and installs a new secure communications module from Cassidian in Phase A , followed by the Tactical Information Exchange (TIE) datalink from General Dynamics in Phase B.

Tornado GR1A / GR4A

The GR1A is the reconnaissance variant used by the RAF and RSAF , fitted with the TIRRS (Tornado Infra @-@ Red Reconnaissance System) , replacing the cannon . The RAF ordered 30 GR1As , 14 as GR1 rebuilds and 16 as new @-@ builds . When the Tornado GR1s were upgraded to become GR4s , GR1A aircraft were upgraded to GR4A standard . The switch from low @-@ level operations to medium / high @-@ level operations means that the internal TIRRS is no longer in use . As the GR4A 's internal sensors are no longer essential , the RAF 's Tactical Reconnaissance Wing operate both GR4A and GR4 aircraft .

= = = Tornado ECR = = =

Operated by Germany and Italy , the ECR is a Tornado variant devoted to Suppression of Enemy Air Defenses (SEAD) missions . It was first delivered on 21 May 1990 . The ECR has sensors to detect radar usage and is equipped with anti @-@ radiation AGM @-@ 88 HARM missiles . The Luftwaffe 's 35 ECRs were delivered new , while Italy received 16 converted IDSs . Italian Tornado ECRs differ from the Luftwaffe aircraft as they lack built @-@ in reconnaissance capability and use RecceLite reconnaissance pods , also only Luftwaffe ECRs are equipped with RB199 Mk.105 engine , which has a slightly higher thrust rating . The German ECRs do not carry a cannon . The RAF uses the IDS version in the SEAD role instead of the ECR . It also modified several of its Tornado F.3s to undertake the mission .

= = = Tornado ADV = = =

The Tornado ADV (air defence variant) was an interceptor variant of the Tornado , developed for the RAF (designated Tornado F2 or F3) and also operated by Saudi Arabia and Italy . The ADV had inferior agility to fighters like the McDonnell Douglas F @-@ 15 Eagle , but it was not intended as a dog @-@ fighter , instead it was a long @-@ endurance interceptor to counter the threat from Cold War bombers . Although the ADV had 80 % parts commonality with the Tornado IDS , the ADV had greater acceleration , improved RB199 Mk.104 engines , a stretched body , greater fuel capacity , the AI.24 Foxhunter radar , and software changes . It had only one cannon to accommodate a retractable inflight refuelling probe .

= = Operators = =

Germany

German Air Force had 64 IDS and 29 ECR aircraft in service in December 2015 .

Italy

Italian Air Force had 62 IDS and 16 ECR aircraft in operation in December 2011 .

Saudi Arabia

Royal Saudi Air Force had 82 IDS in operation in December 2011 .

United Kingdom

Royal Air Force had 102 GR4 / GR4A aircraft in service in March 2014 .

= = Aircraft on display = =

Bulgaria
44 + 13 Tornado IDS on display at the National Museum of Military History , Sofia
Germany
D @-@ 9591 Tornado Prototype P.01 on display at Militärhistorisches Museum Flugplatz Berlin @-@ Gatow
XX948 Tornado Prototype P.06 on display at Hermeskeil
43 + 01 Tornado IDS (first series aircraft) at Taktisches Luftwaffengeschwader 33 in Cochem / Büchel
43 + 96 Tornado gate guard at the German air base in Jagel , near Schleswig , Schleswig @-@ Holstein
44 + 97 Tornado IDS of the Einsatzgeschwader (Expeditionary Air Wing) Mazar @-@ i @-@ Sharif at the Deutsches Museum Flugwerft Schleissheim , Oberschleißheim
44 + 31 Tornado IDS (Blue Lightning paint scheme) of the 31st Fighter Bomber Wing " Boelcke " at Nörvenich AB
Tornado IDS on display at the Luftwaffenmuseum , in Berlin
Tornado IDS on display at the Technikmuseum Speyer
43 + 86 Tornado (MTU corporate design paint scheme) at MTU Aero Engines , in Munich
Italy
MM7210 Tornado F3 on display at the Italian Air Force Museum , Vigna di Valle
Saudi Arabia
Tornado ADV on display at King Abdul @-@ Aziz Air Base , Dhahran
Tornado ADV on display at the Royal Saudi Air Force Museum in Riyadh
Tornado IDS on display the Royal Saudi Air Force Museum in Riyadh
Tornado IDS on display at King Abdul @-@ Aziz Air Base , Dhahran
United Kingdom
XX946 Tornado Prototype P.02 on display at the RAF Museum Cosford , England
XX947 Tornado Prototype P.03 , was gate guardian at Shoreham Airport in West Sussex , England but was for sale in September 2014 .
XZ631 Tornado GR4 Prototype P.15 on display at Yorkshire Air Museum , Elvington , England
ZA319 Tornado GR1T Gate Guard , MoD DSDA Arncott , Bicester , Oxfordshire , England
ZA326 Tornado GR1 on display at Bruntingthorpe Aerodrome , Leicestershire , England .
ZA354 Tornado GR1 on display at Yorkshire Air Museum , Elvington , England
ZA361 Tornado GR1 on display at RNAS Can Florit , Calvia , Palma Mallorca , Spain - not on public display
ZA362 Tornado GR1 on display at Highland Aviation Museum , Inverness , Scotland
ZA452 Tornado GR4 on display at Midland Air Museum , Coventry , England .
ZA457 Tornado GR1B on display at RAF Museum , Hendon , England
ZA465 Tornado GR1 on display at Imperial War Museum , Duxford , England
ZA475 Tornado GR1 on the gate at RAF Lossiemouth , Scotland .
ZA549 Tornado GR4 on display at RAF Marham , Norfolk , England .
ZE760 Tornado F3 on the gate at RAF Coningsby , Lincolnshire , England
ZE887 Tornado F3 on display at RAF Museum , Hendon , England .
ZE934 Tornado F3 on display at National Museum of Flight , East Fortune , Scotland
ZH552 Tornado F3 on display at RAF Leeming , North Yorkshire , England
United States
ZA374 Tornado GR1 on display at the National Museum of the United States Air Force , Wright Patterson AFB , Ohio
43 + 74 Tornado IDS of the German Navy , Marinefliegergeschwader 1 at the Pima Air & Space Museum , Tucson , AZ

= = Specifications (Tornado GR4) = =

Data from International Warbirds : An Illustrated Guide to World Military Aircraft , 1914 ? 2000 , Tornado , Modern Fighting Aircraft

General characteristics

Crew : 2

Length : 16 @.@ 72 m (54 ft 10 in)

Wingspan : 13 @.@ 91 m at 25 ° wing sweep , 8 @.@ 60 m at 67 ° wing sweep (45 @.@ 6 ft / 28 @.@ 2 ft)

Height : 5 @.@ 95 m (19 @.@ 5 ft)

Wing area : 26 @.@ 6 m2 (286 ft2)

Empty weight : 13 @,@ 890 kg (30 @,@ 620 lb)

Loaded weight : 20 @,@ 240 kg (44 @,@ 620 lb)

Max. takeoff weight : 28 @,@ 000 kg (61 @,@ 700 lb)

Powerplant : 2 × Turbo @-@ Union RB199 @-@ 34R Mk 103 afterburning turbofans

Dry thrust : 43 @.@ 8 kN (9 @,@ 850 lbf) each

Thrust with afterburner : 76 @.@ 8 kN (17 @,@ 270 lbf) each

Performance

Maximum speed : Mach 2 @.@ 2 (2 @,@ 400 km / h , 1 @,@ 490 mph) at 9 @,@ 000 m (30 @,@ 000 ft) altitude ; 800 knots , 1 @,@ 482 km / h , 921 mph indicated airspeed near sea level

Range : 1 @,@ 390 km (870 mi) for typical combat mission

Ferry range : 3 @,@ 890 km (2 @,@ 417 mi) with four external drop tanks

Service ceiling : 15 @,@ 240 m (50 @,@ 000 ft)

Rate of climb : 76 @.@ 7 m / s (15 @,@ 100 ft / min)

Thrust / weight : 0 @.@ 77

Armament

Guns : 1 × 27 mm (1 @.@ 06 in) Mauser BK @-@ 27 revolver cannon internally mounted under starboard side of fuselage with 180 rounds

Hardpoints : 4 × light duty + 3 × heavy duty under @-@ fuselage and 4 × swivelling under @-@ wing pylon stations with a capacity of 9 @,@ 000 kg (19 @,@ 800 lb) of payload , the two inner wing pylons have shoulder launch rails for 2 × Short @-@ Range AAM (SRAAM) each and provisions to carry combinations of :

Missiles : AIM @-@ 9 Sidewinder or AIM @-@ 132 ASRAAM air @-@ to @-@ air missiles for self @-@ defence

6 × AGM @-@ 65 Maverick ; or

12 × Brimstone missile ; or

2 × Storm Shadow

9 × ALARM anti @-@ radiation missile

Bombs : 5 × 500 lb Paveway IV ; or

3 × 1000 lb (UK Mk 20) Paveway II / Enhanced Paveway II ; or

2 × 2000 lb Paveway III (GBU @-@ 24) / Enhanced Paveway III (EGBU @-@ 24) ; or

BL755 cluster bombs ; or

Up to 2 × JP233 or MW @-@ 1 munitions dispensers (for runway cratering operations)

Up to 4 × B61 or WE.177 tactical nuclear weapons

Other : Up to 4 × drop tanks for ferry flight / extended range / flight time

Avionics

RAPTOR aerial reconnaissance pod

Rafael LITENING targeting pod ; or

TIALD laser designator pod

BAE Systems Sky Shadow electronic countermeasure pod

= = Popular culture = =