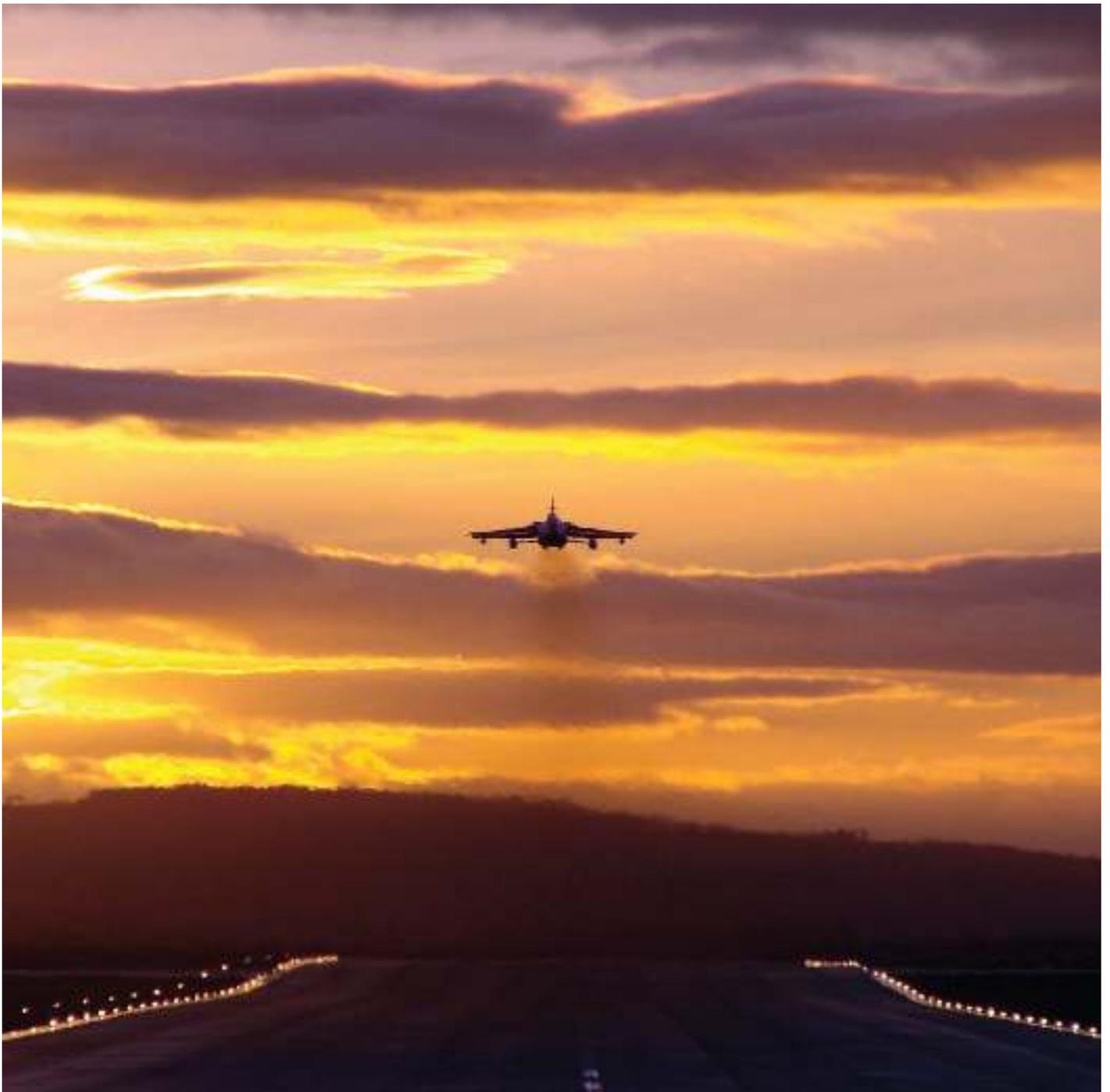


MICHAEL LEEK

THE PANAVIA TORNADO

A PHOTOGRAPHIC TRIBUTE

The Panavia Tornado



After a long and relatively successful career in Royal Air Force service the Panavia Tornado GR4 is scheduled to be retired in 2019, even though its original out-of-service date was to be 2025. Indeed, substantial investments in avionics, reconnaissance and weapons systems have been made and tested through 41 (R) Squadron at RAF Coningsby, Lincolnshire, to facilitate the aircraft's service to 2025.

With continued international concerns over developments in the Middle East, resulting from ill-conceived wars in the region, in the Ukraine and in the Baltic, amongst other places, the need to retain a viable and proven aircraft for the reconnaissance and ground-attack roles has been highlighted – yet again. With the Eurofighter Typhoon still not fully multi-role capable and the controversial Lockheed Martin F-35 Lightning II many years away from front-line operational service with either the RAF or Royal Navy we could see the Tornado's service life extended beyond 2019, as previously intended.

Whatever the short-term future holds, the Tornado, the RAF's last front-line remnant of the Cold War, is nearing the end of its service career. This image of an unidentified Tornado GR4 taking off from RAF Lossiemouth, Moray, in Scotland, under a dramatic mid-winter sky on 19 December 2006, is perhaps a poignant statement of a sight that will soon be the end of yet another chapter in the RAF's history. When this photograph was taken there were four Tornado squadrons at RAF Lossiemouth. Now, in February 2015, there is only one, XV (R) Squadron, the aircraft's much reduced Tornado Operational Conversion Unit. *Sony DSC-H5; 72mm, 1/800 sec at f/5.6, ISO 125.*

(Photo by Michael Leek)

The Panavia Tornado

A Visual Tribute to the Royal Air Force, Germany, Italy and
Saudi Arabia's Successful Multi-Role Combat Aircraft

Michael Leek

With additional photographic contributions from Steve Barnett, Giorgio Ciarini,
Iain Common, Graham Farish, Brian Hodgson, Alex Klingelhöller and 'PhotoRich'.



Pen & Sword
AVIATION



Special tail GR4 ZA469/029 is shown turning over Grasmere lake as the pilot lines up for the climb towards Dunmail Raise, on 20 June 2008. This GR4 commemorates 25 years of the Tornado GR variant and includes the IX (B) Squadron 'Bat' logo, which is traditional to the squadron as their motto is *Per noctum volamus* ('Throughout the night we fly'). In 1944, during the Second World War, equipped with Lancaster bombers, the squadron took part in the successful sinking of the German battleship *Tirpitz* when she was lying off Tromsø in northern Norway. As a result of this operation IX (B) Squadron aircrews would often use the radio callsign 'Tirpitz' when conducting sorties in the UK! Canon 30D; 330mm, 1/500 sec at f/5.6, ISO 400. (Photo by Graham Farish)

DEDICATION

To the memories of

Flight Lieutenant Nigel Morton RAF

and

Flight Lieutenant Kenneth Thompson RAF

of

43 Squadron, RAF Leuchars, Fife, Scotland,

who died when their Tornado F3, ZE982 (BLACKSMITH 1) crashed at
Glen Kinglas, Argyll, Scotland, on Thursday 2 July 2009

and to

Squadron Leader Samuel Bailey RAF

Flight Lieutenant Adam Sanders RAF

and

Flight Lieutenant Hywel Poole RAF

of

XV (R) Squadron, RAF Lossiemouth, Moray, Scotland, who died when their
Tornado GR4s, ZD743 (ASTON 1) and ZD812 (ABBOT 2) collided
over the Moray Firth, Scotland, on Tuesday 3 July 2012

May their loss not be in vain

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Acknowledgements

As with the first in this mini-series of photographic aviation books dedicated to three significant and long-serving RAF aircraft I must record my sincere thanks to the contributors, all of whom, like me, are amateur photographers. Those who contributed to *The British Aerospace Hawk: A Photographic Tribute* and who stayed the course by offering their photographs for this volume are Iain Common from Scotland, Graham Farish and Brian Hodgson from England, and Alex Klingelhöller from south-west Germany.

Iain Common has spent many hours on the hills around Pitlochry photographing military aircraft. Considering that Scotland north of the central belt is the largest designated low-flying area in the UK, the one trait that is needed in abundance by photographers is patience, and having spent many hours with Iain I can testify that patience he has. His patience over many years has paid dividends when it comes to capturing the rare or unusual in Scottish skies. Unfortunately the resolution quality of some of Iain's early photographs were too low, which restricted the numbers that could be used in my Hawk book. However, I'm pleased to say that this has been rectified in this volume, thereby offering readers the opportunity to see Tornados operating in a low-level environment through some of the most beautiful of landscapes in the UK, an environment rarely witnessed by the majority of aviation photographers. Indeed, as I write this Iain is by Loch Ewe where he's been photographing Falcons, Hawks and Swedish Air Force Gripens during the second of 2014's JOINT WARRIOR exercises.

Having worked with Graham Farish on three aviation photography books I can now state with some conviction that, when it comes to the low-flying system in the United Kingdom, Graham is probably the most widely travelled amateur low-flying photographer in the UK. I have seen more of his photographs than can be reproduced here – and not just of Tornados – and it is obvious that distance is no barrier to Graham seeking out new locations, often with a high degree of success. From Ullapool in Wester Ross to the south-west of England, obscure

corners of Dumfries and Galloway, and most places in between, Graham has travelled widely for his photography. Of particular note are the well-used low-flying areas in northern England, where few amateur photographers visit, probably because these locations lack the convenience of The Mach Loop in central Wales. Graham's home is in the English county that will always be associated with the RAF. In the interests of aviation history we can only hope that Graham will one day produce his own book – it will, by default, be a very large book too!

Close on Graham's heels is Brian Hodgson whose work is not widely known, but should be. He too is not averse to travelling some distance for his photography, his most recent being a visit to the USA photographing low-level USN and USMC F-18 Super Hornets and AV-8B Harriers from the Naval Air Weapons Station China Lake in California! Brian's aviation photography development runs parallel to the development of digital photography itself, as will be evident from some of his photographs and the equipment he has used; updating as the technology has improved (he took up low-flying photography in 2002). A personal commitment to his low-level photography has resulted in Brian having recorded some unusual or rarely seen aircraft, particularly in a low-level environment. Brian is also prepared to travel in order to record on camera a particular aviation event, anniversary or a different low-flying location, and is on a hillside as I write these words! In fact Brian is on a hill between Loch Merkland and Loch Shin, above Merkland Lodge, in remote but beautiful Sutherland.

Alex Klingelhöller is a keen amateur photographer of military aviation who has the advantage of having completed compulsory military service with German army aviation. He has developed good relationships with his local Lufwaffe units that were, until closure, close to his home in south-west Germany. One of his photographs included in this book is of an RAF Tornado GR4 low-level. It was taken on Alex's first trip to The Mach Loop in mid-Wales in the summer of 2014, where he and his family took a holiday. Unfortunately whilst he was in Wales the number of

low-flying movements were few and far between – a situation that is now, sadly, the norm – otherwise I have no doubt that this book would have contained more of Alex's excellent photographs. Since Alex's contributions to my Hawk book, he has upgraded his equipment and now has an impressive Canon suite.

For this book the newcomers are Steve Barnett, a former RAF technician who spent many years working on the Tornado F2 and F3, the fighter variant of the original Tornado MRCA, and who now works for Rolls-Royce maintaining Tornado RB.199 Mk 103 turbofan engines and soon to be doing the same on Eurojet EJ200 engines used in the Eurofighter Typhoon. Secondly is Giorgio Ciarini from Novara, a few miles south of the Italian air base at Cameri in northern Italy. The third and final 'newcomer' wishes only to be known by his online username, 'PhotoRich', although it will be obvious to all that 'PhotoRich' has connections with the RAF as there's no other way he could have taken air-to-air photographs of Tornado F3s over the Falklands!

As with other amateur photographers – the author included – the contributors all have lives outside military aviation photography so it is with my gratitude that they responded as they did in order that this book should be completed, representing as wide a selection of photographs of Tornados as was possible within the space limitations of the book.

Not surprisingly, considering the length of service of the Tornado in RAF, German and Italian service, the number of photographs to choose from would have made it easy to fill a number of volumes. The vast number of images from all concerned made the selection process extremely difficult and whilst I make no apology for my very personal and subjective choices, be they my own photographs or those of the contributors, putting this book together was far more demanding than my Hawk volume. Inevitably, space restrictions have meant that some images previously selected for inclusion have had to be removed and because of this I would like to add to my thanks, appreciation and gratitude to the contributors for their understanding.

For help confirming details of Tornados in Italian service I must thank Giorgio Ciarini again. Giorgio is a noted aviation photographer and writer. From the German perspective, Alex Klingelhöller, in addition to supplying photographs, kindly checked my service history for Tornados in Lutwaffe service. However, any errors in my listings of squadrons and units from these two countries are mine and mine alone.

A special thanks must be extended to Warrant Officer Anthony Hughes BSc RAF, formerly of RAF Lossiemouth. Such are the ways of the world that it

was through Tony's wife Nicky that we met. I needed a number of inoculations prior to extended visits to Vietnam and South-east Asia, and Nicky was the nurse tasked with giving them to me. Her screen saver – an elevated panoramic photo of a classic Scottish highland landscape that she took herself – got us talking about photography and eventually aircraft flying low-level through the glens. This led Nicky to telling me about her husband who then worked at RAF Lossiemouth. The rest, as they say, is history.

Of course I must also record my thanks to the wider RAF, particularly those who worked with the Tornado, be they from RAF Coningsby, RAF Leeming, RAF Leuchars, RAF Lossiemouth or RAF Marham. Without their professionalism in servicing, maintaining and operating the Tornado it would not have been possible to take the photographs reproduced in this book. Whenever I have come into contact with the people who fly and maintain the Tornado I have always been made welcome.

I would have liked to have involved the RAF in this book but the draconian 'rules' laid down by the faceless bureaucrats in the UK's Ministry of Defence (MoD) following Operation TELIC and Operation HERRICK prevented it. These 'rules' now preclude any involvement by any of the British armed services unless there is a moneymaking spin off for the MoD. A sad state of affairs compared to not so long ago when the Royal Navy, the British Army and the Royal Air Force went out of their collective ways – within the bounds of security and operational requirements – to help those members of the public, amateur photographers and authors who, by their interests, actively supported the work of their country's armed services.

It will be obvious that a number of photographs have been taken at the fence line at RAF Lossiemouth, in Moray, Scotland. RAF Lossiemouth was one of the major Tornado fast jet stations, but since further Tornado squadron disbandments in 2014 it is sadly now relegated to hosting the much smaller Tornado Operational Conversion Unit, XV (R) Squadron. However, over many hours photographing departing, arriving and taxiing Tornados, and waiting for 'something different' to appear (reminiscent of the Cold War days when Lossiemouth was alive with visiting aircraft from practically every NATO country, and more), I have got to know many other enthusiasts. Whilst they have not contributed to this book, I would like to acknowledge them if only because of their company, good humour and sometimes passionate interest in the Tornado and in other military aircraft, be they RAF or from elsewhere. They include Tom and Sally Tolman, Paul Dalton, Les Goodison, Chris Milne,

Niall Paterson, John Reid and Martyn Wraight, amongst many others. Niall Paterson, in particular, has been a mine of sometimes detailed information when it comes to aircraft movements, almost on an hourly basis!

A few years ago I was having a conversation with a pilot from 12 (B) Squadron. He asked me what I did with the hundreds if not thousands of photographs I took, be they low-level or from a fence line somewhere. At the time I posted some photographs on a number of aviation forums, uploaded some to one of my two websites and even had a few published in aviation and photography magazines, whilst the remainder filled up storage space on computers or external hard drives, rarely seeing the light of day. Thanks to my publisher, Pen and Sword Books, I have had that rare opportunity to get many of my photographs published in book form, and, for this mini-series, in a format that allows me to maximise my personal image selection. Even though it's up to me to take the photographs, process them, write the text, organise the contributions from others, and much else besides, I'm aware that having my work published is a privilege and I'm grateful to the team at Pen and Sword Books. From Pen and Sword itself I must again record by name my thanks to Laura Hirst, the Aviation Imprint Administrator, for her continued support, encouragement and professionalism (and patience!). I would also like to thank my editor Richard Doherty, an established military historian in his own right.

As with my two previous aviation photography books I must record my thanks to my good friend

Patrick Adamson. Patrick has no interest in military aviation but has nevertheless provided regular moral support and encouragement during sometimes long and frustrating periods trying to pull this book together, particularly the organisation of the images.

I'm grateful to the help afforded me by the staff at Elgin Library. They and their colleagues in Buckie have always been extremely helpful.

Image processing for this book started during my first extended stay in Hà Nội, Vietnam, from November 2013, where my partner, Dr Kristan Schoultz, took up a new post with the United Nations. To even contemplate image processing meant setting up a small study in the house Kristan and I shared in Hồ Tây district in Hà Nội. I would like to thank her for her forbearance even though, like most of my friends and family, she has no interest whatsoever in the military. However, and maybe not so surprisingly, she did enjoy the excitement of watching fast jets – and Tornados in particular – when I took her to the fence line at RAF Lossiemouth in August 2013. This was a first for her even though her home in the USA lies under the flight path of a former USAF F-15C Eagle base.

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November 2013—February 2015
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The author on the flight deck of a British Airways Concorde supersonic airliner. This was taken in 1984 when the author was Senior Lecturer in Technical and Information Illustration at what is now the Arts University Bournemouth. British Airways allowed unrestricted access to their Concorde fleet when the author was researching a project to illustrate the design and construction of the aircraft for the Science Museum, London.

Chapter One

Context

On Monday 16 June 2014 there was a news announcement that, by 2017, the United Kingdom's defence expenditure was, in real terms, likely to fall to 1.9 per cent of the UK's national economy (or gross domestic product), and, the report stated, is likely to fall to 1.6 per cent by 2024 unless government acts now. This is below the North Atlantic Treaty Organisation's (NATO) agreed target that, alongside the USA, the UK should spend at least 2 per cent of gross domestic product on defence. This simple fact highlights a continuing problem over the past three or more decades regarding defence expenditure, procurement and management by the UK Ministry of Defence (MoD), arguably the most problematic department of state due to poor management (unbelievably the MoD only produced its first ever business plan in November 2010). With poor management has come weak leadership and a lack of clear, long-term strategic direction by successive governments and senior civil servants. Indeed, between November 2010 and June 2012 the senior civil servant in the MoD – known as the permanent secretary – came from the Department of Works and Pensions, and before that the Ministry of Justice. This suggests that a knowledge or understanding of the work of a particular department or ministry is not considered a prerequisite for such a senior position, a state of affairs that probably wouldn't be tolerated outside of government. Indeed, during a cross-examination, by the Parliamentary Public Accounts Committee in April 2012, the lack of knowledge and a refusal to answer questions by the permanent secretary on the excessive cost overruns on the two Royal Navy (RN) aircraft carriers being built in Rosyth was evident to all.

It may now be considered a cliché, such are the number of times it's stated, but it would seem that through the MoD the British armed services plan for the last war, or the last conflict. There seems to be an inherent lack of corporate ability to look to the future – based on the past and the present – and plan accordingly. This is unlike countries such as the USA, the French or some of the Scandinavian countries, who seem more able to develop relevant geopolitical

strategies that allow defence chiefs to plan flexibly for an increasingly hostile future, even though the illegal and immoral invasion of Iraq in 2003, based entirely on falsehoods and deliberate deceptions by both President Bush Jnr and Prime Minister Blair, has resulted in an understandable distaste on the part of the public from the USA and UK in particular to get involved in some of the world's increasingly volatile regions. At least that is the state of public opinion in the UK in mid-2014.

It makes no difference to government and politicians how many retired defence chiefs get on their soapboxes to pontificate *ad nauseum* – sometimes extremely and surprisingly subjectively – about the need for more ships, more soldiers and more aircraft. This poses the rhetorical question as to why they were so timid or silent when serving in their exalted positions. Why none of these senior military chiefs had the courage of their convictions to resign over what they saw as unreasonable and unprecedented defence cuts is not known. Maybe bravery in Whitehall – on behalf of those they command – is not as easy as on the battlefield! Could it be fear of the civil servants who run the MoD or a lack of the independent qualities that made Nelson, Wellington and Trenchard achieve so much in comparison? Whilst the retired defence chiefs might be correct in their assessments of their respective services, demonstrating a serious and petty-minded lack of joined-up thinking because of inter-service rivalries, and in their 'demands' for increased defence spending, the fundamental problem remains that the MoD continues to be seemingly unmanageable as it continues to offer advice to ministers that is nothing more than expensive short-termism. This long-running situation is not helped by events outside of government and MoD control.

Yet when the ignorance – and arrogance – of politicians and the incompetence of civil servants result in major shortcomings in training and equipment, such as insufficient helicopters in Afghanistan, seriously inadequate training schedules for Tornado aircrew, or the perverse reasoning underlying the decision *not* to fit anti-collision

warning systems in the Tornado fleet, that result in unnecessary deaths of service personnel, one has to ask why no one is ever held to account. In any other sphere of life in the UK, criminal prosecutions would undoubtedly follow, but for the politicians, some senior civil servants and, indeed, some middle and senior ranking officers, the 'system' protects them.

* * *

The weekend of 27/28 September 2014 saw RAF Tornado GR4s flying combat missions over Iraq in delayed support of the US-led coalition against the Islamic State (IS, or Islamic State of Iraq and the Levant, ISIL, or the Islamic State of Iraq and al-Sham, ISIL – all one and the same organisation). The so-called coalition highlights the complexity of what the UK's prime minister, David Cameron, said could be a long-drawn out campaign against IS, lasting many years. Qatar and the Kingdom of Saudi Arabia are both partners in the US coalition (NATO partners include France, The Netherlands and, later, Belgium, Denmark and the UK). However, both of these predominately Sunni Gulf states have allowed, if not formally sanctioned, the funding of IS. That the US or the UK have publically done little to discourage this funding is probably because both Saudi Arabia and Qatar are significant customers for US and British armaments. This level of hypocrisy by the US and UK is not new when it comes to international politics and government-led arms sales. Sadly, those who suffer as a result of such grand double-standards are inevitably innocent civilians, the misnomer that is 'collateral damage'.

During the early days of US attempts to reduce the violent brutality of IS there was discussion about the most effective air-to-ground aircraft. Not surprisingly the Fairchild Republic A-10 Thunderbolt II was mentioned as an ideal platform from which to launch attacks against IS convoys and known fixed locations, etc. However, the A-10 Thunderbolt II, affectionately known as the Warthog, has been earmarked by the USAF for early retirement because it is considered inflexible due to it being a 'single mission aircraft', ground attack only, and specifically in the anti-AFV role (a design legacy from the Cold War). Retiring the Warthog would save millions of dollars because of budget sequestration resulting from a failure of the US administration to come to an agreement with Congress in setting federal budgets, a fiasco that by US law was first implemented in January 2013, and continues. Whilst no official decision on the Warthog's future has been made at the time of writing, it could be that this very capable aircraft

could remain in service for at least a few more years because international circumstances require, in the case of the campaign against IS, a proven and fit-for-purpose platform that would hopefully ensure limited collateral damage.

In the meantime, the US and much of NATO are currently in the process of trying to get the Joint Strike Fighter (JSF) Lockheed Martin F-35 Lightning II into service, despite an incredible list of cost overruns, technical, development and safety problems, not the least being serious engine fires and a number of groundings. This so-called fifth generation stealth aircraft has been designed to operate in a high tech environment of the type anticipated should the Cold War have ever developed into a 'hot' war. The JSF was never designed for 'basic' counter-insurgency operations such as is currently required against organisations like IS. Besides the fact that the F-35B, the version of the JSF the RAF and RN will be obliged to operate due to the inevitable poor planning on the part of the MoD and decisions by ill-informed and ignorant politicians, the aircraft will have severe operational limitations due to its extremely short range and a degrading of its stealth capabilities when carrying external stores and/or weapons. What adds to the perversity of the JSF programme insofar as the RAF and RN are concerned is that the decisions were based on incoherent planning in respect of the RN's next generation of aircraft carriers. The RAF will be obliged to operate the F-35B because that is the version the RN *must* operate since the UK government decided, for cost reasons rather than long-term strategic reasons, not to build aircraft carriers with conventional catapults. There's nothing quite like expensively ignoring the experience, expertise and knowledge of your closest ally.

The seemingly never-ending fiasco of the JSF's journey towards operational service must be seen in the context of the decision by the UK government to retire the Tornado GR4 six years early, and the wider context of international tensions such as stemming the brutal tide of IS in the Middle East. The unavoidable linking of these contexts suggests, yet again, a fundamental flaw in the muddled thinking that results in vast sums of money being spent to ensure the Tornado GR4 continues to be fit-for-purpose until 2025 at least, but, according to a recent press release by BAE Systems, it will be retired in 2019. The JSF is not expected to be operational by the RAF and RN until 2018 at the earliest – and even then the RAF's experience in getting the Typhoon fully operational as an integrated multi-role platform suggests 2018 is incredibly optimistic. With the Typhoon still not fully operational in the ground attack role until 2017 at the

earliest, yet first accepted into RAF frontline service in 2007, the decision to retire the Tornado GR4 in 2019 seems completely irrational.

However, defence matters are rarely, if ever, simple or straightforward; too many vested interests by subjectively and narrow-mindedly thinking individuals, self-interested groups and corporate shareholders prevent a broader view from being taken that leads to rational decision making. For example, in February 2012 it was estimated that the cost to the RAF alone for operations over Libya (Operation ELLAMY – see Chapter Three) amounted to £1.35 billion, with an estimated £40,000 per night being spent on four-star hotels in southern Italy for air and ground crews. Libya highlighted, yet again, why the UK needs carrier-based aircraft and why it was probably one of the most incomprehensible of recent MoD/government decisions to scrap the Harrier fleet. In the words of a written presentation made to the Parliamentary Defence Committee on 19 July 2011, C. J. A. Pope stated:

It does not take a mathematical genius to realise that operating [Harrier] GR9s from a carrier lying just outside Libyan territorial waters has simply got to be substantially cheaper than flying Tornados and Typhoons from their base in Italy the 600 miles or so nautical miles to Libya and then back again, with VC10/Tristar refuelling on route – not to mention the massive logistical support train by air and hotels in southern Italy.

Pope goes on (*italics represent my emphasis*):

Launched from carrier, [Harrier] GR9 can be on task delivering weapons within 30 minutes of, for example, a call for urgent support from ground forces. In contrast, a Tornado/Typhoon operating from Gioia del Colle has a transit time of 1.5 hours to reach its target and, of course, requires air-to-air refuelling. In addition, *the RAF insists on having 24 hours' notice of close air support missions* in order to support ground forces.

In quoting the above I am not in anyway denigrating the work the RAF did over Libya, or elsewhere, or to question the already proven effectiveness of Tornados once in position, but this ridiculous state of affairs demonstrates a real and urgent need for some serious long-term thinking on the part of government, the MoD, the RAF and the RN. The starting point should be whether retiring the RAF's Tornados in 2019 is a sensible decision. We – the UK, and the MoD in particular – could also learn from our closest ally and how they deploy their forces at short notice.

The UK parliament's vote in favour of supporting action against IS in Iraq has probably led to a realisation that with the Eurofighter Typhoon being incapable of operating independently (as evidenced during operations over Libya), delays to the JSF programme and the scrapping of the Harrier fleet means the Tornado, regardless of its age, is the only capable 'platform'. The circumstantial evidence for this is the fact that the number of Tornados deployed to Cyprus in September 2014 in the fight against IS is to be increased and that 12 (B) Squadron, formerly at RAF Lossiemouth, was reformed at RAF Marham in January 2015, meaning there are now three front-line Tornado squadrons – the minimum to support eight aircraft operating against IS. Originally it was planned to retain II (AC) Squadron on Tornados for at least another year, but this squadron has converted onto the Typhoon at RAF Lossiemouth.

If Prime Minister David Cameron's assertion that the fight against IS will take years rather than months to conclude then it is my considered opinion that common sense might prevail and we'll see the Tornado GR4 continue in service until at least its original out-of-service date in 2025.

* * *

This book is not presented as the definitive history of the Tornado, be it in RAF, German, Italian or Saudi service. Such a history is for others to write. Authors such as Peter Foster, an established and authoritative military aviation writer who has already written two very well-received books on the Tornado, come to mind to write the conclusive history. In the coming years, as the Tornado's actual retirement date approaches, there will undoubtedly be many books published on this significant, combat-proven aircraft. This book represents a visual contribution to what will very soon become a historical legacy of a long-serving aircraft. The emphasis is understandably centred on Tornados in RAF service, although fortunately it has been possible to include limited examples of Tornados in German, Italian and Saudi service (although the latter only because some have flown in UK airspace).

The selection of images has been entirely subjective. The starting point has been from my own collection of digital photographs supported by those from the contributors. The criteria I set myself was to present, from an amateur photographer's perspective, a visual record and tribute to the Tornado, in as many aspects of its 'life' as was possible. Unless otherwise stated, all photographs have been taken from publically accessible locations.

As with my previous military aviation photography books, the text has been written to complement the

text, to provide some background information and wider context in which the photographs were taken.

* * *

‘Missing’ from this book is a chapter on photographing the Tornado. Whilst the aircraft is completely different, my approach has not differed significantly from the way in which I photographed the Hawk, so if readers are interested I refer them to the first book in this mini-series (*The British Aerospace Hawk – A Photographic Tribute*, 2014) and to my low-flying book (*Military Low Flying in the UK: The Skill of Pilots and Photographers*, 2012). Even though some of my equipment and post-processing software have changed since I wrote about the Hawk, these changes are not significant enough to warrant a dedicated chapter. Also, and although there are three new contributors to this book compared to the Hawk, I have not included profiles of any of the contributors, because the new ones did not want to write such statements and, secondly, to repeat previous statements or profiles seemed unnecessarily repetitive.

As with my Hawk book I have deliberately avoided having photographs that run across a double-page spread. This is because alignment between two pages can often be a problem, plus the fact that the gutter frequently makes it difficult to view the image as a whole without running the risk of breaking the spine. However, compared to many books and magazines, the prime image format that I adopted for use in these books is still larger than most, so I don’t believe there has been any compromise on quality or detail. Fortunately too, the prime image format almost conforms to the proportions of the Golden Mean (approximately 1.62:1) which I would argue is one of the best proportions for an image, be it digital or otherwise, landscape or portrait.

All of the original photographs were digital as I decided that to include film-based photographs – amateur photographers like Iain Common have many – would have not only involved far more work, but also might have detracted from the primary purpose of this mini-series. The selection of the Hawk, Tornado

and Harrier aircraft for photographic tributes was entirely on the basis that these three aircraft will soon be retired from RAF service, prematurely or otherwise (or already retired in the case of the Harrier), so I decided to focus on the last few years of service, which of course coincides with the widespread use of digital photography, a medium that lends itself perfectly for the recording of low-flying military aircraft in particular.

The accompanying text is not intended to be a conclusive or definitive history of the Tornado. It is, in a wider sense, an introduction to the aircraft in the broader context of the political decisions that have influenced its service deployment, particularly in recent years, and, more significantly, the premature out-of-service date for the Tornado GR4 from RAF frontline service. The text is very much a personal interpretation, whilst Chapter Two is an attempt to summarise accurately the salient design features and technical specifications of the Tornado in RAF service.

The emphasis throughout is, of course, on the photographs and, where necessary and/or appropriate, detailed captions, including basic shooting data. Serial numbers of aircraft have been included where known, although I have to admit to not having any interest in such matters – my interest is merely in trying to take interesting photographs within the limitations imposed by the subject and having to maximise opportunities when they present themselves. The photographs have been selected to show the Tornado in detail from different angles and, for the GR4 in particular, in the environment for which it was designed; fast, low-level and in all weathers, day or night. The Tornado GR4 is no fair-weather blue-sky aircraft; it’s at its best down amongst the heather, gorse and mountain grasses. And because the Tornado is the last RAF aircraft in service that was designed to support NATO operations should the Cold War ever have become ‘hot’, it is hoped that this book will be at least a small contribution to the visual history of what was a highly successful career of an aircraft that was originally criticised for trying to be ‘all things to all men’.

Chapter Two

The Panavia Tornado

The Panavia Tornado is a variable-geometry, two-seat, twin-engined, all-weather day and night strike, attack and reconnaissance aircraft. It can operate at supersonic speed, be it low-level or at altitude.

The fuselage is an all-metal semi-monocoque structure built primarily of aluminium alloy, with extensive use of titanium (this was before lightweight composite materials had been developed). The fuselage is in three sections: front fuselage, including the two-seat tandem cockpit cell; centre fuselage, including the wing glove box; and the rear fuselage that includes the twin-engine section, or bay.

Integral in the fuselage sections are self-sealing fuel tanks (which were extended on the lengthened F2/F3). On the starboard side, just below the forward cockpit sill in the front fuselage section, is a NATO-fit in-flight retractable refuelling probe. Further internal and integral fuel tanks are housed in the forward part of the fin and within the centre of each wing. A Tornado is capable of carrying over 5,000 kg of fuel in its internal and self-sealing tanks, or bags (equivalent to five long tons).

The nose, forward of the windscreen, is the radome housing. In the GR versions this comprises the forward-looking terrain-following and ground-mapping radar. In the F3 the Foxhunter airborne interception radar was fitted. Both systems went through a number of upgrades, particularly the F2/F3 where the early radar system was prone to high levels of failure resulting in unusually high workloads for the crew. Fortunately the F2 was never put to the ultimate test.

The front cockpit, incorporated within the widescreen space, is the pilot's head-up display (HUD) and associated weapons aiming computer. This system enables the pilot to access important and relevant data without having to constantly avert his or her attention by looking at the instrument panel. Since the introduction of the Tornado into frontline service the HUD system, and other avionics, have undergone numerous improvements, thereby enhancing the whole combat systems management into an even greater integrated whole. This, along with

improvements in weapons systems and delivery, and advances in electronic reconnaissance systems, makes the Tornado GR4, even after over thirty years of service, a still formidable weapons and reconnaissance platform.

The windscreen itself is in three parts, all being specially armoured against bird strikes, something the RAF understandably takes very seriously by imposing strict minimum impact standards. The windscreen also incorporates de-icing and demisting heating, and a rain dispersal system fed by hot pressurised air.

The cockpit at first appears relatively spacious, but, having sat in both seats, I can testify that even though the comfortable ejection seats are identical, the pilot's position is decidedly tighter in overall space, particularly in terms of leg room. Considering the numerous displays and control panels that are necessary to operate the aircraft, and for what the aircraft is designed for, the limited space is inevitable. The Weapons System Officer's position is fronted by three screens, whilst below and to the left and right are other essential controls but the space feels more spacious. Once tightly strapped in though, the perception of increased space takes effect for both positions.

Aft of the cockpit cell and the air intake units, and behind the short forward main spar, is the wing glove box, previously mentioned, the outer ends being the wing pivot points for the outer, variable-geometry wing panels. This box is integral with the wing centre section, which itself is a significant part of the aircraft's structure in terms of both weight and strength. The design of the variable-geometry wing structure and its operation means the aircraft can land safely with the wings in any position. The top and outer sides of the centre section, surrounding the bay in front of the engines, contain an integral, self-sealing fuel tank.

The engine bay itself, part of the rear fuselage, is divided down the centre line by a titanium firewall.

The taileron unit is a single, all-moving unit. On each side, between the roots of the taileron and the huge fin, are the hydraulically operated airbrakes. The fin itself contains not only the rudder, but

also the passive forward and aft-facing electronic countermeasures (ECM) housing. These are located to the top of the fin, protruding both fore and aft. Fuel dumping, when necessary, is achieved by a fuel jettison point below the aft-facing ECM housing (there is at least one photograph in this book of a Tornado jettisoning fuel whilst on finals into RAF Lossiemouth). The forward base of the fin, just above where it joins the spine of the centre fuselage, is the heat exchanger ram air intake housing.

From the outset the Tornado was designed for ease of maintenance. As a result over 45 per cent of the total surface area consists of removable access panels. At the time this was considered exceptional.

On the outside of the front fuselage section, alongside the rear cockpit, are fitted the two-dimensional horizontal double-wedge engine intakes with variable inlet ramps.

The undercarriage has been designed to withstand operations from semi-prepared strips, a factor that was dictated by perceived operations in a primarily north European war against the former Soviet Union where fast-moving battlefield scenarios required much higher levels of force mobility to get assets in the right place at the right time, with little time to prepare in advance. The twin-wheel nose gear is steerable and retracts forwards. The main undercarriage legs are single-wheel and retract forwards and upwards into the fuselage.

All Tornados carry arrester hooks, located on the centre aft of the fuselage. This hook is purely for emergency use should the brakes or reverse thrust fail.

The centre fuselage is common to both GR and F2/F3 types, but moving forward and aft the F2/F3 was longer in both directions. This increase in length was to fit the Foxhunter radar and to enable larger internal fuel tanks to be fitted. The increased length also

accommodated the larger airbrakes required for the F2/F3.

The variable-geometry wing is, in optimum use, angled relative to a given speed. In four stages this would equate to the following wing sweep angles:

25° to Mach 0.73
45° to Mach 0.88
58° to Mach 0.9
67° above Mach 0.9

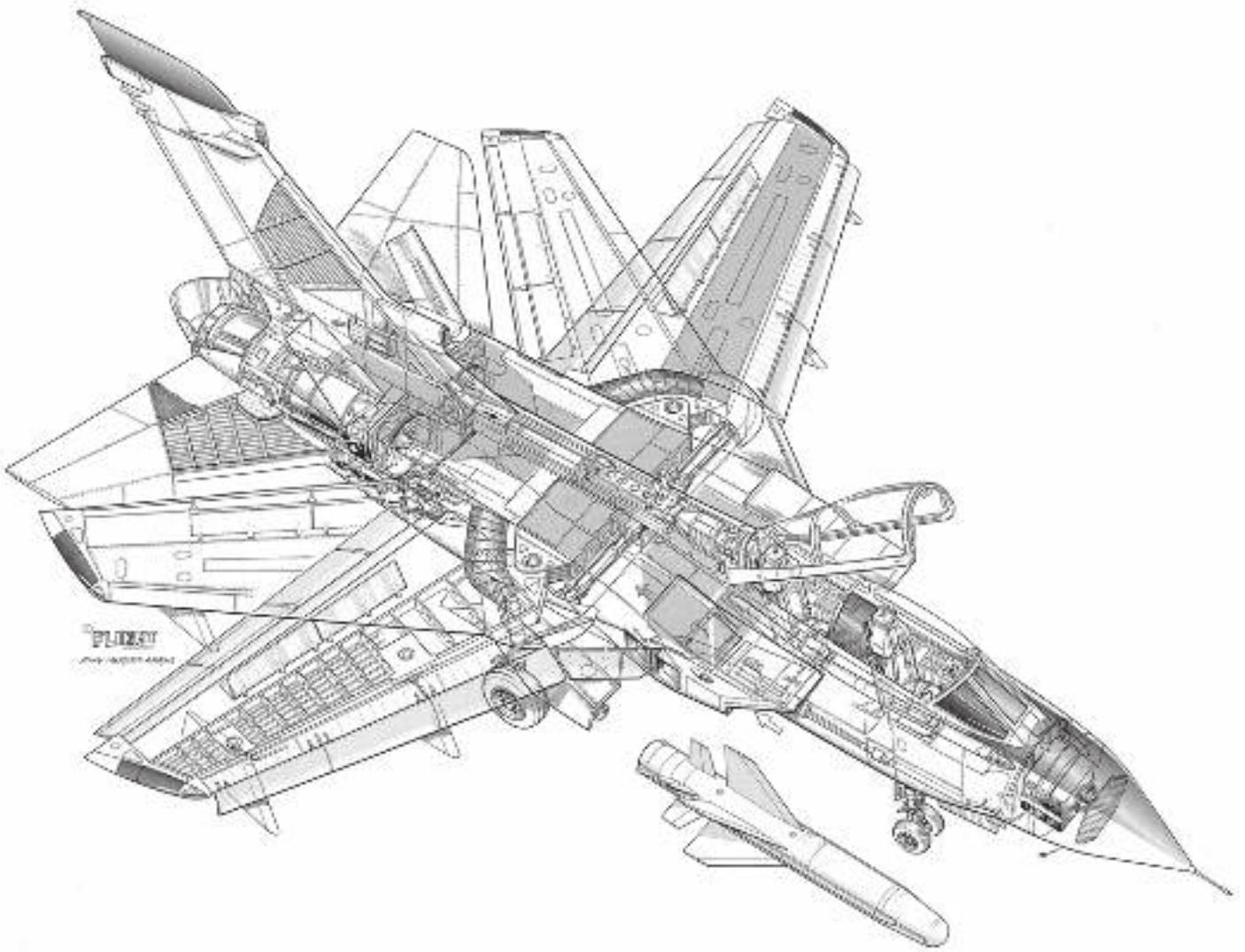
RAF Tornado specifications

As in my book on the Hawk, finding accurate and reliable data on the Tornado has proven surprisingly problematic. No two sources have the same information when it comes to the aircraft's technical specification. Even RAF websites contain contradictory data. However, the most comprehensive data (but not complete) may be found in *RAF Tornado – 1974 onwards (all marks and models)*, by Ian Black, published in 2014. Other consistent specification data, but again incomplete, is in various editions of *Jane's All The World's Aircraft*. I would particularly recommend Bill Gunston's excellent *Panavia Tornado*, published in 1980, and Doug Richardson's extremely detailed description that is *Aviation Fact File – Modern Fighting Aircraft: Tornado*, published in 1986. What is presented below is therefore not offered as definitive, except for the obvious.

For the Tornado weapons fit a useful reference is *Royal Air Force Aircraft & Weapons*, edited by Squadron Leader Brian Handy RAF. Whilst published in 2003 and therefore significantly out-of-date, it is nevertheless a very useful source and must be considered accurate, within security limitations, as it was published by the MoD.

GR4 specification

Primary role:	All-weather, night-and-day, low-level supersonic tactical strike and reconnaissance aircraft
Crew:	Two: Pilot and Weapons Systems Officer (WSO, sometimes incorrectly referred to as Navigator)
Ejection seats:	Martin-Baker Mk 10A
Overall length:	16.70m (54ft 9.5in)
Wing span, at 25° sweep:	13.91m (45ft 7.25in)
Wing span, at 68° sweep:	8.60m (28ft 2.5in)
Taileron span:	6.80m (22ft 3.5in)
Height:	5.95m (19ft 6in)
Wing area:	26.60m ² (286.3sq ft)
Track:	3.10m (10ft 2in)
Wheel base:	6.20m (20ft 4in)
Internal fuel:	514kg (11,310lbs)
External fuel:	1,800kg (3,960lbs)



Panavia Tornado GR1

This perspective cutaway illustration was completed and published in *Flight International* prior to the type entering service with the RAF in 1979. It shows as much internal information as was permissible at the time, and whilst not comprehensive it is nevertheless accurate and shows the salient internal arrangements of what was then an advanced and genuine multi-role aircraft. For security reasons prevailing at the time it was not possible to include the range of weapons fit or reconnaissance equipment that the aircraft was designed to carry. Illustration by the late John Marsden AMRAeS, former senior technical illustrator at *Flight International*. (© *Flightglobal/Imagestore*; www.flightglobalimages.com)

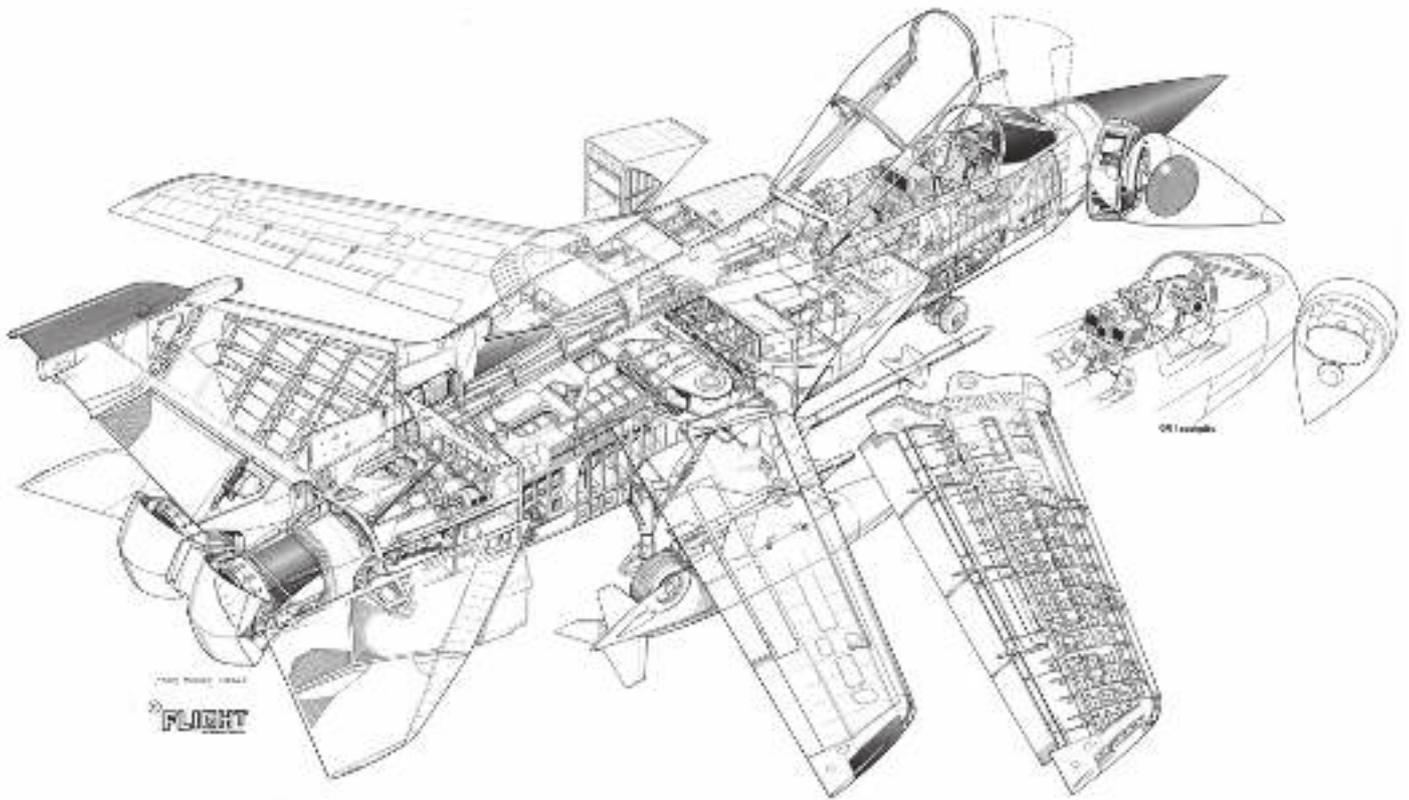
Maximum take-off mass:	28,500kg (62,883lbs)
Empty mass:	13,890kg (31,620lbs)
Powerplant:	Two Turbo-Union RB.199-34R Mk 101 three-shaft afterburning turbofans with integral reversers (see below).
Dry thrust:	43.8 kN (9,850lbf) per engine
Thrust with afterburner:	76.8 kN (17,270lbf) per engine
Service ceiling:	15,240m (50,000ft)
Rate of climb:	4,602m/min (15,100ft/min)
Combat range (external fuel):	1,389km (863 miles)
Ferry range (external fuel):	3,890km (2,417 miles)
Max speed:	Mach 1.3 (approximately 1,592.55km/h or 989.57 mph at sea level)

Armament

Guns:	1 x 27mm (1.063 in) Mauser BK-27 revolver cannon with 180 rounds, internally mounted on the starboard side of lower fuselage, below cockpit.
Hardpoints:	4 x light duty 3 x heavy duty under-fuselage 4 x swivelling under-wing pylons (two inner-wing pylons have shoulder-launch rails for 2 x short-range AAM (SRAAM) missiles each)
Payload:	9,000kg (19,800lbs)
Missile capability:	4 x AIM-9 Sidewinder or AIM-132 ASRAAM missiles 6 x AGM-65 Maverick 12 x Brimstone 2 x Storm Shadow cruise 9 x ALARM anti-radiation
Bomb capability:	5 x 500lb Paveway IV 3 x 1000lb Mk20 Paveway II/Enhanced Paveway III (EGBU-24) Hunting Engineering BL755 cluster bombs 2 x JP233 or MW-1 munitions dispensers 4 x B61 or WE.177 tactical nuclear weapons
Other:	Up to 4 x drop tanks for ferry purposes, plus 1 additional centreline fuselage drop-tank (sometimes known by the nickname <i>Hindenburgs</i> because of their size: capacity 2,250 litres)
Avionics:	RAPTOR aerial reconnaissance pod RAFAEL Litening targeting pod TIALD laser designator pod BAE Systems Sky Shadow electronic countermeasures pod
Cost per airframe (1980):	£7.8 million
Cost per flight hour:	£35,000 (compared to £70,000 for the Typhoon). These were costs as at 14 September 2010

Tornado F3 specification

Primary role:	All-weather, night-and-day, supersonic air defence aircraft
Crew:	Two: Pilot and Weapons Systems Officer (WSO, sometimes incorrectly referred to as Navigator)
Ejection seats:	Martin-Baker Mk 10A
Overall length:	18.68m (61ft 3.25in)
Wing span, at 25° sweep:	13.91m (45ft 7.25in)
Wing span, at 67° sweep:	8.60m (28ft 2.5in)
Taileron span:	6.80m (22ft 3.5in)
Height:	5.95m (19ft 6in)
Wing area:	26.60m ² (286.3sq ft)
Track:	3.10m (10ft 2in)
Wheel base:	6.20m (20ft 4in)
Internal fuel:	1,424kg (18,904lbs)
Maximum take-off mass:	28,059kg (61,729lbs)
Empty mass:	14,500kg (31,970lbs)
Powerplant:	Two Turbo-Union RB.199-34R Mk 101 three-shaft augmented afterburning turbofans with integral reversers (see below)
Dry thrust:	40.5 kN (9,100lbf) per engine
Thrust with afterburner:	73.5 kN (16,410lbs) per engine
Service ceiling:	21,336m (70,000ft)
Rate of climb:	4,602m/min (15,100ft/min)
Combat radius (external fuel):	in excess of 1,853km (1,151 miles)
Ferry range (external fuel):	4,265km (2,650 miles)
Endurance:	2 hours combat air patrol at 560–740 km (345–460 miles)



Panavia Tornado F2

This perspective cutaway illustration was first published in *Flight International* in 1984. It shows an RAF Tornado F2. The F2 was the first of the fighter, or air defence variant, of the Tornado to enter service, although only eighteen were built (but quickly followed by the F3, which was built in much greater numbers). Compared to the GRI cutaway, this illustration shows more internal details, not the least the structure and cockpit layouts for both types, the latter by way of a useful comparison. Illustration by the late Frank Munger AMRAeS, former senior technical illustrator at *Flight International*. (© Flightglobal/Imagestore; www.flightglobalimages.com)

It is worth noting that Frank Munger and John Marsden (who illustrated the GRI reproduced elsewhere in this chapter) were the world's finest technical illustrators of aircraft; their knowledge of structures and systems were unsurpassed. John Marsden, during a long career with *Flight International*, visited, with his sketchbook always to hand, every single aircraft factory in the world; a record that is unlikely to be equalled. The author knew John Marsden well, appointing him a consultant to the School of Illustration at what is now the Arts University Bournemouth. Frank Munger's cutaway illustration of the Blackburn Buccaneer, also drawn for *Flight International*, is considered the most detailed and comprehensive cutaway of an aircraft ever drawn.

Max speed:	Mach 2.2 (approximately 2,697.9km/h or 1,676.4 mph at sea level)
Avionics:	GEC-Marconi/Ferranti AI.24 Foxhunter radar
<i>Armament</i>	
Guns:	1 x 27mm (1.063 in) Mauser BK-27 revolver cannon with 180 rounds, internally mounted on the starboard side of lower fuselage, below cockpit
Hardpoints:	10 (4 x semi-recessed under-fuselage; 2 x under-fuselage; 4 x swivelling under-wing). The two inner-wing pylons had shoulder-launch rails for 2 x short-range AAM (SRAAM) missiles each.
Payload:	9,000kg (19,800lbs)
Missile capability:	4 x AIM-9 Sidewinder or AIM-132 ASRAAM missiles 4 x BAE Systems Skyflash or AIM-120 AMRAAM missiles (mounted on the 4 x semi-recessed under-fuselage hardpoints)
Other:	2 x drop tanks to extend combat range 4 x drop tanks for ferry purposes (at the expense of missiles mounted on the 4 x semi-recessed under-fuselage hardpoints)
Cost per airframe (1980):	£9.4 million

Turbo-Union RB.199 Mk 101 technical specification

Length:	3.23m (10.58ft)
Weight:	900kg (1,980lbs)
Diameter (max):	87cms (2.875ft)
Intake:	Annular; no inlet guide vanes
Air flow:	70kg/sec (154lbs/sec) approximately
Bypass ration:	1:1
Low pressure fan:	Three-stage
IP compressor:	Three-stage
HP compressor:	Six-stage
Combustor:	Annular with vapourising burners
Turbine inlet temperature:	1,227°C (2,240°F)
HP turbine:	Single-stage air-cooled
IP turbine:	Single-stage air-cooled
LP turbine:	Single-stage air-cooled
Max thrust (dry):	36kN (8,090lbs)
Max thrust (afterburners):	71kN (15,950lbs)

* * *

Tornado Development

MRCA	Multi Role Combat Aircraft. Generic designation prior to the name Tornado being adopted by lead partners.
Tornado IDS	Interdictor/strike version. Primarily a bombing role. German and Italian air force designation. In addition specific fits for German, Italian and Saudi air forces: Tornado IDS Germany, Tornado IDS Italy and Tornado IDS Saudi.
Tornado GR1	RAF designation of IDS variant.
Tornado ECR	Electronic Combat and Reconnaissance. German and Italian air force designation.
Tornado GR1A	RAF designation of ECR variant.
Tornado GR1B	RAF designation for anti-shipping role.
Tornado GR1 (T)	RAF dual-control GR1.
Tornado GR4	RAF mid-life upgrade designation for GR1.
Tornado GR4A	RAF mid-life upgrade designation for GR1A.
Tornado GR4B	RAF mid-life upgrade designation for GR1B.
Tornado ADV	Air Defence Variant (a dedicated design rather than an option with the MRCA framework).

Tornado GR/IDS timeline

January 1968	Genesis of the Multi Role Combat Aircraft (MRCA) concept to replace the Lockheed F-104 Starfighter in European service.
17 July 1968	Six governments (Belgium, Italy, The Netherlands, West Germany and the UK) sign agreement to launch the MRCA conceptual phase.
30 April 1969	End of conceptual phase.
15 December 1968	NATO MRCA Management Agency established to consolidate and coordinate individual member states' requirements.
	Seven roles eventually identified;
	1. Interdiction.
	2. Counter-air attacks (against enemy airfields).
	3. Battlefield interdiction.
	4. Close air support.
	5. Reconnaissance.
	6. Maritime strike/attack.
	7. Point interception.

29 March 1969	Founding of Panavia GmbH, a multi-national defence consortium of the three partner nations responsible for the design, development and production of the Tornado MRCA. Headquarters are in Bavaria, Germany; 2014 parent companies are EADS (Germany), BAE Systems (UK) and Alenia Aeronautica (Italy).
1 May 1969	Detailed design work commences.
1 June 1969	Turbo-Union Ltd formed, dedicated to the design, development and manufacture of the Tornado's engines.
September 1969	Rolls Royce selected to provide engines (Rolls-Royce RB.199) through Turbo-Union Ltd.
14 August 1974	Maiden flight of Panavia MRCA P.01, D-9591 (98+04), from Manching, Bavaria, West Germany, flown by BAC Chief Test Pilot Lt Cdr Paul Millet OBE DSC BSc RN (ret'd) (1931–2009). Paul Millet was the only pilot to make three 'first flights' in a Tornado. In the rear seat was Messerschmitt-Bölkow-Blohm's (MBB) Chief Project Test Pilot, Nils Meister, from West Germany. P.01 was the first of ten prototypes (the tenth, P.10, never flew). When first flown, all prototypes were painted in a distinctive high-visibility red-and-white colour scheme.
29 August 1974	MBB's Chief Test Pilot Nils Meister goes supersonic in MRCA P.01, D-9591, from Manching, West Germany.
September 1974	MRCA formally named Tornado.
30 October 1974	First flight of Tornado P.02, XX946, in the UK. This was also the first prototype to have fully-variable inlets which enabled higher speeds to be reached. It is believed that this aircraft was the first to be painted in what eventually became the first standard colour scheme for RAF Tornados, a disruptive green-grey camouflage pattern, with the under-belly of the fuselage in a pale grey. At low-level, where the Tornado was designed to be most effective (and still is), this scheme has proven to be the most successful; the medium altitude wrap-around grey that all Tornados now carry makes the aircraft far more conspicuous in a low-level environment.
5 August 1975	First flight of Tornado P.03, XX947, in the UK, the first aircraft to have dual controls. This aircraft was also used for stall and spin trails.
2 September 1975	First flight of Tornado P.04, D-9592/98+05, in West Germany, the first aircraft fitted with a fully integrated avionics system, including an automated terrain-following system.
5 December 1975	First flight of Tornado P.05, X586/MMX586, in Italy. This aircraft crashed on its sixth flight but was successfully returned to airworthy condition after being rebuilt over a two-year period, after which it rejoined the flight test programme.
19 December 1975	First flight of Tornado P.06, XX948, in the UK. Note: some sources state the first flight of P.06 was on 30 December 1975.
30 March 1976	First flight of Tornado P.07, 98+06, in West Germany. This was the second avionics trials aircraft.
15 July 1976	First flight of Tornado P.08, XX950, in the UK.
10 July 1976	First UK production aircraft flew (ZA319) from Warton, Lancashire. RAF adopted the name/title Tornado GR1.
17 July 1976	First German production aircraft flew (4301) from Manching.
29 July 1976	Contract for Batch 1 aircraft signed.
5 February 1977	First flight of Tornado P.09, X-587/MM587, in Italy.
14 April 1978	Tornado first shown to the public at RAF Boscombe Down, Wiltshire.
31 July 1978	First firing by P.09 of the MBB Kormoran anti-ship missile. This took place over the Sardinia missile range.
5 June 1979	ZA319, first production aircraft of 228 GR1s for the RAF, rolled out at Warton.
6 June 1979	Second production aircraft (GT.001) rolled out at Manching, West Germany.

14 March 1980	First flight of first UK GR1 production aircraft (ZA319), from Warton. (Some sources state first flight was 30 August.)
1 August 1981	Tornado Tactical Weapons Conversion Unit (TWCU) formed at RAF Honington.
August 1981	Batch 4 aircraft fitted with new RB.199 Mk 103 engines following severe under-performance and excessive maintenance requirements resulting in high levels of aircraft unavailability (a factor that continues to this day – probably the Tornado’s most significant weakness in terms of reliability).
25 September 1981	First Italian production aircraft flew from Turin.
6 January 1982	IX (B) Squadron becomes first RAF Tornado squadron, formed at RAF Honington.
13 February 1985	First flight with ALARM anti-radar weapon.
October 1985	Saudi Arabian Training Flight established at RAF Cottesmore, Rutland, under the auspices of the RAF. Unit closed early in 1987 when the RSAF took responsibility for its own training.
10 October 1985	RAF Tornado (ZA361) first to reach 1,000 flying hours, closely followed by a West German Tornado (43+05). Both events were at RAF Cottesmore when the aircraft were being flown as part of the TTTE (see below).
28 February 1986	Italian Tornado (MM55000) reaches 1,000 flying hours, also from RAF Cottesmore as part of the TTTE (see below). This particular aircraft became, in late 1989, the first Tornado to reach 2,000 flight hours.
May 1987	Flight testing of improved RB.199 Mk 105 engines.
19 December 1987	500th airframe delivered to West Germany.
18 August 1988	First flight of German ECR Tornado (P.16/9803), from Manching.
16 March 1989	RAF sign agreement for Tornado mid-life update (MLU).
1998	End of Tornado production: 992 airframes completed (all variants – see below).
21 May 1990	First delivery of the German and Italian Tornado ECR.
31 October 1997	First RAF Tornado GR1 upgrade to GR4 standard delivered.
14 June 2009	First RAF Tornado GR4s depart UK to Afghanistan; 12 (B) Squadron.
27 June 2011	RAF Tornado fleet reaches one million flight hours. The GR4 that flew the one millionth hour was flown by aircrew from 617 Squadron (The Dambusters) on an operational sortie over Afghanistan. Tornado GR4 ZA547, from XV (R) Squadron, RAF Lossiemouth, specially painted to commemorate the event.

Tri-national Tornado Training Establishment (TTTE) timeline

1975	RAF Cottesmore, Rutland, selected as the TTTE’s base.
1979	Memorandum of understanding signed by the three countries.
April 1978	Groundcrew start arriving.
5 May 1980	Instructors for the Tornado Operational Conversion Unit (TOCU) start training under the auspices of the Service Instructor Training Courses at Manching, West Germany. First cadre comprised nine pilots and six navigators.
1 July 1980	First two aircraft arrive (ZA320 and ZA322).
2 September 1980	First West German Tornados arrive.
5 January 1981	No. 1 Course commences (lasting thirteen weeks).
29 January 1981	TTTE as a unit officially inaugurated.
5 April 1982	First Italian Tornados arrive.
1 April 1990	By this date TOCU had trained 2,000 aircrew: 1,084 pilots and 916 navigators on 140 Main Courses.
1998	RAF under pressure to find bases for squadrons returning from Germany. All three Tornado partner countries agree to conduct their own training, with Germany transferring Tornado aircrew training to the USA.
24 February 1999	TTTE officially disbanded.

March 1999	Last TTTE Tornados to fly from RAF Cottesmore.
Tornado ADV timeline	
4 March 1976	Mod/RAF announces that 165 of 385 Tornados on order will be ADV variants. Development of Tornado ADV formally launched (generating controversy and many questions over the ADV's performance and suitability – controversy that stayed with the aircraft for much of its service career).
9 August 1979	Roll out of first F2 prototype.
27 October 1979	Maiden flight of Tornado F2, A.01, ZA254, from Warton, Lancashire. Pilot was British Aerospace (BAe) Chief Test Pilot Lt Cdr John David Eagles AFC FRAeS FSETP RN (Retd) (1936–). In the rear seat was BAe Chief Project Navigator Roy Kenward. A.01 was the first of three Tornado ADV prototypes (the three F3 prototypes were ZA254, ZA267 and ZA283).
18 July 1980	First flight of Tornado F2, A.02, ZA267, from Warton. Pilot was Lt Cdr Paul Millett (see above, 14 August 1974). In the rear seat was Roy Kenward.
18 November 1980	First flight of Tornado F2, A.03, ZA283, from Warton, flown by BAe Deputy Chief Test Pilot Flt Lt Peter Gordon-Johnson RAF (Retd). In the rear seat was Leslie Hunt. (Some sources state that the first flight was 20 November.)
5 March 1984	First flight by first production airframe (ZD900).
November 1984	Declaration of the first front-line Tornado F3 squadron to NATO.
11 November 1984	First F2 to be delivered to the RAF (ZD901). Airframe joined 229 Operational Conversion Unit at RAF Coningsby.
20 November 1985	First flight of Tornado F3 (ZE154) from Warton.
1 November 1987	29 Squadron the first to be declared operational on the ADV.
20 September 1988	Tornado F3 (2907) delivered to Royal Saudi Air Force (RSAF) at Dhahran, Saudi Arabia, joining 29 Squadron RSAF.
1993	Last production Tornado aircraft delivered (an F3)
7 December 2004	Last flight of an Italian Air Force Tornado ADV. The aircraft flew from Italy to RAF Saint Athan.
22 March 2011	Disbandment of 111 (F) Squadron, RAF Leuchars, marks the end of all RAF Tornado ADV operations. The disbandment of 111 Squadron also marked the end of pure fighter squadrons in the RAF as eventually all Typhoon aircraft will be multi-role.
28 March 2011	Last 111 (F) Squadron Tornado F3s depart RAF Leuchars for RAF Leeming for scrapping (known by the MoD/RAF euphemism as 'RTP' – return to produce or reduction to produce).
20 June 2012	Final mission flown by an F3. The aircraft was one of four F3s operated by QinetiQ from MoD Boscombe Down, Wiltshire.
5 July 2012	Last low-level flight of a Tornado F3 in UK skies. The aircraft, ZH552, went through The Mach Loop in mid-Wales before landing at RAF Leeming for scrapping.
9 July 2012	Final three Tornado F3 flights from MoD Boscombe Down to RAF Leeming, again for scrapping.

Tornado GR/IDS/ECR production

Prototypes	10
Production models	764
Total	774

Tornado ADV production

Prototypes	3
Production models	215
Total	218

Overall total	992
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