

Responsibility for Royal Air Force Tornado and Typhoon operational test and evaluation rests with 41 (Reserve) Test & Evaluation Squadron. Unique for its two-type fleet, engineering and flight test capabilities, it supports an extensive trials program

# Double measures



# ires

**1 //** Number 41(R) TES gave Typhoon FGR4 ZK315 special centenary celebration markings. Here it flies with one of the unit's Tornados (Photo: Steve Davies)



**2 //** BAE Systems keeps a two-seat Typhoon for trials work at Warton. It's finished in 41(R) TES markings (Photo: BAE Systems)

**S**itting in the heart of rural Lincolnshire, England, just a mile or two northeast of the hamlet of New York and presided over by the imposing battlements of Tattershall Castle, Royal Air Force Coningsby is home to the UK's Quick Reaction Alert (South) station. Its frontline Typhoon squadrons ensure two armed jets are ready to launch 24/7.

The busy station also houses the RAF's Typhoon operational conversion unit and, most famously, the Battle of Britain Memorial Flight. Nowhere else in the world do frontline warplanes share the circuit with Spitfires, Hurricanes and a Lancaster, while the sharp-eyed 'spotter' will notice that the workhorse Tornado GR4 is also no stranger to Coningsby's runway.

Easily overlooked and regularly misunderstood, 41 (Reserve) Test & Evaluation Squadron (TES) is the RAF's only two-type fast-jet unit, with varying numbers of Typhoons and three Tornados on strength. It works

closely with industry and the frontline, trialling new capability and reacting to service issues as they arise.

The RAF has two frontline fast-jet types, while the F-35B Lightning II remains under test with 17(R) TES at Edwards Air Force Base, California. The Lightning's planned move to the UK in 2018 will herald the beginning of the end for the Tornado, or the GR4 as it is known, with an out of service date (OSD) around 2019. In the meantime, the GR4 is heavily committed to Operation Shader, the UK's contribution to air strikes against Islamic State in Iraq and Syria. Indeed, the Tornado GR1 and GR4 between them have been in near continuous combat since 1991.

There has been a dramatic expansion in Tornado capability over those 25 years, with new weapons and extraordinarily more capable avionics. Since 41(R)'s formation as a TES in 2006, its weapons integration and software evaluation effort for GR4 has continued apace, with only a moderate slow down in recent weeks.

**2** months-long 41(R) TES deployment to the USA for the High Rider exercise

**4** major Typhoon trials programs underway

## OPERATIONAL ANALYSIS

Six MoD operational analysis (OA) civil servants are embedded in 41(R) TES. They are typically high-achieving graduates with a mathematical, science or engineering-based degree, often with post-graduate education to master's or PhD level.

Alongside the trials managers, pilots and engineers, the analysts are a fundamental component of the test team, which collectively designs, delivers and reports on a wide variety of trials.

Operational analysis was first used to describe the scientific assessment

of military scenarios in 1938. It came to prominence during World War II, when Solly Zuckerman advised Air Chief Marshal Tedder and General Eisenhower on which transport nodes should be bombed for the greatest impact on German logistics.

Physicist Reginald Jones was another key OA personality. His work included study of the German Knickebein radio navigation system and subsequent development of a method to jam its signals.

Today, 41(R) TES's OA staff lead the development of test objectives, ensuring

their conclusions have scientific basis with the required level of confidence. The squadron's OA requirements cover many areas, including assessing targeting pod accuracy, radar system evaluation and understanding overall weapon system performance. The weapons and sensors on modern aircraft produce amounts of data unimaginable even 25 years ago, creating a major challenge, but high-power computing, modern data processing techniques and statistical methods ensure that the best evidence-based advice reaches the frontline.



3 // These Tornados were en route to China Lake for a High Rider detachment (Photo: 41(R) TES Archive)

same time we also completed a huge volume of work connected with the latest radar software. It's the version that Centurion will be declared on in December 2018; it enables Meteor firing and is expected to be very robust.

"In June we began work on DASS [defensive aids sub-system] Package 2, which includes MAWS [missile approach warning system] and is again required for Centurion. Pretty much every DASS and radar trial requires four jets and we embedded smaller trials in each effort.

"At the same time we're involved in the ASRAAM Block 6 program. The latest block is scheduled to replace the other in-service variants from late 2017. It's been going on for a couple of years and we're doing a lot of industry development testing, with lots of captive carriage gathering data, plus occasional firings. But in a trial this summer we had an enhancement to the forward detent assembly that mounts ASRAAM and for this we fired 40 missiles."

These four major trials have been in addition to a long list of minor tasks, the combined result keeping the squadron extremely busy. Other work this year has involved close cooperation with BAE Systems. Brimstone carriage, Storm Shadow release, NVG and helmet assessment trails have seen 41(R) personnel at the manufacturer's Warton base, which is something of a home-from-home for the unit's aircrew.

Later this year, the squadron will take an early look at Typhoon's next software load, P2Ea, which is scheduled for delivery in the New Year. Abdallah explains: "Flying under BAE's governance, we'll be able to say: 'Before you seal this software load off, we think you should tweak these areas.' It lets us catch things before the door is closed."

### INDUSTRY PARTNERS

There is a distinct sense of partnership at 41(R), where personnel talk of their BAE Systems, MBDA and QinetiQ

The squadron also has a long-established Typhoon relationship with BAE Systems, based on planned upgrades in the aircraft's capability through defined phases of software development and capability insertion. Now the Typhoon workload has expanded greatly, under Project Centurion, which is transferring the full suite of GR4 capability over to the Eurofighter in time for the Tornado's OSD.

### TYPHOON TESTING

Squadron Leader Mahmoud 'Mo' Abdallah commands the Typhoon Trials Flight. He has major Typhoon trials mapped out in a demanding schedule that will take the squadron until late 2018, with much of the work focused on delivering Centurion.

"We've been testing the latest P1Eb Further Work software package for Tranches 2 and 3, which will go out to the frontline at the end of the year," he says. "It took up a lot of our capacity up to September 2016, but at the

**"None of the airframes in either 'fleet' are identical"**



4 // 41(R) TES Typhoons on Coningsby's busy flightline (Photo: UK MoD ©2016)

5 // The squadron's engineering cadre is unusually large as a result of its mixed fleet (Photo: LAC Jack Welson/ UK MoD ©2016)

colleagues as they might regular squadron mates. Paul Ascroft, technical manager for Typhoon P1E and P3E capability and overall BAE Systems technical lead for Project Centurion, describes the concept from the industry perspective.

"There is a close working relationship between BAE Systems' flight operations team and 41 Squadron, with dialog on a regular basis on the progress of development activities. The coordination of key events is managed through the Combined Test Team community, a mix of key industry and customer individuals that maximizes the work performed between industry flight test and the UK customer.

"As part of the Phase 2 Enhancements contract on Typhoon we've defined customer flight test activities to gather feedback through development on the maturity of the product. The close relationship enables us to maximize these activities and gather the operational type feedback as well as information against the contractual requirement. Additional customer flight testing performed in advance of full operational evaluation also provides invaluable feedback into the development program."

### TORNADO TRIALS

Squadron Leader Dave 'Wills' Wilson manages 41(R)'s Tornado trials. He perceives a reduction in Tornado work, but also identifies the possibility of trials continuing almost up to the jet's OSD. "I came back to the squadron in 2010, when there was a series of major trials going on. Once they were complete it was supposed to go quiet, but so far that hasn't happened!

"We ran major communications and Link 16 trials, then it was into Brimstone 2 work, including firings at China Lake. After that we integrated TCAS II, which was an unusual program that generated a lot of interest. We were left with Brimstone 2 to finish, which brought us through to the beginning of this year.

"Since then we've been working on the Common Jamming Pod to replace Sky Shadow. There's usually a new software drop for the aircraft every 12 to 15 months as well, and testing that generally takes up to three months. Then we get notifications of anomalies noted in-theater and these become an immediate priority.

"We've also just finished a Phoenix trial - it's a generic name for our software testing - and a life-preserver trial. I've been on the unit, on and off, for

**“Ideally you’d fly on at least one of your sorties, particularly if something contentious crops up”**



**6 //** The words 'Seek' and 'Destroy' on the centenary jet's foreplanes are from the squadron's 'Seek and Destroy' motto (Photo: Steve Davies/www.fjphotography.com)

around 12 years, and since those two trials finished things have gone just a little quieter for the first time.”

**DOUBLE TROUBLE**

The unique nature of 41(R) TES makes particular demands on its personnel. Its aircrew are a mix of test pilots and flight test engineers, all graduates of the Empire Test Pilots' School at Boscombe Down, and evaluator pilots and navigators. The latter, posted in from the frontline, bring with them an intimate knowledge of the latest tactics and challenges, their fresh experience ensuring the squadron remains in-touch and relevant.

The major challenges reside with the unit's engineers, not least in the complexities of operating two very different airframes built according to design philosophies 40 years apart. The Tornado is essentially a 'metal' airplane with flight control and mission avionics systems; the Typhoon is a composite machine, driven by multiple computers through a complex digital architecture. These differences mean that 41(R) effectively maintains two engineering teams for day-to-day support, one maintaining the three Tornados, the other working with the Typhoon fleet, which is

**3**  
Tornado GR4s remain in the squadron's fleet

**40**  
missiles fired in intensive Block 6 ASRAAM trials

**100**  
The squadron celebrated its centenary in 2015/2016

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established at five but swells according to requirements; there were seven in July.

Further complicating the engineering task is that none of the airframes in either 'fleet' are identical. The squadron has the only pair of Tranche 3 jets in RAF service, for example, while its other Typhoons are all to different software standards, each supporting unique capabilities. Thus the engineers juggle the serviceability and deeper maintenance issues faced by any squadron, with the need to ensure that the jet with the required capability is serviceable ready for the trial only it can fly.

Both types are wired to collect test data on solid-state recorders installed on 'pallets', which on the Typhoon slide inside the gun bay with the 27mm cannon removed. It takes information from each of the jet's multiple databuses, potentially generating several gigabytes of information per trial, feeding 41(R)'s embedded data and operational analysts.

Flight test engineer Flight Lieutenant Laura Frowen is engaged in trials with the Litening targeting pod. She explained the test process from an engineering point of view: "I'm part of the trials management office. We get the initial request, then do all the prep work and paper work to set it up and run it, typically over three to four months. Usually it's all done from the ground with 41 Squadron, but ideally you'd fly on at least one of your sorties, particularly if

something contentious crops up or if your pilot is trying to explain something they've seen and it doesn't come across well in the debrief.

"We try to keep a two-seat Typhoon on the squadron for that reason, but sometimes it's also useful to have two pilots, for supervision or safety - NVG [night vision goggles] tanking trials would be a good example, where the flying pilot wears the NVGs and the back-seater observes.

"Most of our work is operational test, so the safety case for it has already been made and we're looking at how we'll use it at a tactical level and whether it will function in the environment we want to put it in."

In the scenario Frowen describes, the trial has been expected and planned for some considerable time, but 41(R) also reacts to emerging requirements, typically solving issues that emerge on the frontline. How are these approached?

"It depends on the nature of the trial. It might be a capability urgently required but outside the release to service on the frontline, in which case we take that and our test pilots generate a trial and report back on how it should be done. If it's an issue, often with the software

## “Once we’ve seen the fault we can say why it happened, and how to avoid or work around it”

experienced engineers perform is extremely technical, some is essentially simple: “It could be that every time we remove a panel we ‘round’ the screw heads and a different type of screw is required.” TMT adds that detail to its report so that it has no chance of becoming an issue on the frontline.

behaving not exactly as expected – perhaps it won’t allow a ‘9’ to be entered from the multifunction keys – we may be able to understand it very quickly.

“We might write a brief trials program to investigate, then go out and look for it in a safe and repeatable manner. Once we’ve seen the fault we can say why it happened, how to avoid or work around it, and give some advice for the interim while we send it back to industry.”

Flight Lieutenant Andy Power leads 41(R)s trials and modifications team (TMT), sitting between the Project Teams that manage equipment programs at Ministry of Defence level and the squadron. “My team ensures all the paperwork and equipment is in place ready for a trial to begin. We produce the service modification leaflets – written instructions that will be delivered to end users so that they know, for example, what modification they’re doing and how to do it.

“We also produce reports and recommendations that go into the modification process. We’ll perhaps look at the military utility of a piece of equipment, noting issues, working out how it should be handled, transported and so on.”

Like Frowen’s ‘number 9’ example, Power says that while much of the work TMT’s highly

### HIGH RIDER

No matter the platform, nature or urgency of the task, one factor generates more challenges than any other – the weather. Speaking in mid-July, Frowen and a test pilot colleague ruefully explained how since the beginning of June they had been attempting to satisfy a series of test points requiring clear visibility from 20,000ft to ground level – but the weather defeated them every time.

For this reason, and because of the facilities on offer, 41(R) TES makes an annual High Rider deployment to the USA. Given its uniqueness, the squadron takes its aircraft with it; the cost in tanker and logistical support is easily offset by the intensive trials completed.

This year the squadron departs Coningsby late in September and Wills expects to return around late November or early December. The work will focus on DASS testing for Project Centurion and fifth-generation platform integration with the F-35.

“Then we’ll be back and working up for the next round of trials,” Abdallah says. “Early in 2017 it’ll be P2Ea, then some Meteor and Storm Shadow work, plus Laura Frowen and a couple of pilots are embedded in a Litening demonstration with BAE Systems.” The work that goes on in 41(R)s Coningsby enclave may not be well understood or particularly well known, but it is essential to the frontline and seemingly relentless. \

7 // A salvo of three Brimstones fired during a 41(R) TES Tornado trial (Photo: 41(R) TES Archive/ UK MoD ©2016)



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8 // A Typhoon main operating base, Coningsby is an ideal location for 41(R) TES (Photo: UK MoD ©2016)



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