Synopsis of Lecture to RAeS Loughborough Branch on 18 October 2011

The Work of a Test Pilot in Rolls-Royce (and Flying the Rolls-Royce PR.XIX Spitfire)

by Phil O'Dell, Chief Test Pilot and Head of Flying, Rolls-Royce plc

(Notes Written by Colin Moss)

1. Introduction

Phil joined the RAF in 1984 and flew Buccaneers, Hawks and Jaguars. Whilst in the RAF he attended the French test pilot training school (EPNER - École du Personnel Navigant d'Essais et de Réception). He joined Rolls-Royce in November 2001 and since then he has flown the Hawk, various Airbus aircraft (including the A380), Boeing 777, Gulfsteam G450, Spitfire and Vulcan. He has also flown Rolls-Royce's own Boeing 747 Classic with one of its four engines replaced by a Rolls-Royce Trent 1000 engine on test.

Phil's lecture was divided into two parts; a description of the activities of a Rolls-Royce test pilot and his experiences in flying the Rolls-Royce PR XIX Spitfire.

2. The Work of a Rolls-Royce Test Pilot

2.1 General

A test pilot is the interface between the front line pilot and the design engineer. Together with the project and flight test engineers, a test pilot defines what test are required and what results are to be obtained. This leads to a definition of the flight test programme and an associated risk assessment. The test pilot also participates in the trials analysis and reporting process.

Increasingly the role of a test pilot is being orientated towards "operational support". This is because of the increasing role of Rolls-Royce as a services company with the aim reducing customers' operational costs.

A Flight Operations Support Team was founded in 2003 with the aim of providing technical liaison with both military and civil customers. Its current strength wihin Rolls-Royce is 3-4 pilots and 5 engineers. The Team assists with accident and incident investigations, supports sales campaigns, and answers operationally biased technical queries. This has led to a much closer involvement with servicing organisations including a series of fuel saving trials.

2.2 Example Test Programme – the Rolls-Royce/SNECMA Adour Mk 951 Engine

The Adour Mk 951 is an upgrade to an old engine, one which has powered the BAE Systems Hawk jet trainer for many years. The Mk 951 has a thrust of 6,500 lbf and is a considerable upgrade to previous versions.

BAE Systems Hawk Jet Trainer

The Mk 951 has an increased life over previous versions, lower life cycle costs, reduced servicing and maintenance requirements, more thrust, fewer engine restrictions and surge detection and recovery. It is designed to keep pace with changing requirements for the next generation of training aircraft.

A flight test programme was undertaken to confirm the surge detection and recovery characteristics of the Mk 951 FADEC system. Surges can occur as a result of a variety of causes including bird injestion,

operating an engine in the wake of an air-to-air refuelling drogue/basket, injesting the eflux from a lead aircraft jet engine when operating in formation with other aircraft and operating an aircraft outside its normal operational boundary.

The FADEC surge recovery logic is required to detect a surge, confirm the surge within 0.5 sec., instigate a fuel dip whilst the surge clears and finally to ensure that the engine recovers to its pre-surge throttle setting after the surge has been corrected. Crucially the FADEC must not attempt to correct a surge when an engine will self recover from that surge. Hence the FADEC is required to resolve the difference between the pop-pop-pop of short term self recovery type surges and longer duration surges requiring corrective action.

In addition, Rolls-Royce were not permitted to make changes to the pilot's cockpit displays in order to provide pilot awareness of a surge correction in progress. In the event the IGN (igniters) light was used to indicate that the FADEC had switched on the engine igniters to restart the engine after implementing a fuel dip.

The flight test programme comprised a series of aggressive agitated aircraft spins at high engine power with the throttle setting left in its pre-surge position throughout four full 360° spins. The aim was to promote engine surge. The tests were carried out at the Arniston Bay test facility in South Africa as that country was to be the first customer for the new version of the Hawk to be fitted with the Mk 951 engine. The test location offered the advantage of relatively uncluttered airspace and also "ownership" of the airfield during the trials. The latter ensured that forced landings could be made at any time and indeed, the majority of test flights were preceded by a practise forced landing.

A BAE Systems test pilot in the front seat was required to fly the aircraft whilst Phil, in the back seat, was given control of the throttle during the spin manoeuvres. The aim was to leave the FADEC to correct the surge, but Phil was required to check the telemetry to confirm that the surge correction was proceeding satisfactorily and also to watch the engine temperature indicator to ensure that the engine did not exceed its permitted temperature limits. In the event of problems in either area, Phil was to instigate a manual surge correction.

A second test was to pull the aircraft up into the vertical position wait until the aircraft speed had dropped to zero causing an engine surge. This also resulted in a full avionics failure, a tail side and a quarter turn inverted spin. The test confirmed that the FADEC was able to carry out a full surge recovery even under extreme conditions.

3. Flying the Rolls-Royce PR XIX Sptifire.

Rolls-Royce PR XIX Spitfire

Seventy-nine Mk. XIX Spitfires were built by Supermarine. Rolls-Royce's example was delivered to the RAF in January 1945. During WW2 it took part in nine operational sorties including Operation Overlord. Later it was delivered to RAF Biggin Hill to join the then RAF Historic Flight, now the Battle of Britain Memorial Flight and it was flown by Gp. Cpt. Johnnie Johnson. It was last used operationally in 1962-4 when it was used to give Lightning Fighter pilots experience of engaging piston engined aircraft which were still in service with some air forces.

The aircraft has a top speed of 370 knots, stalls at 60 knots, can operate at +4g but no negative g, has a cross wind limit of 15 knots (25 knots during taxiing with 2 people holding the tail).

The aircraft is a joy to fly and comes into the category of an aircraft "which you wear". This experience is common to all pilots who have flown the Spitfire. It is also relatively easy to fly. That is not to say that the aircraft "will not bite" if it is treated badly. The flying highs of Phil's experiences with the Spitfire have included flying in formation with an Airbus A340 test aircraft trialling a Trent 500 engine, a Boeing 787 at the Farnborough air display and a Typhoon fighter at Filton, Bristol.

This lecture was enthuseastically received by an audience of approximately 190 RAeS Members, Branch Friends, students and members of the public.