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TRAINING THE HELICOPTER TEST PILOT

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ABSTRACT

The skills required by a helicopter test pilot in a military or civilian environment are analysed with reference to the exacting operational requirements laid down for rotorcraft.

The aims and objectives of the helicopter test pilot course at the Empire Test Pilots' School are outlined and the development of the course over its 10½ months is studied in detail with reference to the student entry requirements, their academic training and their test flying training with the emphasis on how the students are taught to observe and to report accurately.

Helicopter test flying training requires a fleet of representative helicopters, well instrumented and maintained. In addition, student test pilots receive training on fixed wing aircraft for familiarisation purposes and carry out exercises in the Basset variable stability aircraft as part of their stability and control studies.

The assessment exercises are discussed and the precautions associated with high risk test flying exercises are outlined. The culmination of the course, in the form of a detailed analysis of a helicopter not previously flown by the student, is known as the Preview exercise and is shown to be the just conclusion of the course in demonstrating that the student has acquired the skills required by a professional helicopter test pilot.

1. INTRODUCTION

1.1 The need for Helicopter Test Pilots. Since the days of Juan de la Cierva, manufacturers have recognised the need for specialist rotary wing (RW) test pilots. On the job training for test pilots was seen to have the penalty of unacceptably high risk to the very costly prototypes and to the pilot's life. As the helicopter's flight envelope expanded, the military and civil authorities also recognised the need for trained test pilots to evaluate the machines being produced. Associated with the helicopter's expanding flight envelopes and increased complexity came ever more detailed specifications and criteria against which the machines had to be tested. Thus formal training for helicopter test pilots was introduced in the early 1960s in response to the needs of a rapidly expanding field of aviation. The main aim of test pilot training is to develop the specialist skills, in a pilot with the correct operational background, to make critical and accurate observations while engaged in a demanding flying task. This ability is not a knack; it can only be acquired by training and diligent application and it pre-supposes above average flying skill and the capacity to cope with a very high workload. The introduction of telemetry and sophisticated automatic data recording has not influenced the test pilot's task of being, in the assessment of handling qualities, the supreme judge.

1.2 The training for helicopter test pilots is carried out at 3 locations in the free world; at the United States Naval Test Pilot School (USNTPS), Patuxent River in the United States, at L'Ecole du Personnel Navigant d'Essais (EPNER) located 25 miles from here at Istres and at the Empire Test Pilots' School (ETPS), Boscombe Down in the UK. This paper describes the training of helicopter test pilots at ETPS but the general training methods described are similar to those of the other two schools.

1.3 Aims of the ETPS Course. The aims of the test pilot training at ETPS can be summarised as follows:

1.3.1 To develop a critical approach. It is the role of the test pilot to identify problems in handling, to establish limits and to develop techniques. This critical approach to flying is not encouraged in operational pilots who are trained to compensate for any deficiencies in their machines.

1.3.2 To broaden experience. Most students have experience of only a few operational aircraft. The School aims to provide the type diversification necessary to allow test pilots to approach test programmes on new aircraft with confidence based on experience and good training. The type diversification also encourages a broad minded approach to new developments in helicopters and systems.

1.3.3 To understand the theory. Ground school teaches the necessary theory so that the students may understand and contribute positively, to a test programme.

1.3.4 To learn test techniques. During the flying exercises the students learn and practise specific test techniques to achieve the required results without hazarding the aircraft.

1.3.5 To learn to report. The success of a test pilot depends as much on his ability to communicate clearly and fully and to emphasise the essential as it does on his skill as a pilot. Therefore the skills of reporting verbally and in writing are taught at ETPS and receive considerable attention throughout the course.

1.4 Selection of Students for ETPS. The British candidates for ETPS undergo a careful selection process which involves taking 2 written exams and interviews by 3 boards. The minimum qualifications required for a candidate to be called forward for selection are as follows:

a. A flying assessment of "exceptional" or "above average".

b. A recent operational tour in any Service role.

c. Not less than 750 hours first pilot and in current flying practice.

d. GCE 'O' Level mathematics.

e. Age 32 or under.

f. A full flying medical category.

Most students have qualifications well in excess of these minima; recent RW courses have had a majority qualified to University degree level.

2. THE EMPIRE TEST PILOTS' SCHOOL. The Empire Test Pilots' School is situated at the Aeroplane and Armament Experimental Establishment, Boscombe Down, Wiltshire, England, and is controlled by the Procurement Executive, Ministry of Defence. Fixed and rotary wing courses are run concurrently from February to December each year and are composed of officer pilots of the Royal Navy, the Army and the Royal Air Force and of professional Ministry of Defence Procurement Executive staff. Civilian pilots from the Society of British Aerospace Companies, officers from Commonwealth Services and allied nations and civilians sponsored by foreign governments are also eligible. A typical course consists of 20 students of 8 different nationalities. The Rotary Wing Course normally represents around 40% of the total course.

2.1 History of ETPS. The Empire Test Pilots' School was formed at Boscombe Down, England in 1943. Its function was to provide suitably trained pilots for test flying duties in aeronautical research and development establishments within the Service and the Industry. In 1945 shortage of space caused a move to Cranfield and in 1947 a further move to Farnborough was followed by 20 years of progressive curriculum development which included the setting up in 1963 of the Rotary Wing Course to meet a growing need for trained helicopter test pilots. In 1968 the School returned to Boscombe Down and the Flight Test Engineer Course was added in 1974. To date more than 900 pilots and engineers have graduated from the School, including some 350 personnel from overseas. In the 19 years of rotary wing courses over 100 helicopter test pilots and flight test engineers have been trained.

2.2 Instructional Staff at ETPS. The School is commanded by a wing commander, who is an experienced test pilot, and staffed by selected officers who have the ability to teach at the advanced level necessary. All are highly experienced in their own specialisation. See Figure 1. The 6 flying wing tutors are all trained test pilots, of whom 2 are helicopter specialists. They are assisted by a Qualified Flying Instructor and a Qualified Helicopter Instructor for appropriate routine flying training. Ground training is carried out by 2 officers of the Royal Air Force Administrative (Education) Branch, one of whom is the rotary wing aerodynamics specialist. A General Duties (Navigator) officer is responsible for the Aerosystems content of the ground school training.

3. ROTARY WING FLEET

3.1 Aircraft. The School has a fleet of 5 helicopters which comprises the following aircraft:

a. Aerospatiale Gazelle. The Gazelle is powered by a single fixed shaft turbine engine, is particularly manoeuvrable and is used for test exercises up to 20,000 ft.

b. Westland Scout. The Scout is a single-engined army recce helicopter with several interesting characteristics which make it particularly useful for inclusion in the School fleet.

c. Westland Wessex. The Wessex has benign autorotational characteristics suitable for solo student engine off landings and the assessment of all aspects of autorotational flight. Until recently ETPS operated a single engine Wessex Mk 3 but this has been withdrawn and replaced by a twin-engine Wessex Mk 5. The philosophy of assessing engine off handling in a twin engine helicopter tends to cause surprise but the task of ETPS is to train test pilots safely.

d. Westland Lynx. This Lynx is a pre-production aircraft which was used for many of the early deck landing trials. The aircraft is powered by two twin spool engines, has a semi-rigid rotor with handling characteristics to match, and a duplex AFCS.

e. Sikorsky Sea King. The twin-engine Sea King was the first aircraft of that type acquired by UK before full scale delivery of the licence built Sea Kings began at Westlands. The aircraft has been modified since its introduction onto the ETPS fleet with the addition of modern navigation aids. With its fully automatic transition capability and AFCS runaway box the ETPS Sea King is a suitable aircraft for system evaluation exercises.

f. Beagle Basset. A description of aircraft used by the RW course would be incomplete without a mention of the Variable Stability Basset. The Basset is a twin piston-engined communications aircraft which has a response feedback type variable stability system installed to operate through the co-pilot's controls. The rotary wing students fly 6 sorties in the Basset to experience and evaluate a range of handling qualities some of which are considerably more unpleasant than those seen on the rest of the School fleet. The Basset will be replaced by a 'vari-stab' Hawk which will offer a wider envelope for the demonstration of fixed wing high speed characteristics.

3.2 Future Fleet Considerations. Other changes intended in the future for the RW fleet are the replacement of the pre-production Lynx with a standard production aircraft and the replacement by the late 1980s of the Sea King with a Chinook.

3.3 Instrumentation. The instrumentation fit of the Wessex, Gazelle, and Sea King is thorough with visual indications of flying control positions in the cockpit, a cockpit voice recorder, fuel-gone counters, and Hussenot paper recording of all vital engine and airframe parameters on 3 recorders. The Lynx and the Sea King also record AFCS actuator position but in the case of the Lynx all the parameters are stored on the Adam digital system. The Scout instrumentation comprises basic control position indicators, fuel-gone counters and provision for an automatic recording camera which photographs the standard instrument panel and control position indcators. The instrumentation display in the Gazelle is shown at figure 2. The Sea King also has provision for a hovermeter, a vane device which detects relative airflow, to allow free air hovers and a strain gauge system to measure tension in a cable suspended on the aircraft underslung hook. Both these devices are used during the assessment of vertical performance.

3.4 Other Rotary Wing Aircraft. The students usually fly and conduct exercises in a number of other aircraft. These include a light piston engine helicopter and a modern military helicopter not on the ETPS fleet. These machines are usually not instrumented at all and are used for specific assessment exercises.

4. ETPS ROTARY WING COURSE. At ETPS the students are divided into a fixed wing and a rotary wing course. Some of the theoretical instruction is common to both courses and although RW students do the bulk of their test flying in helicopters, they are also given some demonstration flights in fixed wing aircraft, and complete a stalling exercise in the Hawk. Student flight test engineers are trained with either course, depending on their sponsor's requirements. The course is broadly divided into ground and flying training although the two are closely interrelated. The flying syllabus, which comprises approximately 120 hours flying spread across the School fleet, covers the main tests employed in RW flight and systems testing.

4.1 Ground School. Ground school includes lectures, tutorial periods and self-tuition relating to the theory underpinning the series of flying test exercises that form the central theme of the course. In addition, outside guest lecturers from a wide variety of backgrounds visit the School. The first 2 weeks are spent wholly in the Ground School revising basic theory and learning mathematics, mechanics, aerodynamics, engines and computers in order to be able to cope with the subjects taught as the course progresses. These include helicopter engines, aerodynamics, performance, stability and control, vibrations, aero-elasticity, non-dimensional methods, weapons, avionics and electro-optics. Student progress throughout ground school is carefully monitored by a tutorial system which comprises a blend of continuous assessment by examinations (open or closed book), assignments and student presentations.

4.2 Ground School Facilities. The ground school is well-equipped with lecture rooms, conference/syndicate rooms, a library and has its own digital computer which is used for data reduction and plotting and an analogue computer which is used to drive a 5 degree of freedom aircraft motion simulator model for stability work.

4.3 Visits and Liaison. To complement their academic instruction, a comprehensive visit programme is arranged. Students see the work of the Aerospace Industry and research/test establishments throughout Britain and Europe, meet aircraft design teams and test pilots and gain experience of the methods used in the various stages of aircraft development. Contacts are also maintained with the other Test Pilot Schools such as the USAFTPS, Edwards, California; the USNTPS at Patuxent River, Maryland; and EPNER at Istres, France, with whom there are regular student and staff exchanges and liaison visits.

4.4 Assessment Exercises. The 20 RW assessment exercises can be subdivided under broad headings of performance, handling and systems assessment. The divisions between the exercises under each broad heading are far from clear cut and most performance and system exercises have some handling content. For example the students' first major exercise is a cockpit assessment - is that a handling assessment or a systems exercise? Each term has a mix of handling and performance and/or system exercises but for practical safety reasons while the student is unfamiliar with the aircraft types and unfamiliar with testing he is introduced to the simple performance exercises such as the determination of airspeed pressure errors at the beginning of the course. Simple handling exercises are introduced in the first few months of the course and thereafter require the application of progressively more skill and specialist technique as the course progresses. For most students the autorotational flight and engine-off exercise is the most rewarding handling phase; it requires several specialist skills and techniques and perhaps the stakes for success or failure are the most obvious. The conduct of that exercise will be described in more detail later. The content of the performance, handling and systems exercises is shown in figures 3, 4 and 5.

4.5 Exercise Aims. The aims of the flying exercises can be summarised as follows:

4.5.1 To develop the student's already above-average flying skill.

4.5.2 To teach the appropriate test techniques.

4.5.3 To encourage meticulous observation.

4.5.4 To develop the students ability to express himself verbally and in writing.

The aims have already been alluded too briefly but the fourth aim of the flying exercises receives particular emphasis at ETPS, perhaps to the surprise of the uninitiated. The ETPS viewpoint is that if the test pilot is unable to report what he has found, clearly and comprehensively, even if he is the best pilot in the world, his effort is wasted.

4.6 Conduct of Exercise. The conduct of a typical exercise is shown at figure 6. When the theoretical aspects have been taught at ground school the test is briefed in general terms by a flying tutor. Then follows a specific brief for the exercise as applied to the helicopter which is to be flown during the exercise. Early in the course this brief is detailed and specifies heights and speeds to be flown; as the course progresses the student is left to plan his own test points but with supervision. When the student has planned his first sortie he is briefed on particularly pertinent points immediately prior to his flight. On many exercises the staff fly demonstration sorties to ensure the student has understood the technique he is to employ. He then proceeds to carry out the tests. He would begin by exploring the aircraft's basic characteristics before embarking on tests of a critical nature. Thus for the evaluation of autorotational characteristics which is carried out in a series of 4 sorties slow entries to autorotation and manoeuvres at low rotor rpm precede throttle chops and lever delay tests. In the lever delay test the student determines the maximum tolerable delay between the failing of the engine (transmission shaft in some twin engine helicopters) and the requirement to lower the collective lever, or take some other recovery action. The exercise then progresses to examine simulated engine-off landing characteristics and finally to carry out actual engine-off landings from a wide range of conditions. It is important to emphasise that the student carries out this

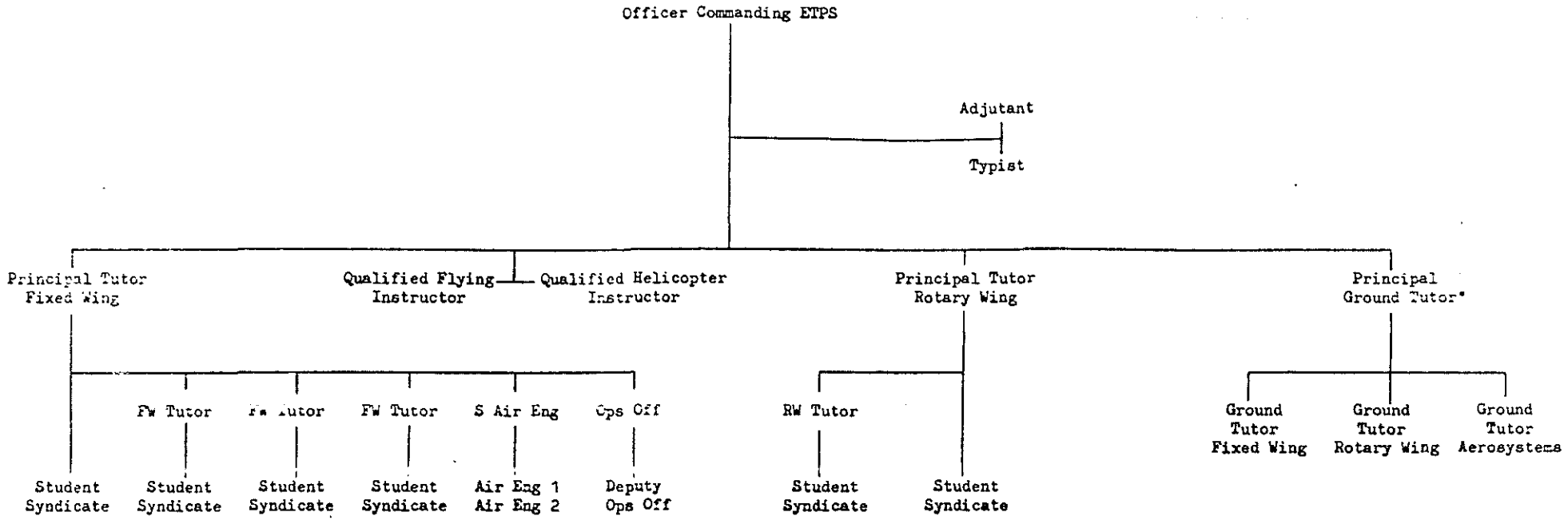
exercise as aircraft captain with either a student flight test engineer or fellow student test pilot in the other cockpit seat. Nothing better emphasises the need for the incremental approach than the autorotational exercise described above. The final sortie of the autorotational flight and engine-off exercise is a brief evaluation of the avoid curve or Height-Velocity diagram for the Scout. This exercise is flown with a staff member however.

4.7 Preview Exercise. The climax of the course is the Preview exercise in which students in teams of two or three carry out a 10 hr flight evaluation of a type which they have not previously flown. This year the Preview aircraft for the RW students will be the Chinook, the Puma and the Huey Cobra. The Preview exercise combines all the skills and techniques taught in the previous 9 months in a single major assessment exercise. The students conduct of the Preview exercise and the quality of the report demonstrate both to the student and to the staff how well the School has achieved its aims shown in paragraph 1. The importance which ETPS attach to the reporting of student flight tests is demonstrated by the fact that the Preview culminates in a 30 minute presentation to a wide audience and in a massive report typically of 300 pages.

4.8 Graduation. During the course student progress is continually assessed - both to ensure safety and to monitor ability. In the past 10 years the School has suspended only 3 RW pilots from training which partly reflects the careful selection of ETPS candidates. On successful graduation the students receive their qualification scrolls and appropriate awards at a prestigious mess dinner, the McKenna Dinner, which honours the name of one of the first commandants of the School.

5. CONCLUSION. This paper has described the need for helicopter test pilots and detailed the aims of meeting that need at the Empire Test Pilots' School. The academic and practical training syllabus has been shown and the conduct of flight test exercises explained. It has been shown how the training leads to the final assessment exercise, the Preview and how that exercise validates our training aims. The ETPS graduate is a professional helicopter test pilot whose experience, critical approach, theoretical background, knowledge of test techniques and communication skills will make him a safe and invaluable member of any test team.

6. LIST OF FIGURES



*Post filled by one of Ground Tutors

FIGURE 1 STAFF STRUCTURE AT ETPS

FIGURE 2 GAZELLE INSTRUMENTATION DISPLAY

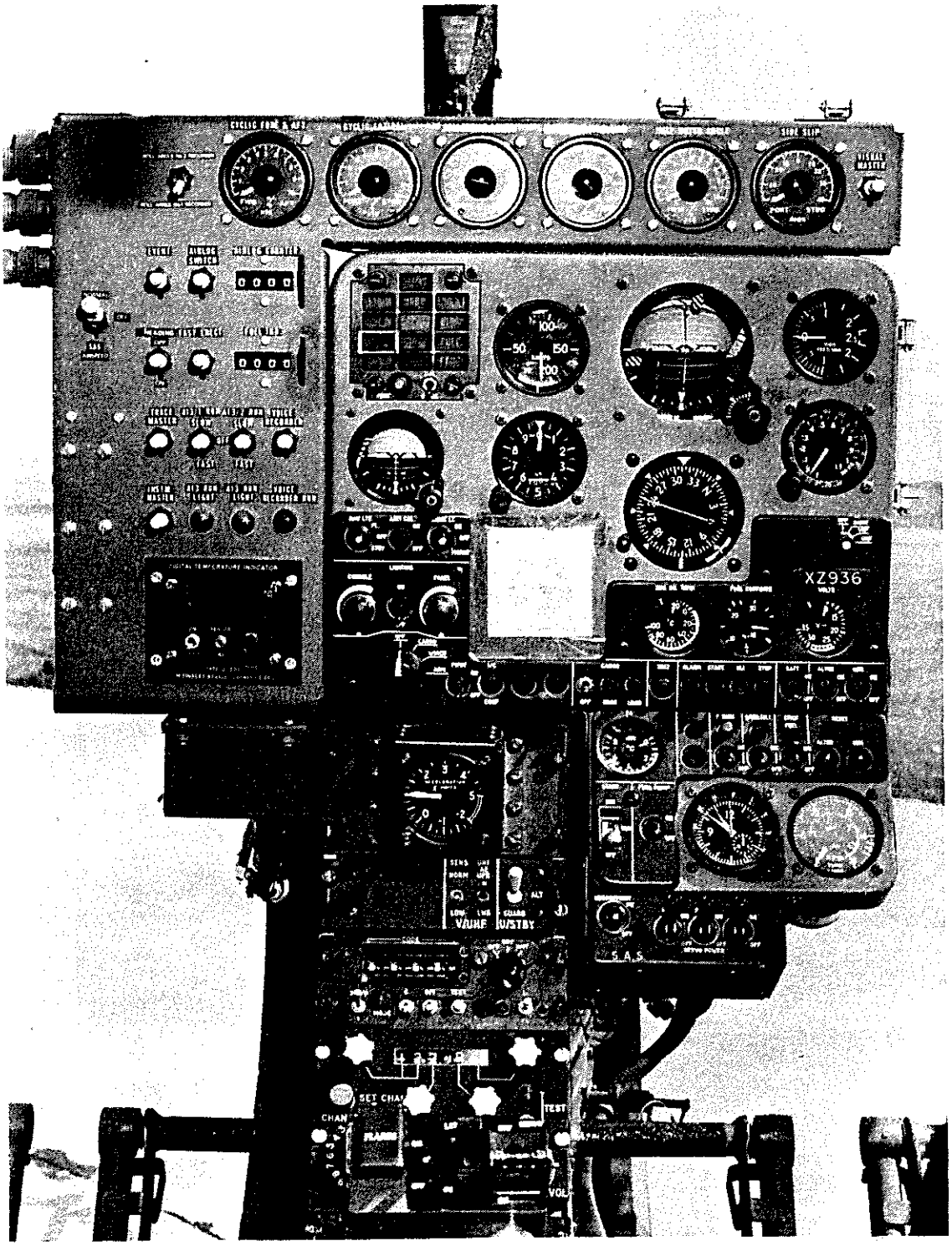


FIGURE 3 THE MAIN HANDLING EXERCISES

TITLE	FLYING HOURS AND AIRCRAFT TYPE	
COCKPIT ASSESSMENT	NO FLYING	SEA KING OR LYNX
TAKE-OFF, LANDINGS AND HELICOPTER MANOEUVRES	4 HRS	SCOUT
MANOEUVRE BOUNDARIES	2½ HRS	GAZELLE
LONGITUDINAL STABILITY	4 HRS	SEA KING OR LYNX
INSTRUMENT FLYING ENVELOPE	2½ HRS	SEA KING
LATERAL AND DIRECTIONAL STABILITY	5 HRS	GAZELLE
ENGINE HANDLING	6 HRS	SCOUT AND LYNX
PILOT'S ASSESSMENT	1½ HRS	ENSTROM
PREVIEW	10 HRS	CHINOOK, PUMA OR COBRA

FIGURE 4 PERFORMANCE EXERCISES

TITLE	FLYING HOURS AND AIRCRAFT TYPE	
PRESSURE ERROR CORRECTION	2½ HRS	GAZELLE OR SEA KING
PARTIAL CLIMBS AND DESCENTS	3 HRS	GAZELLE
VERTICAL PERFORMANCE	4 HRS	SEA KING OR LYNX
CEILING CLIMB (20,000 FT)	1 HR	GAZELLE
LEVEL FLIGHT PERFORMANCE	2½ HRS	SCOUT

FIGURE 5 SYSTEMS EXERCISES

TITLE	FLYING HOURS AND AIRCRAFT TYPE
NAVIGATION SYSTEM EVALUATION (TANS)	2 HRS LYNX OR SEA KING
AUTOPILOT ASSESSMENT (INCLUDES RUNAWAYS)	2½ HRS SEA KING
SIMULATOR ASSESSMENT	NO FLYING

FIGURE 6 CONDUCT OF AN EXERCISE

THEORY IN GROUND SCHOOL

GENERAL BRIEFING ON TEST METHODS

SPECIFIC BRIEF ON ETPS EXERCISE

DEMONSTRATION OF FLIGHT TEST TECHNIQUES

STUDENT FLIES EXERCISE

STUDENT WRITES REPORT

REPORT EVALUATED AND STUDENT DE-BRIEFED