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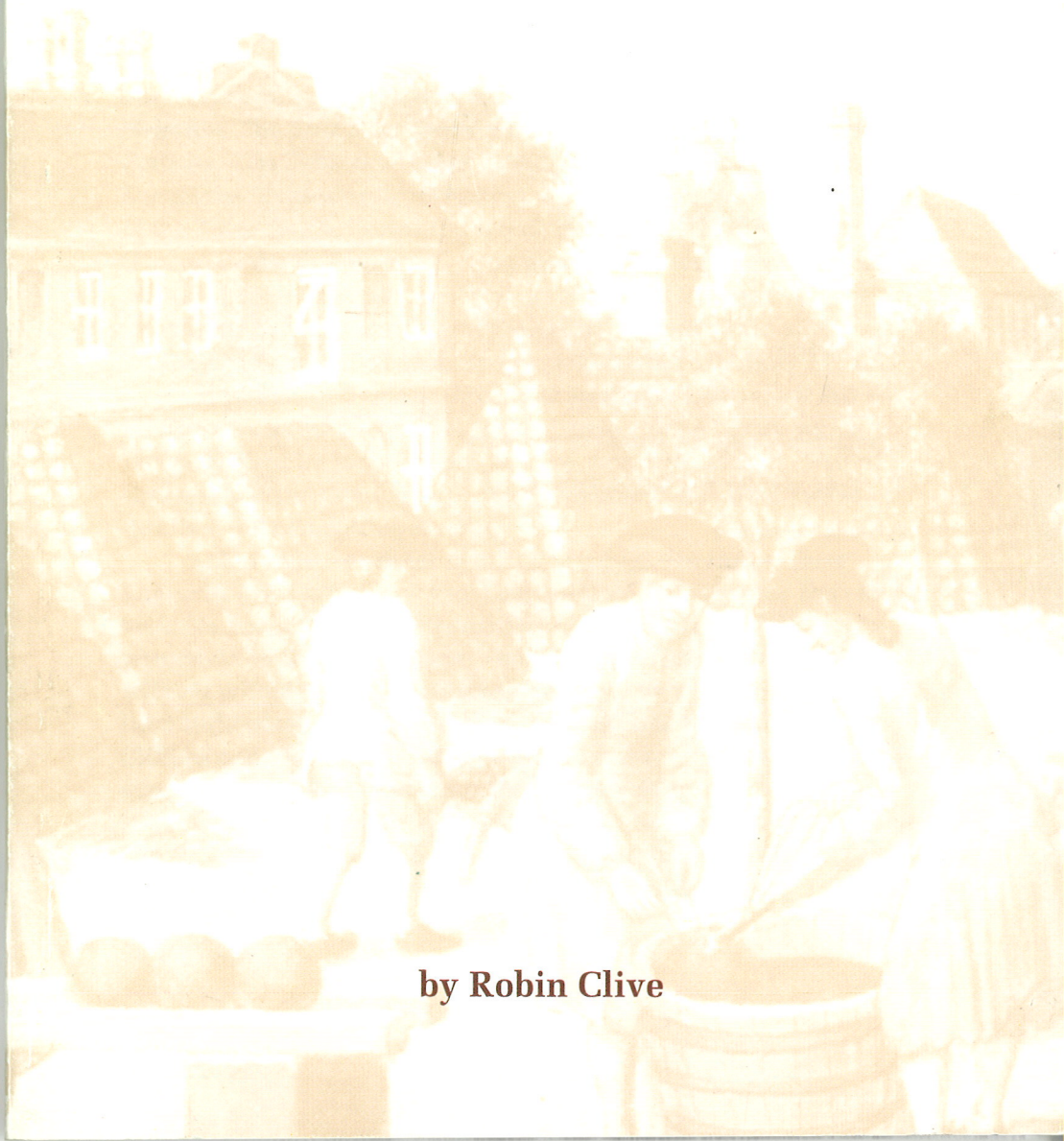
History of
Fort Halstead

Fort Halstead

A celebration of the first 100 years



by Robin Clive

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Cover picture: *When we were at Woolwich*

Acknowledgements

A large number of people have written about Fort Halstead, over a number of years, and I am indebted both to them, and to those who are currently trying to assemble a far more complete and thorough picture as this goes to press. Unfortunately, a number of records were evidently destroyed in the 1960's and 70's, so their task is not easy.

Among the many references I have consulted are 'RARDE, Fort Halstead, a short history' by Neill Griffiths O.B.E.; 'RARDE, Fort Halstead, The First Fifty Years'; Country Life Nov 13th 1986; 'Island Fortress, The Defence of Great Britain 1603-1945' by Norman Longmate; 'Explosion Investigation' by H.J.Yallop; 'Secret weapons of the Third Reich, German Research in World War II' by Major General Leslie E. Simon, US Army Ret'd; The Independent of 28th January 1992; 'The Pilgrim's Road' by F. Ellison-Erwood; various articles by Tim Pentecost about the natural history of the site; 'History of Halstead' by G.H.Warlow; and Hasted's 'History of Kent.'

In particular I am indebted to Brian Cathcart for all of the information in the section about the British atomic bomb, which was published by John Murray in 1994, under the title of 'Test of Greatness, Britain's struggle for the atom bomb.' His story makes detailed and compelling reading.

I should like to thank Maurice Marshall, Ian Cullis, Dave Edwards, Mike O'Connor, and Keith Webber for giving me time and valuable insights and understanding. In particular I should like to give credit to Gordon Pattison, Geoff Robinson and Norman Paul, without whose research and scholarship my own work would have been rudderless. Last but not least, I should like to thank Bill Clifford and Linda Wallbridge, without whose enthusiasm and support this booklet would not have been written.

Despite omissions (due principally to lack of space rather than lack of knowledge) I hope that you will enjoy this short story of the Fort, and how it came to be.

Robin Clive

A fascinating place

This booklet does not claim to be a complete history of what is now DERA, at Fort Halstead. In truth, a proper history of the Fort, as its occupants call it with some affection, would run into many volumes. What is more, if it went into any depth, it could not be read outside the confines of the Fort for at least another thirty years, the Official Secrets Act being what it is!

These words are penned as much for the information of those who do not work here, as for the enjoyment of those who do. However, if we have to gloss over certain matters, there is still much left to tell.

If you have wondered what goes on behind the trees at the top of the hill, we hope to give you an insight both into some less well-known British history, interspersed with glimpses of a world in which terms like originality, state of the art, and cutting edge are everyday banalities.

The reality of military invention is fascinating to an outsider. It is hardly less fascinating to the many who have worked here, and who are justifiably proud of their own achievements, and through them, the Fort's assured place in twentieth century British military history.

The scientists, engineers and technicians at Fort Halstead work for DERA, which stands for the Defence Evaluation and Research Agency of the Ministry of Defence.

They work with 'future knowledge'.

Most obviously, this means that they lengthen the boundaries of current understanding, by conducting fundamental research in nearly every area of technical knowledge imaginable.

They apply this knowledge to answering the needs of their (primarily military) customers, to develop equipment which may not come into service for many years to come....which is why we cannot go into any real detail about more recent work. (Whereas during the Second World War it might typically take a maximum of a year or so to develop some novel piece of equipment, today it may take as long as 20 or 30 years for a very sophisticated 'something' to come into service, from the moment it was first thought of as a possibility.)

DERA has no interest in manufacturing, but devises, develops, specifies or improves much of what is manufactured by industry under tender.

The technical teams also apply this knowledge to assessing the merits of military equipment and technologies, both to assist the military to decide on what to buy, and also to give them an edge in understanding what other people have got.

Britain still has something which is truly world-class, in science and engineering.

After 100 years, it is time for a celebration of Fort Halstead.

Pre-1937

This is a story in two parts, since the organisation which now occupies the Fort arguably originated in the days of Henry V, and only arrived at Fort Halstead in 1937.

We shall come to the story of that organisation in a few pages time, but for now we will concentrate upon how the site came to be owned by the Ministry of Defence in the first place, and what went on here up until 1937, since which time various research activities have continued uninterrupted.

The site

What's in a name?

Hasted's 'History of Kent' has it that "*Halstead derives its name from the height of its situation. It means a place situated on a hill.*" Halstead lies in what was known in the Middle Ages as the Hundred of Codsheath. The word 'Fort' only represents earthworks put in place in the late 1890's, but more of that in a moment.

Elliston-Erwood, author of 'The Pilgrim's Road', maintains that the site of the modernday fort, located atop a hill with a commanding view of two valleys, was a prehistoric fort. It would have made a lot of sense, and the remains of ninth century warriors slain in the fighting between Danes and Saxons were found at Polhill in 1956, but there is no positive evidence of an ancient fortification. However, the Fort does sit astride an ancient track, which runs along the chalk escarpment.

The story of the fortified site goes back only to the last quarter of the nineteenth century.

The reason for a 'fort'

In 1865, Napoleon III of France sent teams of officers to England to study the landing places and invasion routes employed by Julius Caesar, ostensibly for his book, the Life of Julius Caesar. However, following centuries in which France had been Britain's assumed enemy, there was popular suspicion in Britain that his interest was not entirely academic.

These suspicions seemed justified in 1870 when Napoleon declared war on Prussia, whose prime minister, Otto von Bismarck, had by then welded the numerous small German states into a powerful confederation, which had already taken on Denmark, in 1864, and Austria in 1866. Napoleon's plan backfired and he was taken prisoner at Sedan in September 1870. The following January, Wilhelm I was proclaimed Emperor of a new, united Germany, at Versailles, with Bismarck as his Chancellor, and in March 1871 German troops marched through Paris, in triumph.

All this military posturing during the 1860's, not to mention the significant build-up of the French and Russian battle fleets, led to profound disquiet in Britain about the state of the nation's defences. The country was felt to be vulnerable to invasion, and 'dark European forces' were seen as a potential threat.

For many centuries Britain had relied on seapower for domestic defence. A domestically-based defensive army was felt to have little practical purpose, while our large overseas army was garrisoning significant sectors of the world, and fighting for others, supported by the Royal Navy's 'gunboat diplomacy'. Now there was a dawning realisation, certainly in the media, that the navy, which had changed only a little since Trafalgar in 1805, was no longer up to the task of home defence, on its own.

In August 1870, the editor of the Morning Advertiser, A.B.Richards, privately circulated a pamphlet entitled 'The Invasion of England, A possible tale of future times' which used the then novelty of fiction to warn of the danger. However, his story did not catch on, even when re-published in the Morning Advertiser on 20th February 1871.

The more popular Blackwood's Magazine had been sitting on a similar story, 'The Battle of Dorking, Reminiscences of a Volunteer' and published it in May the same year. It was an open secret that the author was Lieut. Colonel (later General Sir George) Chesney RE, and the story was reprinted as a pamphlet which ran to seven editions and printed 80,000 copies. It was also translated and widely read in Europe.

The Prime Minister was not pleased at having the nation's defences so publicly exposed, and on September 2nd 1871 Mr Gladstone attacked the author in the House of Commons. However, it was only some years later that anything was done about the situation, although the subject festered in the minds of the media and military thinkers alike.

Several other fictitious accounts of invasions were published, the most notable of them being Captain Barrington's 'London on the Defensive' (1881), 'The Siege of London' by 'Posteritas' in 1885, and possibly the most scholarly, 'The Invasion and Defence of England' by Captain Maude of the Royal Engineers. (1885)

Maude, and others, argued for an outer ring of defences and an inner line of fortifications, similar to those planned by Pitt in 1800.

During the 1880s, defence experts of the day, led by General Sir Edward Hamley and Colonel Sir Charles Nugent, never ceased to press for action.

Action, at last

Following an address in 1886 by Major H. Elsdale RE at the United Services Institution on 'The Defence of London and of England' chaired by Major General Sir Andrew Clarke, KCMG, CB, CIE, RE, the Inspector of Fortifications, a committee led by the Assistant Adjutant General was set up to plan and implement defences in the south of England.

Hamley, a great proponent of the Volunteer Force (Territorials) which was disliked by regular serving officers, was instrumental in raising government backing and funding. He put together a

plan, published in 1889, which was largely adopted as that of the government. This was announced in the midst of a long speech to the House of Commons by the Secretary of State, Edward Stanhope, on 11th March 1889, and went almost unnoticed, the costs appearing in the army estimates for 1889/90 to 1895/6 under the innocuous heading of 'for purchasing and utilizing sites for mobilisation stations, especially for the Auxiliary Forces.'

Thanks chiefly to the advent of the machine gun, and the magazine rifle, which meant that infantry no longer needed extensive time under cover to reload, and after bitter experience at the siege of Alexandria in 1882, the concept of shock-absorbing earthworks, trenches and small concealed redoubts was gaining ground over rigid and elaborate masonry and concrete fortifications. This guided the planners in devising 72 miles of defence works, stretching from Epping to Vange, near Basildon, and from Farningham to Guildford.

The plan, worked out in detail only between 1890 and 1892, called for the establishment of ten strong points, each commanding several miles of front. These would be supported by mobilisation centres, where stores would be maintained, and the Volunteers would assemble before going to their positions. The Secretary announced that the Volunteers would be able to practice their skills on-site, at the place of their deployment.

What we now know as Fort Halstead was to be one of these mobilisation centres.

Only a small part of the work was carried out immediately, namely the construction of 13 of the mobilisation centres, referred to by laymen as forts, although only those at Halstead, Pewley Hill and Reigate had any real prospect of commanding their surroundings.

The 'Handbook for the London Defence Positions' issued by the War Office in 1903, tells the story in full. Although the work had only just been completed, the existence of the mobilisation centres was already under review, however!

Haldane became Secretary of State for War in 1905, and had the singular experience, at that time, of coming across one of the mobilisation centres, while on a country walk. He reported to

Parliament that it was occupied by some £25,000 of ammunition and tools, and by a solitary caretaker, who told him that not a single army unit had visited the site in three years, and that the guns were all at Woolwich.

Since the rebuilding of the Navy, centred initially on the Dreadnought battleship programme had by now strengthened the Navy significantly, the concern about invasion had faded, and the decision followed quickly that the 'London Defence Positions' would be run down, and the sites disposed of.

Somehow, Fort Halstead survived in government ownership!

Fort Halstead

Three acres of land were bought in 1890, and a further 6.75 acres in 1891. Some of the original working drawings still exist, dated 11th October 1894, and show some of the earthworks with a layer of hand-picked flints a little way below the surface, presumably to form a 'bursting layer.'

The first buildings were erected between 1895 and 1897, and some survive to this day. The cottages, originally built for the caretakers, (Building A14) and the surgery (Building A13) are part of the original construction. The double doors in one of the cottages might have housed field guns.

The Volunteer infantry division which was to be mobilised at the Fort was to be headquartered at Highfield House, Knockholt.

By the time it was finished Fort Halstead was the largest, and proved to have been the most expensive of the mobilisation centres to construct, at £22,354 for works, and £2,929 for land. It is one of perhaps four which could mount mobile artillery. Although all are different, Fort Halstead most closely resembles Fort Darland, at Chatham, in its design. (Darland was of course not one of the London Defence Positions, having been built far earlier.)

Exploring the old fort

If the entire site is today referred to as Fort Halstead, originally the fort was simply an irregular eleven-sided figure, some 600 feet across, surrounded by a moat with a sloping earth counterscarp, (the facing outside wall of the moat) the scarp (the internal wall of the moat) being revetted in concrete.

The rampart has a parapet banquette and terreplein. Four large traverses divide up the rampart, rising six feet higher than the parapet. There is also a central traverse running southwards from the northern rampart, with a passage under its northern end, from which a large magazine of several chambers leads off under the traverse. There is a small magazine on the opposite side of this passage, under the north rampart.

There are more magazines, each of two or more chambers, under three of the four rampart traverses, with access ramps leadingdown from one or both sides of the rear of these traverses.

The central southern traverse is the odd one out, with no magazine.

The layout strongly suggests a main magazine under the central traverse, with a small chamber opposite for fuzes and tubes; three expenses magazines to serve heavy guns to be mounted on the ramparts; and two small magazines next to the shelters for small arms ammunition. There are, however, no signs of any gun positions, so it was probably the intention to use field carriages only.

Of course, in 1895 horses were used to pull artillery pieces, and the 1922 plan of the old fort clearly shows the two dog-legged stables provided to keep them safe from hostile fire.

World War One

During World War One the Fort was used for the storage of ammunition, and contemporary accounts speak of munitions being taken to the railway station in carts, by local small-holders with

armed escorts. A laboratory was built inside the Old Fort in 1915, and a storehouse was added in 1920, although not within the Old Fort perimeter. Both buildings survive today.

The Fort remained in War Office hands until 1922, when it was sold to a Colonel Bradshaw, who lived in the laboratory, and let the cottages. He also used the site as a camp for, variously, Boy Scouts, Girl Guides, Territorials and destitute refugees. He still owned it in 1937 when it was re-purchased from him at the urging of Brigadier McNair, Chief Superintendent, Research Department, who was looking for 'a safe, remote location' at which to experiment with large cordite charges, and who had remembered the abandoned London Defence Positions.

This seems an appropriate moment to turn to the origins and development of the organisation whose first components moved to the Fort in 1937.

After that, we can return to the Fort.

One organisation, or many?

The Office of Ordnance was founded by Henry V in 1414, at the Tower of London, where it carried out gun trials in a field outside the walls, known as the Artillery Garden. Henry VIII incorporated the gunners, by Royal Charter, as the Fraternity of Artillery or Gunners in the Tower, and in the reign of Elizabeth I the Master Gunner at the Tower was given the title of Master Gunner of England, his duties being "*to profess and teach his art to all under-gunners in the exercise of shooting off great pieces of Ordnance.*" This art apparently included not only the servicing of the gun in action, but also proof. In a book of the period we find what may be the first recorded 'proof specification.' It reads "*Prove your guns with the weight of the iron bullet thereof, then with five fourths, then with three halves.*"

A gun depot was set up at Woolwich in the sixteenth century, close to the Royal Dockyard. In 1664 Charles II opened a carriage yard there, as a store for ships' gun carriages, and a year later gun proving commenced at Woolwich, preparatory to closure of the old Artillery Garden. Gun carriage manufacture grew as an adjunct to gun manufacture, and eventually, in 1803, a separate department was set up for this purpose.

In 1683 Charles set up a new Office of Ordnance, whose head bore the title of Master General of the Ordnance, an appointment which survives today.

In 1695 the Laboratory for Ammunition and Pyrotechnics was also set up at Woolwich, at The Warren in Tower Place, replacing the laboratory at Greenwich Palace. By 1770 it was known as the Royal Laboratory for Ammunition and Pyrotechnics.

When the Royal Artillery was formed as a regiment, in 1716, in the reign of George I, Woolwich quite naturally became its headquarters.

Also in 1716, a foundry for brass guns was built at Woolwich, the first such venture in state hands. The Royal Brass Foundry remained in existence until the introduction of wrought iron forged

guns, when all the gun foundries were amalgamated as the Royal Gun Factories, in 1855. (This was in direct consequence of the development by William George Armstrong, of the breech-loading 'rifled' gun.) Guns made at the factories were stamped 'RGF.'

As a result of the growing complexities of gun manufacture, drawing offices were now needed in the factories, and in turn these gave rise to design departments, which, in 1922, came to be part of the Design Department, which during World War II became a cornerstone of the fledgling organisation we now find at Fort Halstead.

In 1805 the all-embracing title of Royal Arsenal was conferred on the site at Woolwich, embracing all the activities there, including the butts, the three factories, artillery barracks and probably the academy.

During the Napoleonic wars the Comptroller of the Royal Laboratory, Sir William Congreve, led Woolwich in the development of rockets, which were used to great effect both in Europe, and, in 1814, at Bladenburg, better known as Baltimore USA. You will find reference to them in the national anthem of the United States, as "rocket's red glare."

An unsavoury story has some credence among historians, concerning the treatment of French prisoners of war at Woolwich, following Waterloo. Several thousand POWs were incarcerated at Woolwich, evidently causing some alarm at Westminster, not very far away, when it was considered what could happen if there were a mass escape. At that time there were extensive tunnels leading from the Arsenal to Woolwich Common, and it is believed that these were used to convey all or most of the prisoners to an untimely end.

During preparations for the Crimean War, the Government appointed a young chemist to the War Department to advise on scientific matters. That chemist, later known as Sir Frederick Abel, Bart., G.C.V.O., K.C.B., F.R.S., carried out with Sir Alfred Noble some now classical work on internal ballistics, and set up a small research department at Woolwich, which became known as that of the War Department Chemist.

The twentieth century

Some years later, in 1903, serious deficiencies in ammunition during the Second Boer War, combined with the growing complexity of weapons, led to the foundation of the separate Chemical Research Department, also at Woolwich. This new group brought in supposedly fresh thinking, and took over the research duties of the War Department Chemist, whose establishment henceforth started to function as an inspectorate.

The Chemical Research Department changed its name to the Research Department Woolwich in 1907, and branches for ballistics, metallurgy and other subjects were added, during the next twenty or thirty years. In 1907 the department also assumed responsibility for the Proof of Ordnance, and continued with this duty for another forty years. It was the first British organisation to be devoted entirely to armaments research, and was one the direct forerunners of the Royal Armament Research and Development Establishment (RARDE) of which we will hear far more, later.

In 1915 the engineering design and development of ammunition was concentrated progressively into a separate department, although the unified Armament Design Establishment only began to take on its final shape in 1922, when the weapon design facilities at Woolwich and Enfield were amalgamated into the Design Department.

The United Kingdom was hopelessly unprepared for war in 1914. Due to a shortage of acetone there was only enough cordite to meet the needs of the Royal Navy. Demand for lyddite, the explosive used in the Boer War, far outstripped supply, and there was no large-scale manufacturing process yet in existence to produce the recently adopted TNT.

The team at Woolwich developed a new type of nitrocelllose, which could be gelatinised with a mixture of ether and alcohol, instead of the unavailable acetone. Factories were hastily erected all over the UK for the manufacture of TNT, and specialist staff seconded to run them.

However there was never enough TNT to go round, and it was

fortunate that the Woolwich team came up with Amatol, in which a small amount of TNT is mixed with ammonium nitrate. The original reports about the development of Amatol are still in the Fort's archives.

After the war a lot of effort was concentrated on settling problems which had become apparent in wartime, but which no-one had had time to solve.

One of the most serious of these was the local decomposition of cordite, due to minute specks of active impurities, such as pyritic coal dust, having entered the mix during manufacture. Growth of these decomposition spots could cause spontaneous combustion and had certainly resulted in the loss of HMS Bulwark in 1917. A new stabiliser was developed, and a test devised, so that doubtful materials could be identified.

A flashless propellant was also developed at this time, because the one in use not only revealed the position of the gun to the enemy but also blinded its own gunners, so dazzling was the flash!

Cordite-operated catapults for launching ship-borne aircraft were devised, along with a whole host of low pressure cordite-operated devices, such as aero engine starters and flame throwers.

Radiological techniques for the quality control of thick steel objects, such as gun barrels and castings were developed and later passed into general use in industry.

Great efforts were made to harness all the new developments in tactics and mechanical warfare, especially in tanks and aircraft. The battleships Rodney and Nelson were built to carry the department's 16" guns, and a 4.7" anti-aircraft gun was developed which could be fired electro-magnetically. (This latter was the fore-runner of so many similar weapons.)

Following the 1924 arms limitation agreements, an 8" gun was developed for our lightly-armoured cruisers, and during the thirties, 12" and 14" guns were developed, in urgent response to the 11" guns of the German pocket battleships, such as Scharnhorst, Gneisenau and Graf Spee.

1937 and on

The lead-up to arrival at the Fort

You may have the impression of a number of research, development and manufacturing organisations which had grown haphazardly over the centuries, and which were not always really in contact with what each other was doing. There is more than a grain of truth in this.

Come the 1930s, Hitler was on the loose, and it became apparent that the armaments design effort was in need of overhaul.

In 1935 the Design Department consisted of four sections: guns, carriages, ammunition, and small arms, and was still, in effect, the design office of the Woolwich Arsenal. The staff consisted of a small number of unqualified serving officers and a large number of civilian draughtsmen, effectively treated as 'other ranks.'

The services would submit rough ideas of what they wanted to the Ordnance Board, who would translate these into specifications. These would, in turn, be translated into detailed design drawings by the draughtsmen. No critical appraisal, no improvements or changes could be considered. The Design Department certainly had no responsibility for long term development, or indeed for any development at all. The specification process took so long that it could, typically, take seven years for one to reach the designers, after many amendments as circumstances changed.

The Duckham (1926) and the Locke (1935) Committees commented adversely, and proposed the appointment of civilian professional engineers, as real designers. The War Office resisted manfully, but in the ensuing years the urgency of the work, the change of reporting lines direct to the War Office, and an influx of RAF officers unaccustomed to stuffiness, changed the working atmosphere markedly. Design Officers actually spoke to draughtsmen, and worked with them collaboratively!

However, the limitations were that the Design Officer could only be as effective as his technical competence, which was far from guaranteed.

Civilian expertise recognised

By 1939, the situation was so grave that the War Office relented, and civilian appointments were permitted to the post of Design Officer. These were not initially a great success because those promoted tended to be more interested in production than in new design work. This was, perhaps, inevitable, given their previous experience, but a start had been made.

In 1942 the Guy Committee was set up to look at the whole question of the design and development of weapons, and in particular at the functions and relationship of the Research and Design Departments and the Ordnance Board.

While it was deliberating, the Design Department was removed from proximity to the bombing, to Knockholt and to Halstead Place, a few miles away. Meanwhile, the Research Department was dispersed all over England, the central registry also having been transferred, but to Shrewsbury. If they could not easily collaborate or communicate with each other, neither were they any longer near to the Ordnance Board or the facilities at the Arsenal.

The Guy Committee debated the fundamental role of the Ordnance Board, based on the acceptance that the Board as specifier needed to be far closer to the user, and involved far earlier in the deliberations as to what was required. It was also admitted that the Board lacked any real technical expertise in all but a handful of areas, and that the services were not in a position to produce competent engineers as designers. However it was also accepted that the draughtsmen in the Design Department were woefully underqualified for a design task.

Virtually all of the Guy Committee's proposals were adopted, and indeed, during the remaining war years only people with first class degrees were employed, a far cry from the situation in 1939. Technically qualified civilians had finally arrived,

and have been working alongside the military ever since.

Despite this, it was only after the war that Designers started seeing the staff requirements, in the form of tactical statements.

The most significant first step was the appointment of Mr F.E.Smith of ICI as Chief Engineer of Armament Design, a position of technical leadership rather than administrative management.

The committee also decided that the Design and Research Departments needed to be in close physical proximity to each other. On hearing that the Projectile Development Establishment (See later) was vacating the Fort, a team inspected the premises and found them suitable, although it was a few months before the Design Department was able to move in, due to the need for structural alterations.

However, the Department's headquarters and registry staff were able to make use of Halstead Place School, while the building took place. The Research Department took even longer to arrive, because laboratories had to be constructed. Between 1939 and 1942 the staff of the A.R.E. had increased from 1,000 to 3,000.

An instrumentation section was added in 1944, since trials were now so complex that instrumentation was vital. Of greater import, Mr Smith set up the Technical Group in 1944, housed at The Grange in Knockholt. This team were responsible both for supplying design data which the drawing office could not produce, and for providing quick answers for the designers who simply could not wait for the long-term scientific view.

A sub-group, the Information Section, became responsible for reading internal and external scientific papers, and ensuring that their information reached the appropriate colleagues, and for circulating reports of the Establishment's work all over the world.

The journey from the nineteenth century to the twentieth had taken no more than ten years to complete, nearly half a century late.

Arrival at the Fort, and back to work

In 1935, well over a century after Congreve's rockets had startled the world, work started in the Explosives Branch at Woolwich on rockets as anti-aircraft weapons, being transferred to Ballistics Branch the following year. By 1937 a design for a 2" calibre weapon had been established, and a 3" version was being considered.

Dr Godfrey Rotter, the long-serving Director of Explosives Research, (and the man responsible for developing RDX, later used by the RAF in their blockbuster bombs,) was apprehensive about the safety aspects of burning large cordite charges, so his boss, the Chief Superintendent, Research Department, Brigadier McNair, set out to find remote premises at which testing could take place.

The first tenants

Elements of the Rocket Section of the Ballistics Branch moved into the Fort in 1937, and this small experimental outstation of Woolwich became the path-finder for Fort Halstead as a Research and Development Establishment.

In 1938, the success of the 3" rocket work persuaded the powers that be that the unit should become the separate Projectile Development Establishment, under the leadership of Sir Alwyn Crow, and it severed its connections with the Research Department at Woolwich, moving to the Fort en masse in 1939.

A year later, after the evacuation from Dunkirk, and at the height of the blitz, the site was deemed vulnerable to air attack, a threat made all the more real by Lord Haw-Haw, who promised the Fort a raid of its own. It was also worryingly on the line of probable advance by Hitler's invading armies. (Where have we heard that before?)

The entire Rocket team was moved to Aberporth in Wales, where a trials range had already been constructed. Unfortunately,

only a few years later, Sir Alwyn became convinced that reports of German advances in rocket design were spurious, and so advised the government, because he believed that their rockets would only function using solid fuel. He interpreted photographs of V2s on launchers as balloons. When the first V2s started arriving he presumably felt a little astonished. When he interrogated the German scientists at the end of the war, they were certainly a little perplexed themselves, when they learnt of his beliefs!

Between 1941 and 1942, when the reduced bombing threat made the site habitable again, major civil engineering works were carried out at the Fort, in anticipation of re-occupation. Roads and drains were laid, and buildings erected, although these were not designed for any specific use.

Although a lawyer would describe the evidence as being circumstantial at best, there have long been rumours of an underground narrow gauge railway, leading from a reputed underground magazine complex beneath the Fort to nearby ammunition storage facilities, and to the Polhill railway tunnel then operated by Southern Railways. There are certainly signs at the Fort that such may have existed, but signs are not absolute proof, and if there was ever anything in it, all surface traces seem to have been both well-concealed, and sealed.

Is it possible, in the interregnum following the departure of the rocket section, and while there was a genuine fear of invasion, that some bright spark hit on the idea of the Fort reverting to its former role as an ammunition store? Might there have been time or reason to undertake what would have been a massive civil engineering feat, on top of all the building...or rather, underneath it? We shall probably never know.

During the war any number of novel weapons were developed at Fort Halstead, or by the people who moved there. Among them was SR 365 incendiary filling for ammunition, used by Spitfires and Hurricanes in the Battle of Britain, hollow-charge projectiles and demolition stores, sub-calibre armour-penetrating projectiles, and the evolution of explosives such as the 'minols' range, and Torpex, a mixture of TNT and RDX with aluminium, used in the destruction

both of the Tirpitz, and of the Ruhr dams in the famous dambusters raid. Fort Halstead also devised the fillings for the 22,000 pound 'earthquake' bombs.

The 2 pounder anti-tank gun devised pre-war was obviously inadequate against German armour, and a six pounder was rushed into production for the 1941 North Africa campaign, but was outmatched in combat. Happily, the new establishments at the Fort were able to respond to what was a well-defined objective, and devise the successful 17 pounder gun with its special ammunition. This was produced in large quantities in 1943/4.

The famous 25 pounder, the Wombat Battalion anti-tank recoilless gun, the ADEN 30mm gun and a range of anti-aircraft guns were also developed at the Fort.

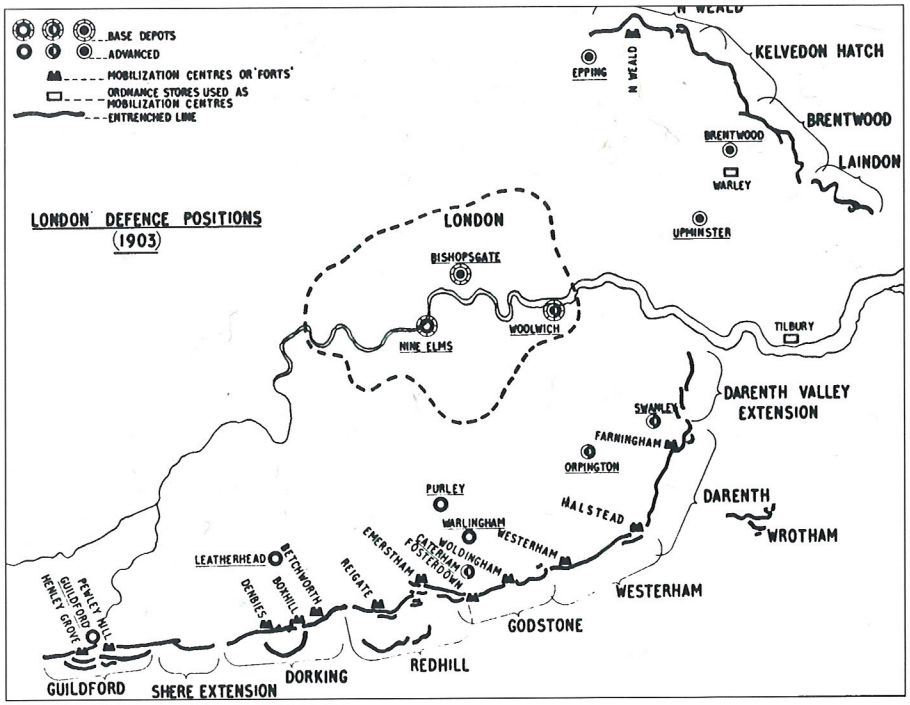
It is worth noting that by 1943 there was considerable criticism that neither the Research nor the Design Departments were undertaking sufficient theoretical work. A theoretical research branch was added to the Research and Design Departments, and used analogue calculating devices in their assessment of our own and enemy capabilities. This unit eventually developed to become CDA (Land). (See later, under Operational Research.)

Post-war

Following the war, a number of nationally important events took place at Fort Halstead, or were organised from Fort Halstead, in rapid succession.

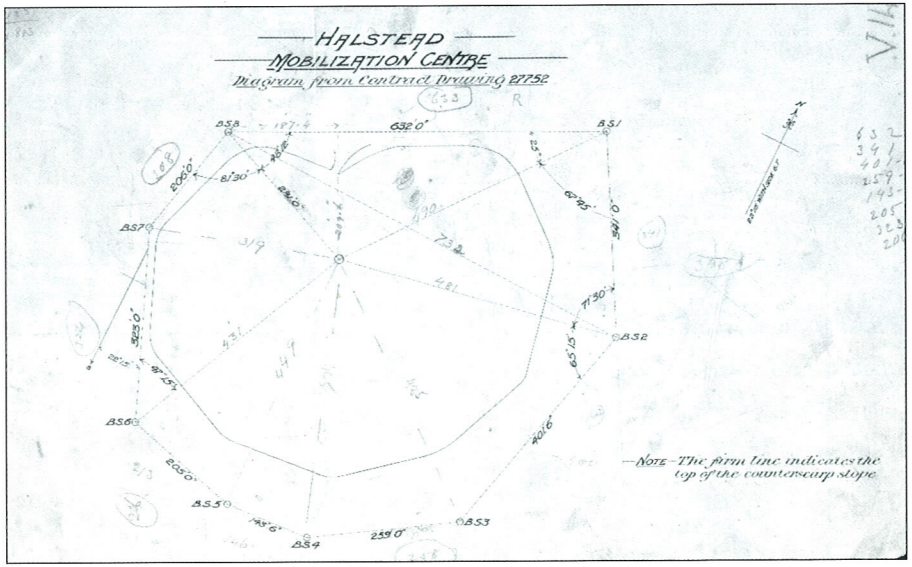
The first was Operation Surgeon. On advancing into Germany at the end of the war, British troops discovered the Luftwaffe's principal research base, quite by chance, near Brunswick.

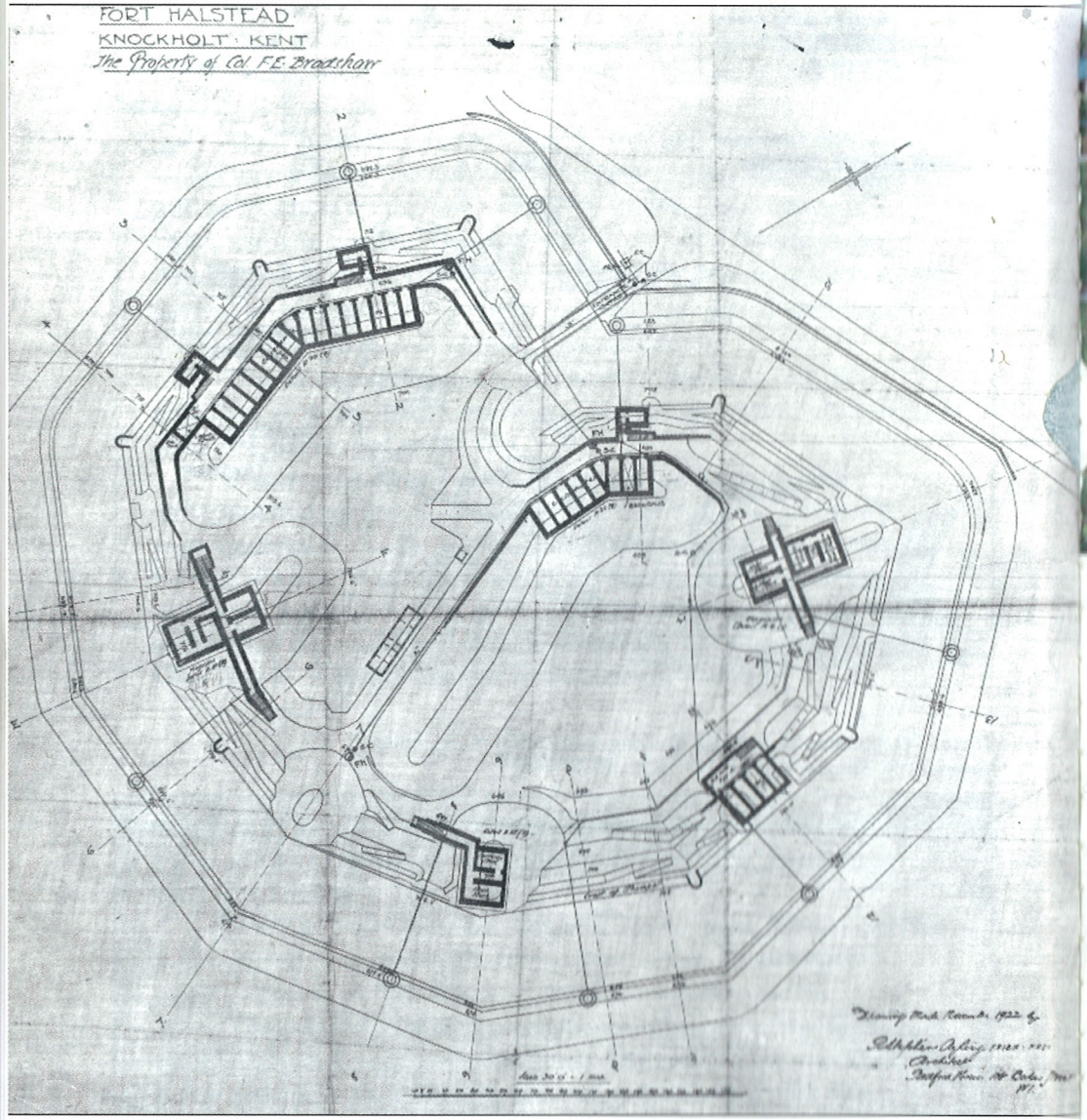
The research buildings were cunningly camouflaged, many in thick forest, although one notable wind tunnel facility was housed underneath an apparent barn, the roof of which removed on hydraulic jacks, to reveal the intake ducts to the tunnel. As a result of their invisibility, the facilities were largely undamaged by bombing, and Fort Halstead personnel were involved in the process



(Above) The London Defence Positions

(Below) Original outline design drawing of the old fort, signed by Sergeant W. Skipper RE, on 14.7.1895

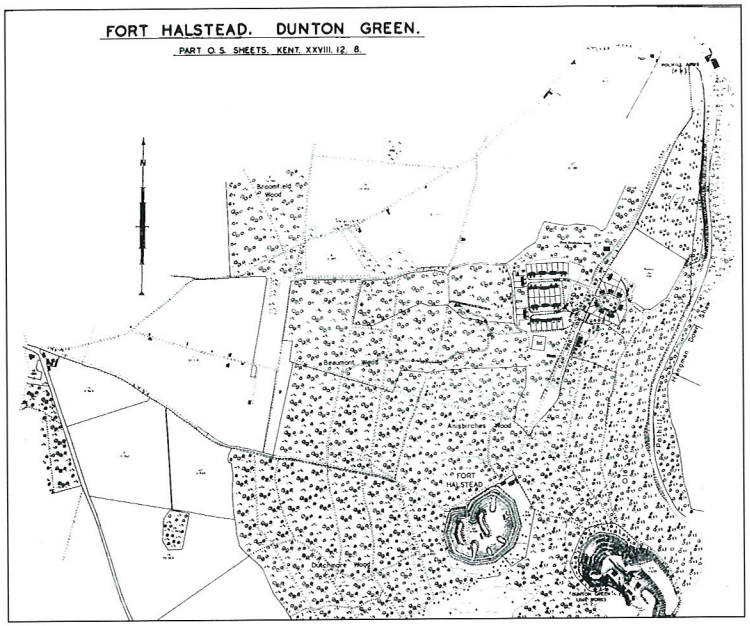




Detailed plan of the old fort, drawn in 1922

(Above) Part of the interior of the old fort, photographed in the early 1980s. It has since been cleaned up!

1928 map of the site.



G. R.

By Order of the Disposal Board.

PARTICULARS, PLAN & CONDITIONS OF SALE
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KNOWN AS

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DUNTON GREEN,

KENT,

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WEATHERALL & GREEN,

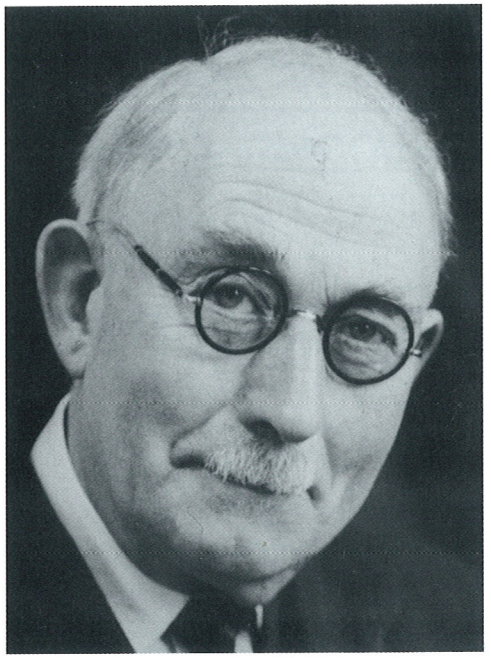
AT THE LONDON AUCTION MART,

155, Queen Victoria Street, E.C.4,

ON TUESDAY, 8th NOVEMBER, AT 2.30.

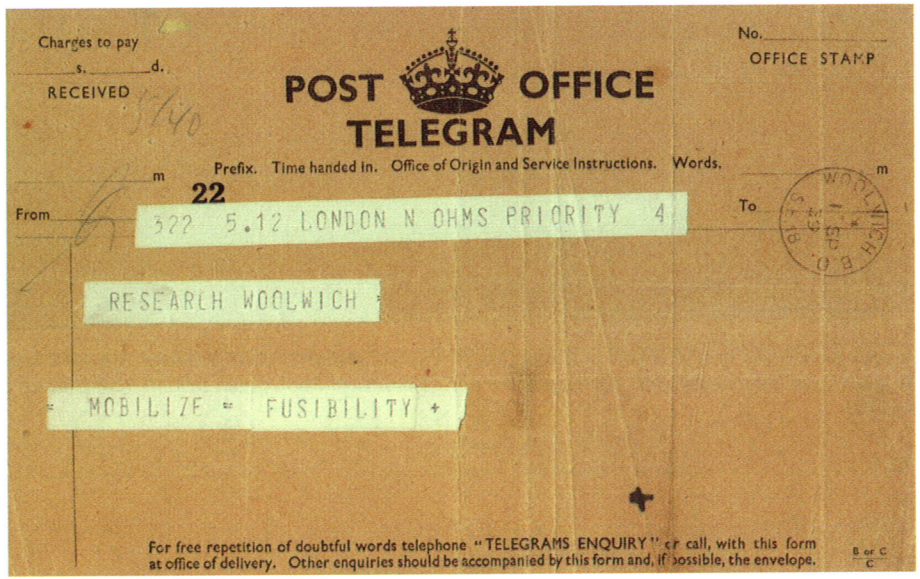
Further particulars can be obtained of the Disposal and Liquidation Commission (D.B. 1a/3), Room 767, Caxton House, Tothill Street, Westminster, or of the Auctioneers, WEATHERALL & GREEN, 22, Chancery Lane, W.C.2. Telephone: Holborn 584.

Fort Halstead is offered for auction, 1921



(Left) Dr Godfrey Rotter, the Director of Explosives Research 1921–1942, who started the search which led to re-occupation of Fort Halstead in 1937.

The original telegram instructing Fort Halstead to mobilise and disperse, dated 1 September 1939.



Charges to pay
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22

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5 Measuring alcoves
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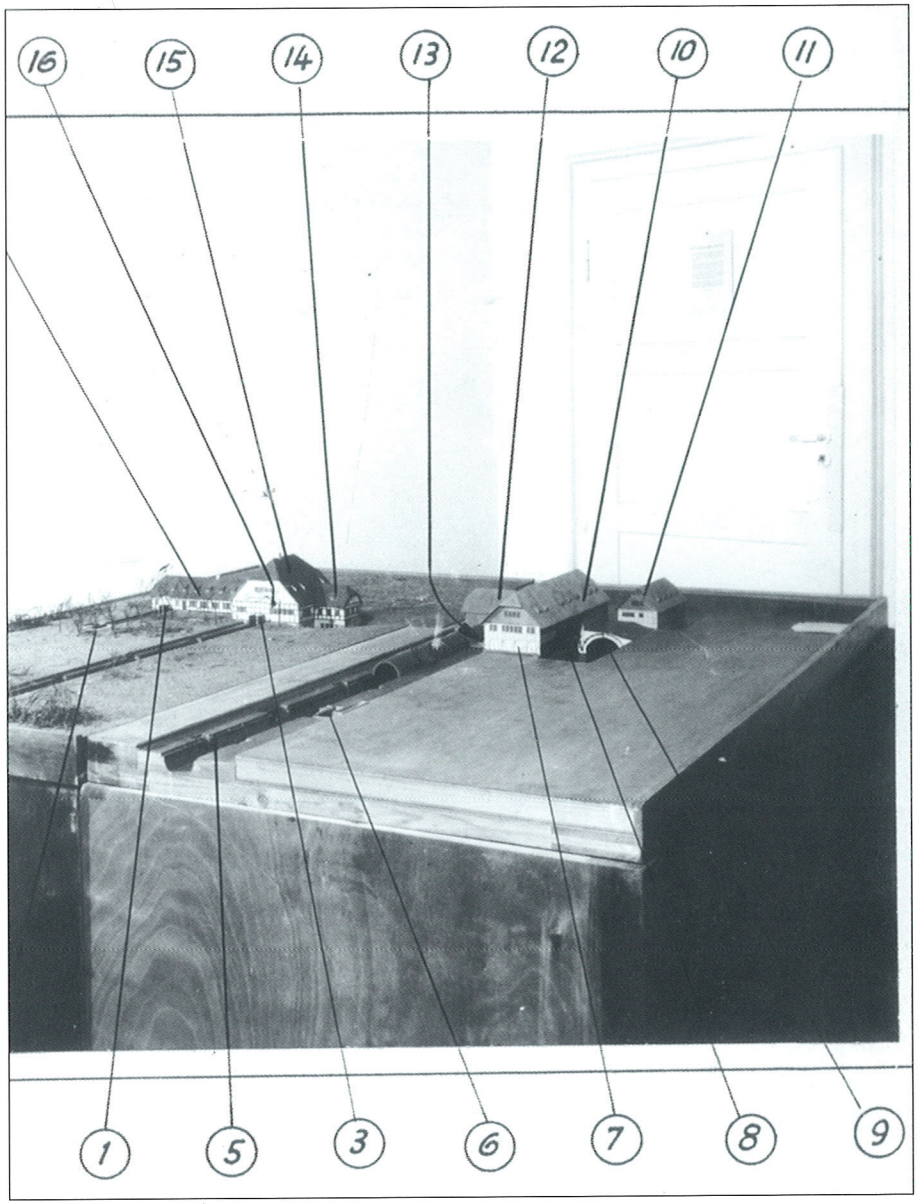
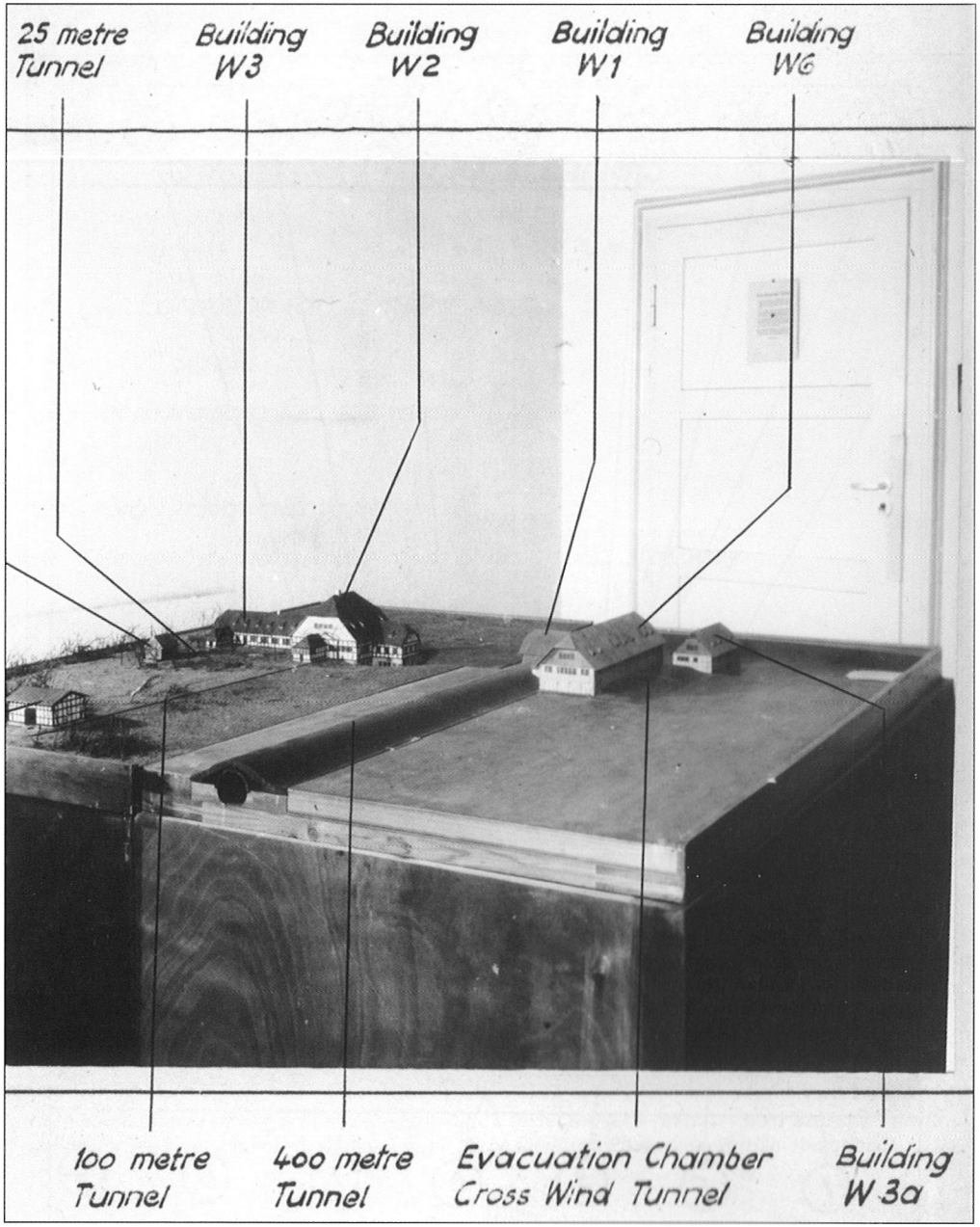
8 Working section cross wind tunnel
9 Evacuation Chamber cross wind tunnel
10 Hall containing evacuation machinery and electrical converting station
11 Wo shop and bomb stability tunnel
12 Firing Chamber 400 metre tunnel
13 Air Extraction shaft 400 metre tunnel
14 Workshop
15 Building containing refrig plant
16 Firing Chamber 100 metre tunnel

German architect's model of one of the Luftwaffe's secret research premises near Brunswick, with the protective layers removed, showing some of the facilities. Photo from British operational records.

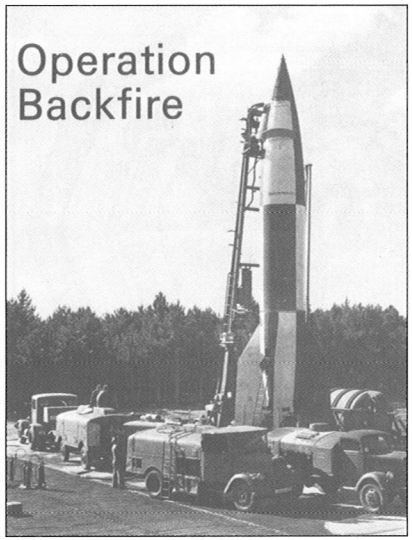




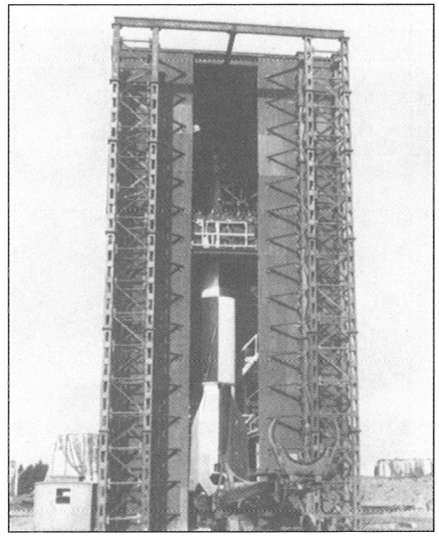
Operation Surgeon. German architect's model of the same Luftwaffe secret research premises near Brunswick, as camouflaged. Photo from British operational records.

(Above) Reconnaissance photograph of the research site modelled on the right in the previous photographs. The major amendment to the plan is that the roof of the barn to the left of the main building lifted off, onto the pedestals just visible, on the left, to reveal the ducting beneath. Photo from General Simon's records.

(Below left) A V2, after the War, ready for firing.



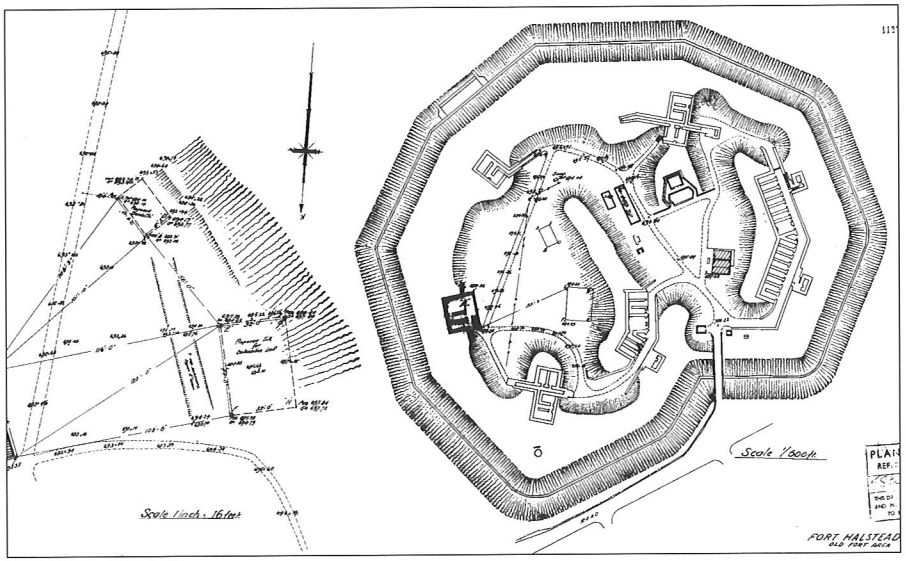
(Below right) The British Bailey Bridge construction, to assist inspection of rockets in the vertical position.



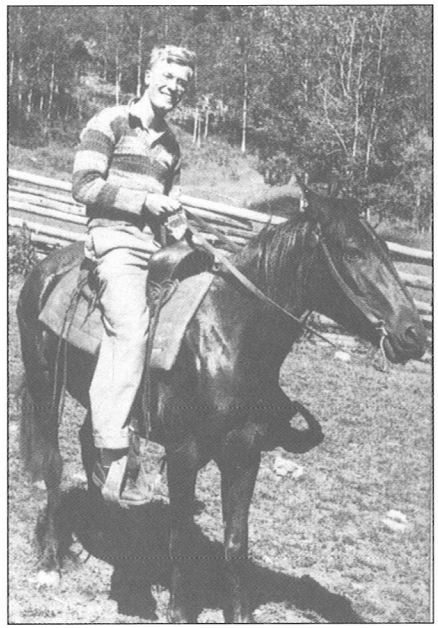
(Above) Reconnaissance photograph of the research site modelled on the right in the previous photographs. The major amendment to the plan is that the roof of the barn to the left of the main building lifted off, onto the pedestals just visible, on the left, to reveal the ducting beneath. Photo from General Simon's records.

(Above) Headquarters Stores, Fort Halstead 1946.

(Below) Plan of the old fort, dated circa 1947, showing plans for a new detonation laboratory and bomb chamber.

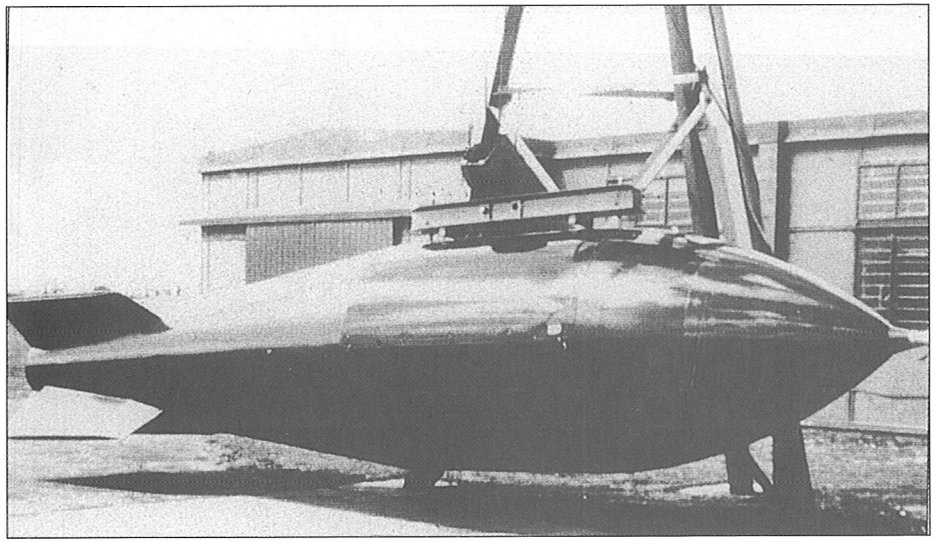


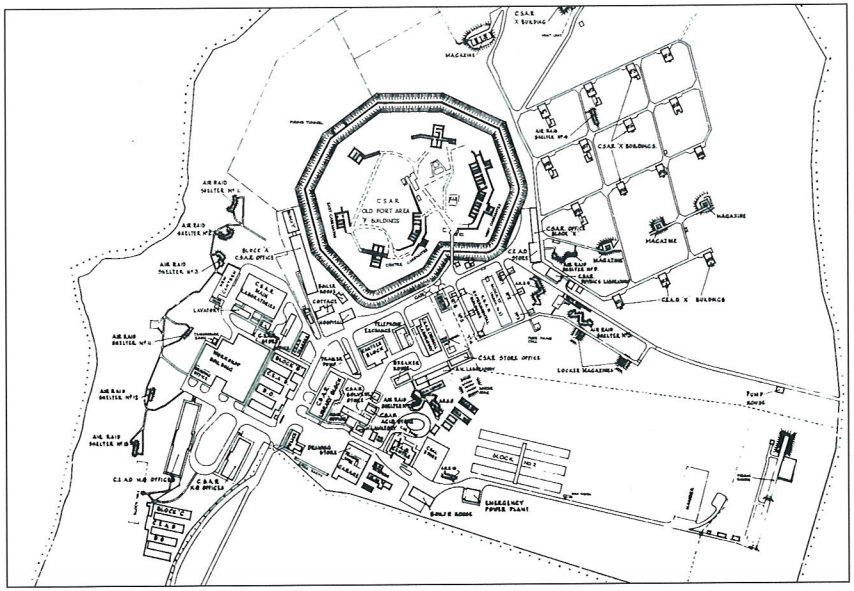
(Top Left) William Penney leaving for work at the Fort in 1952.



(Top Right) 23 year old Penney in 1932, at Robert Oppenheimer's ranch in New Mexico.

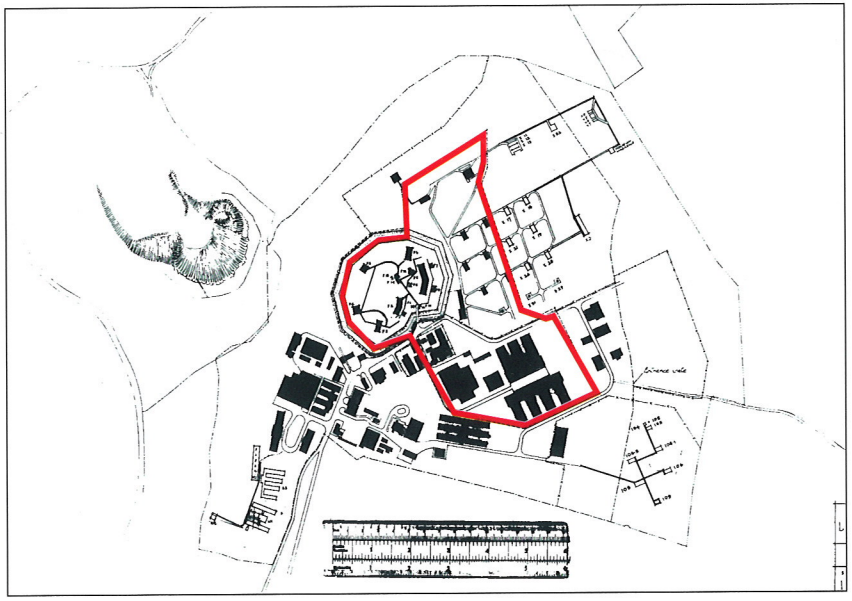
(Below) The first British nuclear weapon, the Mark 1, codenamed Blue Danube, was delivered to the RAF in November 1953.





(Above) January 1945 map of the site, showing clearly the scale of the wartime establishment

(Below) 1950 map of the site, showing (in red) the enclosed area which contained Penney's team.



(Above) Buildings Q17/18/19, now demolished, housed Penney's drawing office.

(Below) AMOS, the Fort's first on-site computer, in 1955.
A modern Pentium PC runs 25,000 times faster.

(Above) NATO group at a briefing at the Fort in 1959.

(Below) Her Majesty the Queen unveiling a commemorative plaque in A3 Building in 1972, beside HRH the Prince Philip and Mr F. East, the Fort Halstead Director.

WAR OFFICE
WHITEHALL, LONDON S.W.1

6th February, 1962.

Dear Dr Black

It gives me very great pleasure to inform you that Her Majesty The Queen has been graciously pleased to honour the Armament Research and Development Establishment by conferring upon it the Royal Title.

To you and all the members of the staff of the Royal Armament Research and Development Establishment I send my heartiest congratulations on the award of this well deserved honour to your establishment whose work on behalf of all three Services is of such vital importance.

Yours sincerely

John Profumo

Dr. D.H. Black, C.M.G.

The letter advising of the award of the Royal Appellation, signed by Secretary of State for War John Profumo, only months before 'that scandal' broke in the media.

(Above) Her Majesty meets the 1971 apprentice of the year, Graham Ayres.

(Below Left) All age groups were pleased to see the Royal party.

(Below Right) HRH the Prince Philip shows an interest in old naval guns.

of 'liberating' entire installations, including four wind tunnels.

Operation Surgeon stood for the wholesale removal of equipment and facilities, literally brick by brick. Operation Spanner Hammer covered the reconstruction phase, back in this country. For many years afterwards, the Fort, and three other Ministry of Defence sites, were equipped with perfectly serviceable Luftwaffe wind tunnels. In fact, the Fort still has a working overhead crane, among other items, courtesy of Hermann Goering!

Operation Backfire was the codename assigned to the post-war launch, by Fort Halstead scientists among others, of three disarmed V2s, from their base in northern Germany. Apart from an unasked-for direct hit from a 'doodlebug' (V1) during hostilities, the Fort also had its own post-war collection of V1s and V2s to work on.

Not content with lots of German equipment to examine, Fort Halstead also had its very own Germans, available on-site to undertake translations of 'liberated' technical documents. 70-80 of them were housed in the Halstead Exploiting Centre, located in Halstead Place School, and run by the Royal Artillery.

In 1947 Fort Halstead was given the opportunity to develop Britain's first atom bomb, under the leadership of its new Research Director, Dr (later Sir William, then Lord) Penney. As this project grew, it actually involved more than half the A.R.E. staff at one point, and it became desirable to create a separate Establishment, in order to focus attention on it. The new organisation, known as the High Explosive Research Establishment, and later as the Atomic Weapons Research Establishment, moved to a new site at the abandoned Aldermaston airfield, and took with it the A.R.D.'s Chief Superintendent (Penney) and many A.R.D. staff.

In 1946 the chemical aspects of the Establishment's work were transferred to a new body, the Explosives Research and Development Establishment, at Waltham Abbey. (See later)

In 1948 the two departments at Fort Halstead were re-named the Armaments Design Establishment and the Armaments Research Establishment, respectively.

On January 1st 1955 the Armament Research and

Development Establishment came into being, absorbing the Armament Design Establishment and the Armament Research Establishment. The marriage proved to be a difficult one to arrange, from an organisational planning point of view, since the research department was organised into divisions dealing with problems on a broad scientific basis, while the design side was arranged in groups dealing with specific projects or groups of projects, such as guns, shells and cartridges, small arms, carriages etc.

The horizontal structure of the A.R.E had to be merged with the vertical structure of the A.D.E. This was achieved chiefly by grouping together, under one Principal Superintendent, groups from each, whose work most closely corresponded, and leaving separate those research groups whose work was of a more fundamental research nature.

In 1962 the Establishment was granted the Royal appellation, and in 1972 received a visit from Her Majesty the Queen and HRH the Prince Philip.

By the middle seventies RARDE (The Royal Armament Research and Development Establishment) had passed from control by the Master General of the Ordnance to that of the newly-created Controllerate of R & D Establishments, by whom it was nominated as the major Land Warfare Systems Establishment, although it continued to provide support both to the Royal Navy and to the Royal Air Force, as well as to the Army. RARDE also possessed three outstations at that time, at Langhurst in Sussex, (The Petroleum Warfare Department during the War,) at Woolwich and at Potton Island, all of which, in the years following, removed to the Fort.

By this time RARDE at Fort Halstead had expanded its activities significantly, and was active in research, design, development and evaluation of

- Anti-tank guided weapons
- Warheads for guided weapons
- Optical systems for the visible and IR bands

- Engineer explosive stores, such as mines and demolition equipments
- Unguided rocket systems
- Battlefield Computer, and Command and Control Systems

Operational Assessment and War Gaming supported R & D activities, and the development of tactical concepts.

Forensic work

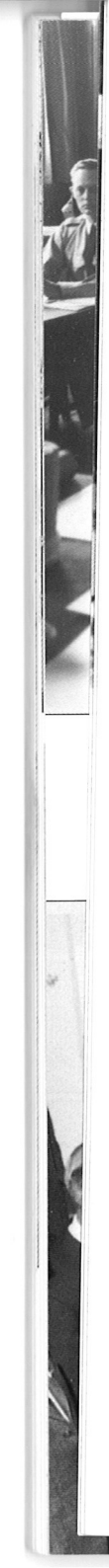
In 1985 the Explosives Forensic Laboratory moved to the Fort from Woolwich.

In 1871 a Captain Majendie was appointed to assist the public inquiry into the massive explosion at the Patent Gun Cotton Company's factory at Stowmarket. Wanting a qualified chemist to advise, he appointed a Dr Dupre, who then continued working in the explosives field, albeit very much as a private consultancy. Most of his work was confined to approving commercial explosives for safe manufacture and transport, until the Fenian outrages of the 1880s.

The emphasis then changed towards investigative forensic work, until the small outfit moved to the Arsenal in the early twenties. The young civil service department, as it now became, continued to be run by Dr Dupre, from whom his two sons eventually took over!

Techniques have changed a great deal since then, and sophisticated instrumentation now enables the identification of the minutest traces of explosives, research being conducted in sterile conditions to ensure acceptability in court. The Laboratory enjoys a world-wide reputation, and had a signal role in analysing the causes of the Lockerbie bombing.

It is also considerably larger than once it was, and, since the early nineties, now trains its own graduate analysts, although very selectively.



New arrivals from Waltham Abbey

Just after the war the Explosives Research and Development Establishment, at Waltham Abbey, ceased to manufacture explosives, to concentrate solely on research. RDX had been developed there originally, as well as HMX and various production processes, and work now included such items as non-energetic materials, and whiskers (which preceded carbon fibre as a stiffener.)

In 1973 the Establishment merged with the Rocket Propulsion Establishment, at Westcott, and in 1977 became the Propellants, Explosives and Rocket Motors Establishment (PERME), based at Waltham Abbey. In 1985 the Waltham Abbey site, which was on two sides of a road, was split in two, the south site becoming part of Royal Ordnance, the north site part of RARDE.

In 1987 the staff at PERME celebrated the 200th anniversary of the original Gunpowder Mills at that site being taken into public ownership by William Congreve.

The following Monday they were told the site would close, staff being transferred to Fort Halstead. However, new buildings had to be arranged at the Fort, and it was 1990 before the first tranche of people 'emigrated' across the Thames. The move, eventually involving 80% of the 150 staff, was completed in 1992.

Like all enforced emigrants they brought various artefacts and mementos of their historic site with them, and as we write in 1997, it has been announced that the North Site at Waltham Abbey will become a world class explosives museum, following completion of ten years of decontamination exercises. £5.5m of Ministry of Defence funds and £6.5m from the National Lottery have been earmarked to fund the venture. The artefacts will surely return.

Their purpose-built Explosive Chemistry Laboratory at the Fort, probably the most advanced in the western world at the time, was opened by HRH the Duke of Kent, in October 1991. It boasts no fewer than 34 separate extraction systems, reflecting a substantial investment in pollution control.

DRA

In 1991 RARDE and Fort Halstead became part of the MOD's new Executive Agency, the Defence Research Agency, not to be confused with today's DERA, the Defence Evaluation and Research Agency. (See below.) The DRA brought together, under one corporate roof, four previously separate defence research establishments, RARDE itself, the Royal Aerospace Establishment, the Royal Signals and Radar Establishment, and the Admiralty Research Establishment.

DRA became a trading fund on 1st April 1993, which basically meant that it started to be run along more commercial lines.

Operations Research and War Games

What is now the Centre for Defence Analysis (Land) has its origins, as we have seen, as a theoretical research group during World War II, which in turn became a CA group in RARDE. Then it became the Operational Studies Sector in DRA. The sector amalgamated with the Defence Operational Analysis Centre to become the Centre for Defence Analysis in DERA.

The Centre exists to assess the value of future equipment, and to look at the way the army operates with existing equipment, as well as with potential future equipment. War games are just one of the tools they use. They have assessed virtually every land system which has been proposed in the last 20 years

The changes in the world order mean that a much wider range of potential threats and scenarios has to be looked at. Scenarios have to be as generic as possible. The Centre were the first in the world to study conditions post CFE (The Conventional Forces in Europe rundown treaty with the USSR) in detail.

CDA (Land) have used a variety of war games, from divisional level down to close combat.

Although it is now being replaced by a game using newer software, the Divisional War Game was, in its day, probably the most elaborate facility of its kind in the west, using something like 30

players at a time, plus various civilian support staff, probably up to 50 people in all. In the early eighties it was used by the US for a year to assess a new concept of their own. It achieved a high profile here and in the United States, where they do not have an equivalent at that level.

At the other end of the scale, CAEN is a newly developed close combat game which is thought to have wider applications, for instance in dealing with riots and civil unrest.

DERA

In April 1995 the Defence Evaluation and Research Agency (DERA) came into being. DERA incorporates all of the Ministry of Defence's non-nuclear research, technology, test and evaluation establishments. Initially comprised of the Defence Research Agency, the Defence Test and Evaluation Organisation, the Chemical and Biological Defence Establishment and the Centre for Defence Analysis, DERA is now the sole trading name employed to describe these and all the other organisations which have stemmed from the initiative of Henry V in 1414.

With some 12,000 staff, of whom fewer than 10% are administrative, DERA now constitutes Europe's largest single research capability. At long last, after some 580 years, the combined efforts of many thousands of people are now coordinated, by one body.

Fort Halstead supplies an even wider range of expertise today than it did just twenty years ago.

The advent of DRA and then DERA enabled the concentration and pooling of expertise, some of which had hitherto been split between sites, which might not even be aware of each other's work on the same subject. It would be foolish to deny that the odd parochial jealousy used to get in the way of progress, occasionally, or that ten experts in one place are better than five in each of three.

The range of work being undertaken might suggest that guns, the original focus of interest, had fallen by the wayside, but the

opposite is the truth, for there will, in the foreseeable future, always be a need to assess and improve gun systems. Guns are still in use throughout the armed services, throughout the world.

The current thrust is for mobility, a cost effective weapon of the right weight, firing so many rounds. Guns are cost effective. Research into sensible projectiles runs alongside developments in such futuristic areas as electromagnetic and electrothermal guns, fields in which Fort Halstead is at the forefront of world competence.

Invention continues, in all areas of work!

GLIMPSES

The Gulf War and Fort Halstead

The Research and Development task in war

Not everyone at the Fort was directly involved in supporting the military effort in the Gulf, but those who were will never forget it. Life as they knew it changed, and it was not unusual for people to return home the day after they had gone to work, for weeks on end.

People became used to being asked to supply speedy answers to a never-ending stream of questions of a 'what if' nature, as events unfolded and more was discovered or suspected about the enemy.

The normal controls, paperwork, approvals for expenditure, and the painstaking research protocols went flying out of the window. Without any specific instruction everyone affected and involved buckled down, to ensure that nothing was left to chance and that the troops had the fullest back-up. The amazing thing was the attitude and atmosphere of the entire establishment changed in that period. All the support services threw themselves into the fray. There was no time to wait for paperwork. You just picked up the phone and it was done.

There was no concern about hours, or whether you were even going to be paid for what you did.

Everything was done at high speed. At the same time as a major test programme was being conducted, the subject matter of the programme was being modified on the hoof, as it were, ready for re-testing. Work transcended research establishment boundaries.

One team of perhaps 20 went to Scotland to do some testing. To quote the team leader, *"We would get up and be at the test site a few hours before sunrise, and get back to the hotel a few hours after sunset. We were so tired that we could not eat in the evening because we just wanted to go to bed. We did that for about 3-4 weeks*

without a break. We ended up doing so much work that when we eventually completed the reports, we found we had achieved the output of a programme lasting years and years."

Some had to go on training courses about working in a potential Nuclear/Biological/Chemical warfare environment, and had to go offsite to learn how to put on a respirator properly and go through the injection routines in case there really was a problem to deal with. Some had to learn Battlefield First Aid which was quite an eye-opener, because it was about what to do if you saw someone lying wounded, if you had no first aid kit. All this in the midst of doing the work!

Quite a few people went out to the Gulf, to provide on the ground analyses and advice.

LEGO the key to planning the invasion

War games are one of the tools we use to assess the value of future equipment and to look at the way the army operates with existing equipment. They are also an established means of planning a military operation.

The War Gamer's task is to take the performance measurements of all the equipments in a given scenario, using data from research about things like range and accuracy, muzzle velocity, visibility, penetration and so on, and convert them to what we call measures of effectiveness, the contribution the weapon system makes to the achievement of military objectives.

A war game requires players, serving military officers, to be put in plausible situations and asked to make battlefield decisions, deciding what they want to do, target priorities, ranges of engagement etc They will allocate the weapons and troops that they have got to the targets and objectives, as they arise in the game. They enter their decisions in the computer, which does all the calculations of casualties and reports the result. The computer is looking at the consequences, but the players are there to take the decisions.

You will almost certainly require a computer to support the players, but if you do, the computer is only there to do the book-keeping, recording who fired what and what the result was, and to assess the consequences of decisions.

While computers have run most War Games for the last 20 years or so, there is still a place for manual games. In a manual game, if the military players do not like the rules they can challenge them, and the rules can be changed. If the rules say it will take 30 minutes to get through a minefield, and the players say that they can do it in 10 minutes, we can change the rules, and see if it matters. You cannot do that so easily with a computer.

Operation Desert Storm did not offer the Centre for Defence Analysis (Land) at the Fort that amount of time. Detailed planning was urgently required regarding the assault across challenging enemy defences. No problem devising the game itself, but a practical problem arose . . . How best to symbolise physically all the different guns, tanks, vehicles etc which would be involved?

Someone 'raided' every toyshop in Sevenoaks, and used LEGO to make the models required. The game was shipped out that night, and doubtless saved many casualties, on both sides.

Computers change the nature of our work

Since the earliest days, the Fort's computer scientists have combined the in-house development of new computer systems (both Hardware and Software) with the use of commercial products.

Today, the Fort is linked to Europe's largest Supercomputer facility, at Farnborough, and staff have developed hydrocodes and other numerical models, which, under the brand name of CAST, are being offered to private enterprise for standalone use as an extremely powerful yet truly cost-effective modelling tool.

The development of reliable hydrocodes and a host of models has revolutionised research and development work at the Fort, because instead of undertaking lengthy, expensive trials, it is now possible to simulate with a fine degree of accuracy, the performance of virtually any product, component, system or process. As a result, the cost to customer has reduced, and the interaction of simulation with trials data has enhanced the quality of the development process.

Had it not been for fast and accurate modelling of the effect on allied tanks of the large mines used by the Iraqi forces in the Gulf War, the result might have been less certain.

As a direct result of the advanced uses made of computers, the Fort probably employs about half the people it did 20 years ago, but in reality turns out considerably more work. In the main it is administration which has reduced in scale, rather than the number of scientists and engineers.

The first computer to be installed at Fort Halstead was called AMOS, built by Ferranti, and delivered in 1954. It took three years to arrive in Building S11, from decision to purchase, and was operated by the Applied Mathematics and Mechanics Division, the fore-runner of CDA (Land.) The first computer to be used by the Fort was the MADAM, in Manchester, developed by a team led by FC Williams between 1949 and 1951. Two Fort Halstead scientists, AE Glennie and KN Dodd, who worked on the early atomic bomb, may

well be described as the Fort's first computer scientists!

AMOS survived into the early sixties, when it was replaced by COSMOS, a transistorised version, and later by the ICL 1906. A modern Pentium may be 25,000 times faster, but AMOS and COSMOS were nonetheless used to make serious calculations of blast, plastic flow, hydrodynamics, even weather forecasting.

In 1982 the Controller, Navy, had a £5m underspend which he donated to the Fort, to enable us to buy the first supercomputer in Britain outside the nuclear industry. Previously we had been buying time on another supercomputer, both expensive and time-consuming.

This focus on hardware masks the Fort's achievements in developing its own high level languages and codes.

A team led by Herman Gawlik developed MIRFAC in the 1950's, as a high level programming language. Forty years later, in the early nineties, another team developed the GRIM hydrocode, together with a range of materials models, some of which lead the world.

The Fort and the first British Atomic Bomb

The project to develop a British Atomic Bomb was initiated by the Attlee government in 1946, but was only given the final green light in 1947.

In January 1946 John Cockroft had been named as the first Director of the Atomic Energy Establishment (Harwell) and Christopher Hinton as the man who would lead the team which would design and construct the atomic pile. But these were peaceful applications of atomic fission, and the military applications were under an unwanted cloud, emanating from the USA.

Churchill and Roosevelt made an agreement in 1944 that *"Full collaboration between the United States and the British Government in developing Tube Alloys for military and commercial purposes should continue after the fall of Japan unless and until terminated by joint agreement."*

Unfortunately, the American copy of the agreement became mis-filed under 'torpedo tubes!' When Britain sought to rely on it, no-one had heard of it. Roosevelt being dead, and Truman lacking any real sympathy for the British, that seemed to be that.

In July 1946, the United States, by a bill sponsored by Senator Brien McMahon, who was in blissful ignorance of the depth of the British-American nuclear relationship, actually forbade the sharing of nuclear secrets with another power. Indeed, General Groves, who had directed the Manhattan Project, felt that Britain was too vulnerable to Soviet attack and should not be given classified information.

To cap it all, this debate was simultaneous with the Nunn May case, which revealed that Nunn May, a scientist cleared by British security, had been working for Moscow.

Britain was on its own.

When the matter was first mooted, it became quickly apparent that the best person to lead the British effort would be Dr William Penney, then the Director of the Armaments Research Establishment

at Fort Halstead, but it took quite a lot of persuasion to get him to accept the appointment.

The reasons why Penney was the preferred candidate were many. His was a brilliant mind, an original thinker in quantum mechanics in the early thirties, but above all a man who had made a massive contribution, during the war, to the American Manhattan Project at Los Alamos, as well as afterwards.

William Penney, born in 1909, son of a Sergeant Major in the Ordnance Corps, obtained a first class degree in mathematics from the Royal College of Science, part of Imperial College London, in just two years, having gained entrance at 18 with the highest marks in the country. His scholarship being for four years, he immediately dived into research, with the Dutch R de L. Kronig, and one way or another, via many more degrees and three doctorates, stayed in the academic arena until he was plucked from it in early 1940 by Sir Geoffrey Taylor, a world authority on fluid mechanics, to help him with research into the behaviour of the blast waves generated by high explosives.

He stayed in this field until asked in 1943 to study wave patterns with a view to devising a breakwater system for D-Day. (These 'Bombardons,' as they were called, were very successfully deployed seawards of the famous Mulberry harbours.)

Meanwhile the Americans, together with a multi-national team of scientists, including many British, (the greatest collection of crackpots ever seen, according to Groves) had been making headway with their atomic bomb research at Los Alamos. Now they needed an expert in waves, for a number of reasons, and the 35-year old Penney, rather against his will, was packed off to the States for a year. On arrival he found, to his surprise, that he would be working with J.Robert Oppenheimer, a young physics professor at Berkeley when they had become friends in 1932, while Penney was on vacation from studies at Wisconsin.

Penney earned the trust and respect of the Americans, and contributed to calculations of blast effect as well as to studying the imploding waves within the weapon itself. He missed observing the first bomb on Japan, but, in company with Leonard Cheshire, went

on the second mission, to bomb the arsenal at Kokura, which ended up bombing the secondary target at Nagasaki. Ten days later he was on the ground in Japan, checking for evidence as to the blast actually produced.

Soon after his return to Britain in November 1945 he was approached by CP Snow, the novelist, but then a Civil Service Commissioner, to become Chief Superintendent of the Armaments Research Department at Fort Halstead. He was not enthusiastic about the prospect, wanting to return to academic life, but was persuaded by Snow, who told him that no decision to make our own bomb had been taken, but that he should take the job 'just in case.' His appointment as CSAR was announced in January 1946, by which time he had already been asked by Groves to help with the first American peacetime tests, at Bikini Atoll.

Penney was effectively the last link between the British and American atomic establishments, in the light of the impending McMahon Bill.

Basic High Explosive Research (BHER) came into being in June 1947 when Penney gathered together in the library at Woolwich Arsenal 34 hand-picked scientists and engineers as the nucleus of his team. Initially BHER would deal with the outer components, the electronics and the high explosives needed to create the implosion wave. Penney decided that the British approach would differ from the American 'Fat Man' model as little as possible. He explained how their work would be organised, and stressed that even ARD colleagues must have no inkling of the fact that they were engaged on atomic work.

Indeed, while Penney reported through Lord Portal to the Prime Minister on atomic work, he reported to Sir Ben Lockspeiser, the Chief Scientist of the Ministry of Supply, on normal ARD work. Part of the inner Fort Halstead site was fenced off from the rest of the Establishment, and Penney proceeded to try to fit a quart into a pint pot. Even so, the difficulties of post-war housing, let alone the dearth of qualified candidates made it astronomically difficult to get the required manpower, especially so since his original 1947 calculations proved to be nearly 100% out, only a year later.

Such was Clement Attlee's paranoia about the need for secrecy, that, during the vital build-up of effort in 1947 and 1948, it often led to the right hand not knowing what it was supposed to know. For instance, the atomic bomb team was given priority status over supplies and recruitment, but the existence of the priority order was not communicated properly, for zealous security reasons, so priority was frequently not given.

The other side of the equation was that the heads of other defence research efforts became tired of being 'raided' to meet Penney's demands at their expense, most particularly because they were not told the reasons. Jealousy was inevitable.

Ultimately, after no less than Donald Maclean had briefed the United States' State Department (and doubtless the USSR) of the venture, Albert Alexander, Minister of Defence, answered a planted question in the House of Commons on May 12th 1948. He told the House "*Research and development continue to receive the highest priority in the defence field, and all types of weapons, including atomic weapons, are being developed.*" D-notices ensured due economy of reporting, and few readers noticed. However, it did mean that Penney could come out of the shadows, or at least in Whitehall.

It was also agreed at this time that Hinton would produce the raw plutonium metal in his group, along with plutonium spheres and the uranium tamper. Harwell would work on the initiators, and Penney would handle assembly, inside his explosive lenses.

Unfortunately, neither Hinton nor Cockroft wanted to be involved, and it became apparent that if Penney's team were to have to build all aspects of the weapon a special site would be needed. Aldermaston was selected, although it took some years for everyone to move in from other sites.

Meanwhile, work continued at the Fort, and at Woolwich, Foulness and increasingly at Aldermaston, leading up to the first British test of an atomic device, in the Monte Bello islands, off Australia, in 1952. The test was successful, and the yield higher than predicted. Just two years later the first operational British atomic bomb was delivered to the Royal Air Force.

Getting to test stage in five years, without any American support, had been quite an achievement. To have achieved a 100% successful test was a remarkable feat.

The story goes that Sir Winston Churchill planned to greet Penney, on his return, with the words "Well done, Dr Penney" were the test to prove less than a resounding success.

He actually said, "Well done, Sir William."

The rest, as they say, is history.

A haven for nature

Fort Halstead's 97 hectares provide a safe habitat for all manner of flora and fauna. More than 60 different species of birds have been recorded on-site, not to mention more than 250 different species of wild flowers, and seven types of fungi.

Birdwatch

The following have all been observed at the Fort.

Kestrel	Swift	Treecreeper
Red Legged Partridge	Swallow	Wren
Grey Partridge	Skylark	Mistle Thrush
Woodcock	Carrion Crow	Fieldfare
Lapwing	Rook	Song Thrush
Herring Gull	Jackdaw	Redwing
Black-headed Gull	Magpie	Blackbird
Feral Pigeon	Jay	Robin
Wood Pigeon	Great Tit	Dunnock
Collared Dove	Blue Tit	Tree Pipit
Cuckoo	Coal Tit	Garden Warbler
Tawny Owl	Marsh Tit	Blackcap
Green Woodpecker	Long-tailed Tit	Woodwarbler
Gold Spotted Woodpecker	Nuthatch	Chiff-Chaff
Meadow Pipit	Linnet	Goldcrest
Pied Wagtail	Redpoll	Yellowhammer
Starling	Bullfinch	Reed Bunting
Greenfinch	Chaffinch	House Sparrow
Goldfinch	Brambling	Tree Sparrow

Wild flowers

The most interesting area of the site is doubtless the Downs Range, which is classified as relict chalk grassland. Wild flowers which like alkaline soil thrive there, among them the Chalk Milkwort, and a variety of orchids, including the Bee Orchid, the Pyramidal, Early Purple, Common Spotted, Common Twayblade and Violet Helleborine. Later in the year Autumn Gentians appear.

The old fort also has a thriving community of plants. Left undisturbed, they provide a rich habitat for numerous species of butterfly, insects, hedge birds and small mammals. Just inside the old fort, on a bank at the perimeter, you can see Solomon's Seal and the Pyrenean Lily, which flowers in July, but which also has a most unpleasant scent. (Quite how it got there no-one knows, nor indeed how it survives in so foreign a habitat.)

While grass has to be kept short, for safety reasons, especially near the exit ports of the firing chambers, this is achieved by cutting rather than spraying, which can do demonstrable damage to living tissue and creatures with which the spray comes in contact.

A walk on the wild side

Around its fringes, the Fort occupies some of the most delightful parts of the North Downs, with a direct link to established countryside footpaths outside the gates. The North and West gates give access to the Pilgrim's Way and the North Downs Way. Star Hill also offers access to the many paths around the southern part of the Downs. A walk around the car park opposite the medical centre, leaving the 'X' area on your right, will bring you to the Downs Range Road which leads to seating inside the fence, on the downland, affording panoramic views.

Small mammals abound, including foxes. The RARDE News of Autumn 1990 tells how a solitary fox cub appeared from the woods adjoining the R32 range area. Having been returned to the woods several times, the cub kept reappearing. Before long it was dining regularly on milk and catfood. There was no sign of the mother, but the cub rarely seemed under-fed.

Within a couple of weeks 'Rusty' had moved into a cable duct outside the range instrumentation room, from which he would emerge to sniff the air, before attacking a pile of food or a bowl of milk. Then in May, 'Rusty's secret was out.

'Rusty' was in fact two fox cubs!

DERA

Fort Halstead, Sevenoaks, Kent. TN14 7BP