# “Harwell” old and new: its renaissance as symbolised by the relocation of an RSC “National Chemical Landmark” plaque, by Michael Jewess

**Fig. 1. Harwell Campus HQ (author, February 2018), previously the RAF commander’s office, then the AERE Directorate building, then the AEA Technology HQ, and then temporarily abandoned. In 2017, the RSC plaque (blue) was relocated to the right of the entrance.**

## AERE, the glory years

Many mathematicians, physicists, chemists, and engineers now aged over 55 will remember when “Harwell” was a name to conjure with. They may also recognise the building in Fig. 1, but not for what it is today (*see the final section of this article*) but rather as the Directorate building of the high-security Atomic Energy Research Establishment (AERE) at Harwell in Berkshire (after boundary changes in 1974, in Oxfordshire). Not only was AERE a major employer of “STEM” graduates but also it allowed visiting academics and research students to use the neutron beams from the research reactors “DIDO” and “PLUTO” for neutron diffraction and scattering experiments (though the reactors’ prime purpose was testing materials for power reactors).

On 29 October 1945 the Prime Minister, Clement Attlee, announced the setting up of “a research and experimental establishment covering all aspects of the use of atomic energy at [the Royal Air Force] Harwell airfield near Didcot”. (The airfield was on a chalk plateau, 2 km from the “Domesday” village of Harwell and 6 km from the town of Didcot.) The airfield had served well in World War II, including in the invasion of Normandy in June 1944, so the RAF were displeased – as might be agricultural locals, according to Giles in the *Daily Express* [1, 2].

For about 40 years thereafter, "AERE" and "Harwell" were used synonymously by scientists and engineers. AERE, initially part of the Ministry of Supply, became in 1954 a component of the United Kingdom Atomic Energy Authority (UKAEA) [3].

The first AERE Director, 1946-1958 [4], was John Cockcroft (1897-1967), previously Director of the Montreal and Chalk River Laboratories in Canada, which had been part of the Manhattan Project producing the nuclear fission weapons used against Japan in 1945. The UK and the USA had collaborated on nuclear technology under the secret Quebec agreement of 1943, but collaboration was terminated by the US McMahon Act of 1946. Independent UK nuclear research became of strategic importance [5]. In 1947, "GLEEP" at AERE became the first nuclear reactor in Western Europe to achieve criticality [6], and the UK's own atom bomb project was commenced. For many years AERE was central to development of UK nuclear power (see Box) and UK nuclear weapons.

**UK power reactors [7]**

The UK's "Magnox" reactors were named after the magnesium-aluminium-beryllium alloy invented at AERE in 1950 [8] for cladding metallic uranium fuel, inert to the uranium at reactor temperatures. Magnox reactors produced electrical power and also $Pu^{239}$ for weapons. The reactors relied on fission of $U^{235}$, constituting only 0.7 % of natural uranium, like the later advanced gas cooled and pressurised water reactors.

Chemistry was peculiarly central to the "fast breeder reactor". Based on AERE research, a prototype in Dounreay, Scotland delivered power to the UK grid until 1994. Indirectly, *via* a chemical reprocessing step, the reactor "burnt" $U^{238}$ (99.3 % of natural uranium):

(1) $Pu^{239}$ in fuel rods undergoes fast-neutron fission chain reaction (generating heat).
(2) Surplus neutrons bombard a "blanket" containing $U^{238}$ converting it to $Pu^{239}$ (after two β-decays).
(3) The blanket is removed and chemically reprocessed to create new fuel rods containing $Pu^{239}$, recycled to step (1).

The use to which AERE put the former RAF station can still be traced in the modern site plan (Fig. 2).

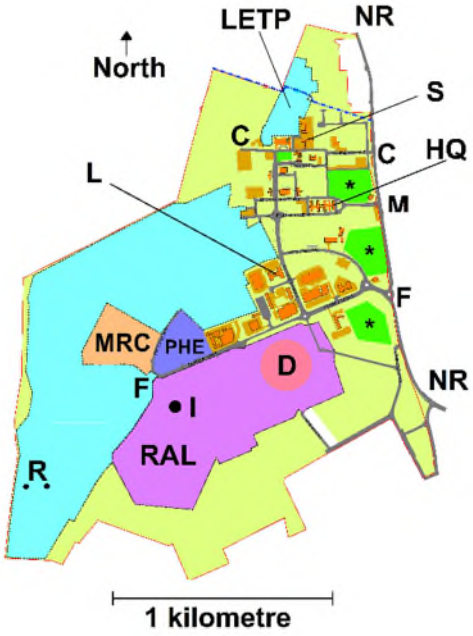


**Fig. 2. Harwell Campus, August 2018 (courtesy Harwell Campus, adapted): NR-NR, Newbury Road (A4185); C-C, Curie Avenue; F-F, Fermi Avenue; HQ, Campus HQ of Fig. 1; R, reactors Dido and Pluto (final decommissioning *ca* 2025); LETP, liquid effluent treatment plant (remediation near completion); S, Curie Avenue shops; *, sports field; M, Thomson Entrance of Campus (formerly AERE main gate); RAL, MRC, PHE, see text; D, Diamond Light Source; I, ISIS.**

In Fig. 2, the larger of the two areas in light blue was in AERE days used for large-scale nuclear operations including for reactors DIDO and PLUTO, and the smaller light blue area for a liquid effluent treatment plant ("LETP"). Laboratories and other working buildings (including repurposed RAF buildings such as "HQ") were in the light green area between Fermi Avenue and Curie Avenue. All three areas had security fencing and were guarded by policemen routinely carrying firearms. Workers presented passes to the police both on entering secure areas and on leaving them. Visitors were required to pass through the police guardhouse at the main gate "M". Such measures prevented unauthorised access – but were not proof against spies on the staff [9, 10]. One British Manhattan Project veteran, Alan Nunn May, had already in 1946 been imprisoned for spying. Two other Manhattan veterans (both naturalised British) transferred to AERE and were exposed in 1950: Klaus Fuchs (a Division Head, one of Cockcroft's most senior people), who was imprisoned; and the extremely talented, popular Bruno Pontecorvo, who defected to the USSR.

In 1964, after further spy scandals, the government produced for employees in sensitive posts, such as in AERE, a somewhat sensational booklet *Their trade is treachery* [10], with photographs of convicted spies including May and Fuchs. Among other things, the booklet told employees to seek advice from Security in respect of even social contacts with people from Iron Curtain countries. The author duly received his copy when he joined AERE in 1980.

Despite the security, there was a university atmosphere at AERE. The scientist and novelist C P Snow portrayed AERE's "men of fission" as new classless intellectuals [11].

AERE was a pleasant and convenient place to work [12]. Cockcroft had rose beds and thousands of trees planted. Outside the security fencing, along Curie Avenue and to the north, brick-built ex-RAF houses and two ex-RAF messes provided accommodation for employees and temporary visitors, and there were shops, a Post Office, a Lloyds Bank, a dentist's surgery, and a nursery (Fig. 3). Sports fields were created (Fig. 4). 200 prefabricated houses ("prefabs") were erected for workers. Works buses ferried many hundreds daily from nearby towns and villages to a large bus park outside the security gate on Fermi Avenue.

**Fig. 3. Shops and a Post Office in Curie Avenue surviving from the AERE time (author, 2017).**

**Fig. 4. Sports field (author, 2018).**

AERE grew to 6200 employees in 1959 [13].

**Decline of AERE and failure of AEA Technology**

By 1973 AERE had shrunk to 4500 employees [13]. When the present author worked at AERE (1980-81), it was still a dynamic organisation, but there was unease over the likely attitude of the UK government to commercial nuclear fission power. This unease was justified [15]: the "Magnox" reactors were progressively switched off (the last, Wylfa 1 in Anglesey, in 2015); the last advanced gas cooled reactor became operational in 1989, followed by a single pressurised water reactor in 1995 (Sizewell B); and for years no further reactors were authorised. No further nuclear power reactors will become operational in the UK before 2025.

AERE diversified into non-nuclear commercial fields by deploying its skills in materials, testing, separation technology, heat transfer and fluid flow, strategic planning, and project management, but this was not sufficient to compensate for the loss of core nuclear business [16]. DIDO and PLUTO were switched off in March 1990 because they were loss-making. This left GLEEP as the last operational reactor on the site, having been also the first; it was switched off in September 1990. The number of employees fell to 2000. The post of Director ceased in 1992 when Peter Iredale vacated it. In 1996, all non-fusion research of the UKAEA was privatised as AEA Technology plc, with no "national mission", at a value of £224 M. Its successor as a quoted company, AEA Technology Group plc, went into administration in 2012; a remnant of the business including a few hundred Harwell-based employees was purchased by engineering consultants Ricardo for £18 M, free of pension liabilities [17-19].

The UKAEA has continued to do work on nuclear *fusion* at Culham in Oxfordshire, 10 km north-east, and still owns the land of the former AERE site.

An important point to note is that whereas – as described above – AERE/AEA Technology rose and fell between 1946 and 2012, during this period establishments *not* primarily related to nuclear power and weapons technology emerged in parts of the former RAF station not needed by AERE and outside the security fencing. These establishments continue to the present day; in Figure 2, they are as follows:

"MRC", a Medical Research Council laboratory whose history on the site dates back to 1947;

"RAL", the Rutherford Appleton Laboratory dating back to 1957 including in particular "I", the ISIS Neutron and Muon source;

"PHE", a Public Health England laboratory opened by the Queen in 1975, and featuring in a "Dr Who" episode shortly thereafter because of its futuristic style; and

"D", the Diamond Light Source, a synchrotron primarily generating X-rays, which became available to outside researchers in 2007.

The first three of these facilities are wholly publicly-owned, RAL *via* the Science and Technology Facilities Council (STFC). STFC also owns 86 % of the fourth facility, Diamond, the remaining 14 % being owned by the Wellcome Foundation.

**The present – "Harwell Campus"**

The building of Fig. 1 ("HQ" in Fig. 2) symbolises the renaissance of "Harwell". After AEA Technology failed, it was closed up with yellow danger signs, looking all the more dismal because of the bare flagpole. But in September 2017, with refurbishment, it became the "Harwell Campus" HQ Building. Moreover, the RSC "National Chemical Landmark" plaque (Fig. 5), previously at "M" in Fig. 2, was moved to the front of the building.


**Fig. 5. RSC "National Chemical Landmark" plaque in its new location (author, 2018).**

This renaissance has been favoured by the following factors:– (a) The four other establishments on the non-AERE part of the former RAF station (MRC, RAL, PHE, and Diamond), as already noted, continue to operate. (b) The trees, rose-beds, and sports fields were well-maintained through the decline and failure of AERE/AEA Technology. (c) Contrary to possible expectation, most of the shops and the dentist's surgery have survived, and a new nursery has replaced the original one. (d) The surrounding district, though still with considerable agriculture as in 1946, has attracted other laboratories and scientific enterprises. (e) Communications are good; Didcot railway station on the Paddington – Bristol line is 6 km away, and the nearby A34 dual carriageway links to the M40 and M4.

*The "Harwell Campus" is a new concept covering the entirety of the original RAF station* [20-25], both the former AERE areas and the three publicly-owned laboratories. The light blue areas of Fig. 2, still enclosed by security fencing, are under remediation – for instance, DIDO and PLUTO, though now without their fuel rods, await final decommissioning *ca* 2025 [26]. But the formerly secure light green area between Fermi Avenue and Curie Avenue is now publicly accessible and houses an increasing number of non-nuclear science-based operations, mutually supportive and taking advantage of the three publicly-owned laboratories.

**Fig. 6. DIDO and PLUTO – the notices on the fence indicate that it is the boundary of a Nuclear Licensed Site on which trespassing is a criminal offence (author, 2015).**

In addition to the HQ building, the 1950s-built former AERE Library has been refurbished for office use, still bearing the name "The Library". But many working buildings of AERE days – and also all the prefabricated houses – have been demolished, and new working buildings have been constructed.

Already, over 200 organisations, including 30 universities, have a presence on the Campus. 80 of these organisations form a "Space Cluster" including the European Space Agency, RAL Space, the UK Space Agency, Satellite Applications Catapult, Airbus, and Boeing. There are also an "EnergyTec Cluster" (including the Faraday Institution for battery technology) and a "Health-Tec Cluster". A long-standing resident is Element Six's Global Innovation Centre, working on synthetic diamond.

6000 people now work on the Campus, with great scope for continued expansion. Angus Horner (Director, Harwell Campus) envisages "millions more square feet of commercial and technical accommodation". Existing eating facilities and the existing 123-room guesthouse, it is planned, will be complemented by a new café and restaurant and a hotel. Up to 1000 new homes are proposed in the north of the Campus, including on LETP land once remediated; the three sports fields will be preserved.

The original mission of "Harwell" as announced by Clement Attlee has vanished though it is commemorated by the RSC plaque. But key features of Cockcroft's original vision are being retained: a collaborative spirit, and a pleasant and convenient environment with trees and sports fields, on-site retail facilities, and even accommodation for workers.

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3. Hance, 42 and 58.

4. Hance, 42 and 149. While Director, Cockcroft was knighted, and with E T S Walton awarded the Nobel Prize for Physics for "pioneer work on the transmutation of atomic nuclei by artificially accelerated atomic particles", http://www.nobelprize.org/nobel_prizes/physics/laureates/1951/. In 1932, they had bombarded lithium with accelerated protons, effecting the reaction $Li^7 + H^1 \rightarrow 2\ He^4$.

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6. Hance, Chapter 10.

7. Numerous articles on the reactor types mentioned can be found on the internet, ranging from Wikipedia to technical reports on Magnox reactors and on the Dounreay reactor in https://www.iaea.org/resources/databases/inis.

8. Hance, 65-66.

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