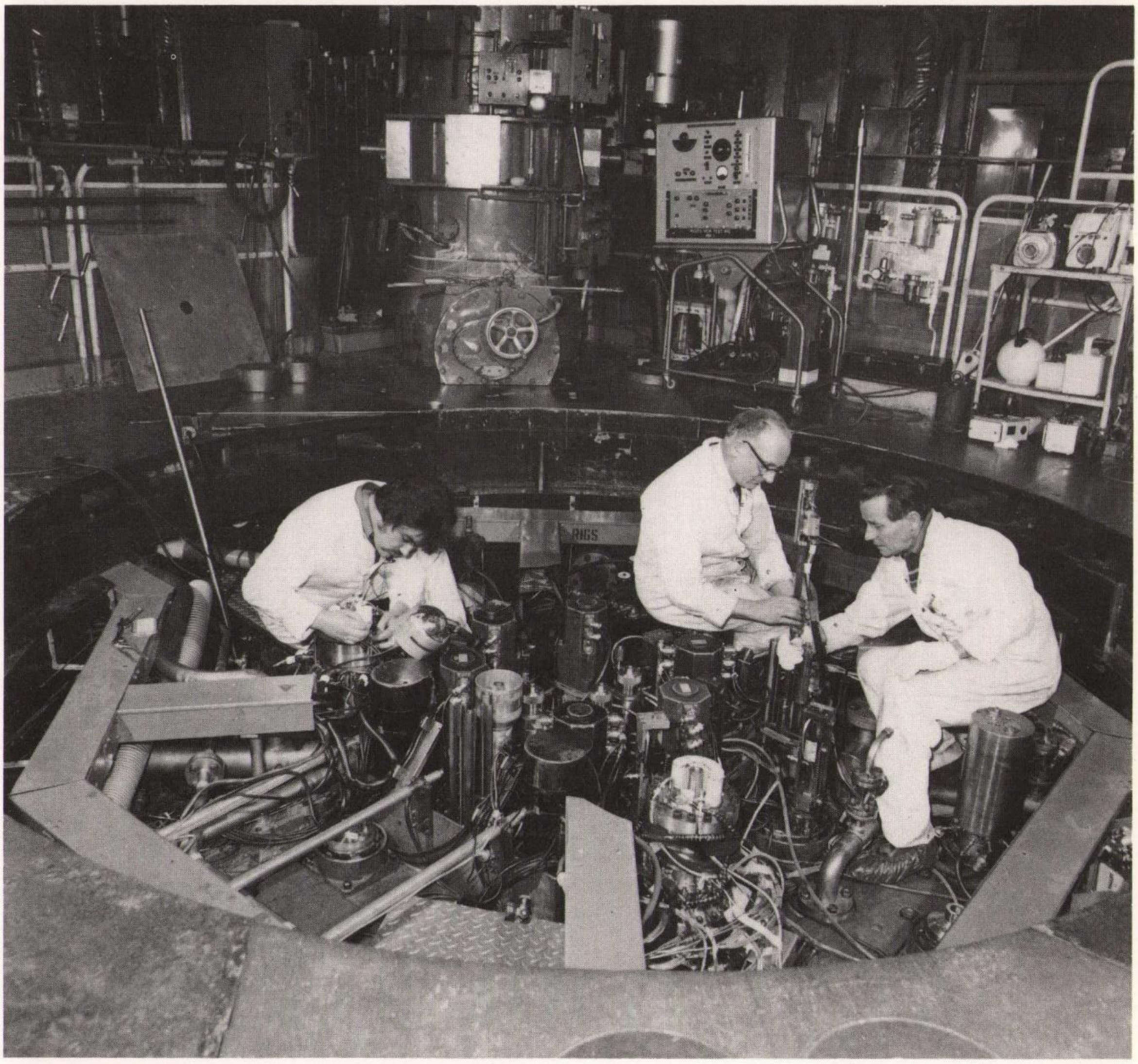
HARWELL

Research Reactors Division

Reactor Irradiation Facilities

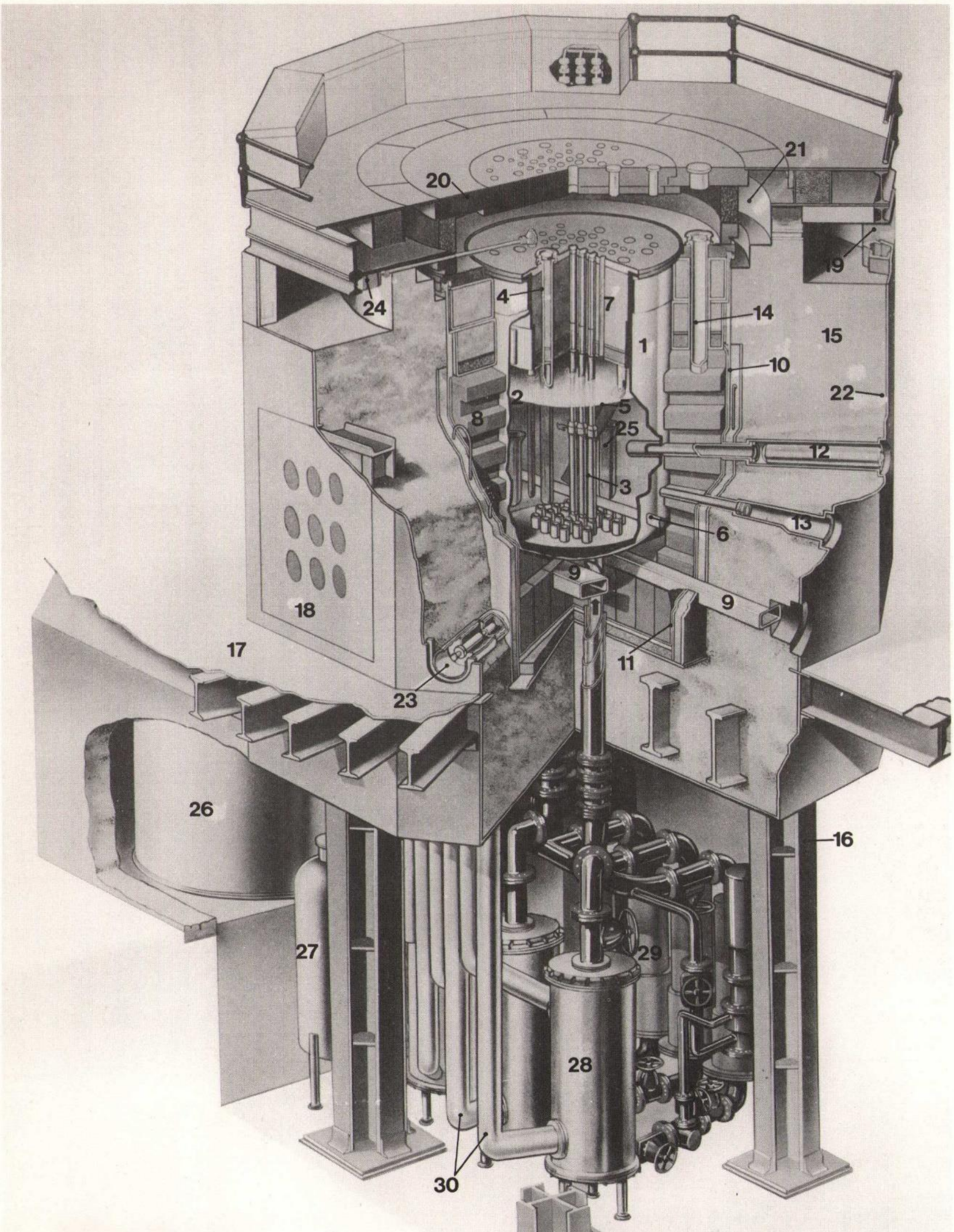


The top of PLUTO reactor showing connections to experiments

Most of the irradiation research and development work of the UKAEA in support of the nuclear power programme is centred on the two high-flux research reactors DIDO and PLUTO at the Harwell Laboratory. The reactors were designed by engineers and scientists at the Laboratory and differ from each other only in their irradiation facilities. Replicas of the reactors are in operation at Jülich in West Germany, at Risø in Denmark, and at Lucas Heights in Australia.

The reactors are moderated and cooled by heavy water and each has a heat power output of 26MW. Their design provides for a wide range of neutron spectra and flux densities, in more than 100 irradiation locations in which neutron fluxes of up to $2 \times 10^{14} n/cm^2 s$ are available at widely differing fast/thermal ratios.

Both reactors operate on overlapping 28-day cycles during which they operate for 24 days at full power followed by 4 days devoted to refuelling and maintenance and the servicing or changing of the irradiation experiments. Shutdowns are staggered so that one reactor is always in operation.



Dido Reactor

1. Reactor aluminium tank containing heavy water
2. Heavy water level
3. Fuel element
4. Vertical experimental hole thimble
5. Control signal arms 6 in number
6. Experimental hole 10 cm x 5 cm
7. Top biological shield
8. Graphite moderator
9. Experimental holes 30 cm x 20 cm
10. Lead thermal shield (water cooled)
11. Reactor steel tank with boral sheet lining
12. Experimental hole entering heavy water zone
13. Experimental hole entering graphite zone
14. Vertical experimental hole entering graphite zone
15. Concrete biological shield
16. Reactor supporting structure
17. First floor
18. Thermal column
19. Hollow stanchions communicating with base of reactor
20. 10″ Thick steel top plate
21. Duct for experimental services
22. Biological shield casing plates
23. Ion chamber
24. Fine control rod gearbox
25. Heavy water outlet pipe
26. Heavy water storage tank
27. Heavy water safety dump tank
28. Heavy water heat exchangers
29. Heavy water main circulation pump
30. Secondary cooling water piping (to cooling towers)

There are, on average, between 70 and 80 experiments in progress, or irradiation positions in use, at any time in the two reactors. In addition to their important role as materials-testing reactors they provide facilities for the production of radioisotopes (70% of all UK-produced isotopes originate from PLUTO or DIDO) and for the bulk irradiation of materials — in tonne quantities — for activation analysis or for use in the electronics industry or for basic research in the fields of solid-state physics, chemistry, and biology.

In support of research for nuclear-power programmes each reactor has a number of semi-permanent installations (including LOOPS) in which operating, power-cycling, and failure conditions for fuel for various reactor types can be duplicated; these include PWR, BWR, AGR, HTR and fast-reactor systems.

The facilities for basic research include collimated beams of thermal neutrons in conjunction with spectrometers, time-of-flight equipment, etc., and are used by university research workers sponsored by the Science Research Council. Many of the research programmes are undertaken in collaboration with the Harwell Laboratory, but all are supported by staff from RRD and experts from other specialist Divisions of the Laboratory.

The safety record and high availability and utilisation of the Harwell research reactors has been achieved by application of the experience and expertise of the management, operating, maintenance and support teams in the fields of nuclear and conventional safety criteria, plant management, and programming. This experience is available to other organisations in the form of consultancy on the design, construction, commissioning, and operation of reactor installations and on-the-job training for staff at all levels.

RRD also operates the GLEEP low-power natural-uranium-fuelled reactor, which has the longest record of continuous operation of any reactor in the world. Its main use is the accurate measurement of nuclear cross-sections, for which it provides a national standard.

Reactor Data

Dido and Pluto

Type	Closed tank, D_2O moderated and cooled
Number of fuel elements	DIDO 25, PLUTO 26
Type of fuel element	Concentric tube
Number of fuelled tubes/element	4
U^{235} per element	205 grams
Enrichment	80%
Burnable poisons	Boron, samarium
Reactor power	26 MW
D_2O investment	10 tonnes
D_2O flow	500 kg/s
Cooling system	D_2O-to-H_2O heat exchanger H_2O evaporation to atmosphere
H_2O flow	500 kg/s
D_2O-blanket gas	Helium (18 cm Hg pressure)
Diameter of reactor tank	2 metres
Material of reactor tank	Aluminium
Control and shutdown absorbers	Angled blades and vertical rods
Material of absorbers	Cadmium, europium, cobalt
Shielding	Water-cooled lead and concrete
Concrete biological shield	1.8 metres thick barytes concrete
Peak neutron flux	Fast: 1.9×10^{14} n $cm^{-2}s^{-1}$ Thermal: 2.5×10^{14} n $cm^{-2}s^{-1}$

For further information about the Research Reactors Division of the Harwell Laboratory and the services it offers, please contact:—

Research Reactors Division,
Building 521,
AERE, Harwell,
Oxfordshire, OX11 0RA,
England.
Telephone: Abingdon (0235) 24141 Extension 5000

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