Reactor Core Building at Berkeley

AFTER three years' work at Berkeley nuclear power station, which is being built for the C.E.G.B. by A.E.I.–John Thompson Nuclear Energy Company, Ltd., the civil engineering work is nearing completion, the mechanical engineering work is about 75 per cent complete, and the main effort is now concentrated on the reactor installation.

Graphite Core

In No. 1 pressure vessel the graphite core, which contains the fuel elements and control rods and serves as moderator and reflector, is being laid. This core is a structure consisting of about 97,000 pieces of graphite, in the form of blocks and tiles, built up into a regular polygonal prism, 30ft high and 48ft diameter overall. The core proper, that part of the structure in which the fuel elements are located, is 24ft high and 42ft in diameter and is surrounded by the reflector, which has a radial thickness of 2ft and an axial thickness of 3ft at the top and bottom.

The core is built up of twelve layers of 8in by 8in by 30in graphite bricks, successive layers being interleaved with two thicknesses of graphite tiles, keyed together, as can be seen in Fig. 2. The vertical channels for the fuel elements and coolant consist of a 4in diameter hole in each brick and tile, with two diametrically opposed keyways $\frac{13}{16}$in wide by $\frac{3}{4}$in deep, cut in each hole to accommodate the fuel element support struts. Vertical channels, 3in diameter, for control rods, flux measurement and a neutron source are formed by machining quadrant grooves from the corners of certain bricks ; these bricks are earmarked to be grouped in fours so that the four quadrant grooves form a cylindrical channel, as can be seen in Fig. 3. The coolant channels are on a square pitch of 8in.

All the bricks are machined from extruded graphite blocks of nominal size 8·55in square by 32in long, the finished size tolerance being $\pm$0·002in. Between the ends of the bricks in successive layers two rectangular tiles are fitted (Fig. 2). Each tile is made so that the longer side (in plan) is in the direction of extrusion and is equal to the lattice pitch of 8in. The two consecutive tiles in each stack are assembled with their shorter sides at right angles to each other, to allow for Wigner growth.* Under all conditions of growth channel alignment is maintained by the cruciform arrangement of keys and keyways in the tiles and blocks. There is sufficient clearance between each keyway and its mating key to ensure that the columns are supported on the faces of the bricks in all stages of differential growth, to keep the coolant leakage to a minimum. To prevent neutrons from streaming through the gaps that allow for Wigner growth, the bricks in the moderator are rotated through 2 deg. about the vertical axis. The core structure is held together radially by tubular tie-bars with peripheral restraining bands. The tie-bars are made up of mild steel and stainless steel members to give them the same effective thermal expansion as that of graphite.

The core rests on a steel support plate 4in thick which contains 3275 circular holes to locate the fuel element/gas coolant channels, and the whole assembly is carried on cross-braced ring girders. Positive location is effected at the plan centre of the pressure vessel by having the four central columns of the core spigoted to the support plates. To allow for differential expansion between graphite and steel, all the remaining columns of the core rest on ball bearings on the support plates.

Building of the core is carried out under clean conditions. Access to the pressure vessel is obtained via changing rooms and all workers and visitors wear special clothing, including caps, rubber-soled shoes and buttonless overalls, as illustrated.

The setting up of the first layer of the core governs the accuracy of the subsequent stages of assembly. First the area of the support plate is divided into quadrants. In the first quadrant straight-edges are accurately positioned to include a 90 deg. angle (Fig. 1) in which four graphite bricks are positioned on a fixed base to act as a locational centre. Flat movable ball races are mounted on the adjacent cavities to carry the other bricks in the quadrant. When the first quadrant has been filled, the straight-edges are removed and realigned on the second quadrant and the laying proceeds.

The arrangement of bricks and tiles in the first layer is shown in Fig. 2 and the method of handling the bricks can be seen from Fig. 3.

Progress on Site

The turbine room, a steel-framed building with side cladding of brickwork and glass, is structurally complete and internal finishing is in progress. No. 1 turbine is installed and the stator of the 85MW alternator is now on site. No. 2 turbine is about two-thirds complete.

The circulating water requirements of the station will be 21,000,000 gallons of water per hour, pumped from the River Severn through intake screen chambers situated about 650ft off-shore. These structures, together with a man-access tower, were built inside a circular cofferdam formed of steel box piles. Concreting on the intake screen chambers was completed towards the end of last year and the intake works include an access shaft and tunnel connected to the shore to enable station operatives to maintain the intake works at all states of the tide. Each intake screen chamber is linked with the c.w. pump house by vertical shafts and horizontal tunnels, each tunnel being 1000ft long and 10ft diameter. The tunnels were driven through rock and were constructed with precast concrete segments finished off with "Gunite" lining. The pump house was excavated to a depth of some 70ft from the surface.

The circulating water outfall works have been built within a steel cofferdam 130ft wide and extending 275ft into the river, and include a permanent access bridge to controlling sluice gates and outfall channels, all in reinforced concrete. A baffle wall of steel piles has been built for a length of 1500ft on either side of the intake structures to prevent the outfall water being recirculated through the cold water intake.

The civil engineering works mentioned above are the responsibility of Balfour, Beatty and Co., Ltd. They are due to be completed on July 31 and are now almost finished, well ahead of schedule.

No. 1 reactor (with Nos. 1 and 2 turbo-alternators) is due to be commissioned in the first quarter of 1961, to be followed by No. 2 reactor in the third quarter.

* Ghalib and Southwood, "The Berkeley Power Station," *Proceedings, Peaceful Uses of Atomic Energy, Second International Conference*, Vol. 8.

Fig. 1—4in thick steel support plate for graphite core. The straight edges define the first quadrant

Fig. 2—The first layer of the graphite is nearly completed

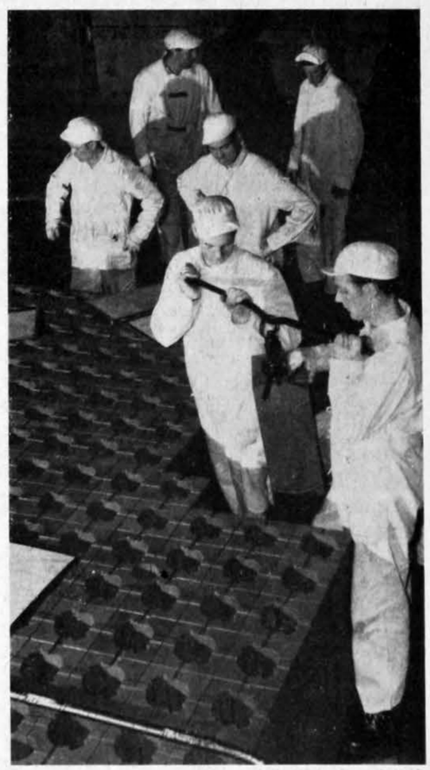

Fig. 3—Handling one of the "bricks" in the first layer of the graphite core