The research facilities of the NRX and NRU reactors have continued to attract individual scientists as well as teams from other countries. A team of Brookhaven (U.S.A.) and AECL scientists is using a neutron beam with a high-speed chopper and long flight path for nuclear interaction studies. Another team with scientists from Harwell (Br.) and other countries is using another system of choppers for studying details of the slowing-down of neutrons by moderators. Both in NRX and NRU the exceptional facilities for irradiations in high temperature water, steam and organic liquids have brought teams from Britain and the United States and individuals from West Germany and Sweden to conduct tests important for the design of future power reactors.

Nuclear Power Prospect.—The generation of electricity by nuclear power on a competitive economic basis is expected to be established by the type of reactor now under construction by the Nuclear Power Plant Division of AECL. This promise rests on the attainment of very-low-cost fuelling by an extremely simple system that has proved satisfactory in the Nuclear Power Demonstration Station reactor where there has been no fuel failure in the first year of operation. The fuel is uranium dioxide specially prepared from natural uranium entirely in Canada. A wide range of tests in hot channels in the NRX and NRU reactors at heat ratings and energy yields in excess of those required has established that this oxide fuel is incomparably more dependable than the uranium metal fuel for which the NRX and NRU reactors were designed. No provision for reprocessing the irradiated fuel is involved, for, by careful attention in the reactor design to minimizing any waste of neutrons, an energy yield of over 9,000 thermal megawatt-days is expected from a ton of uranium before it is discarded. This results in a prospective fuelling cost of about one mill (0.1 cent) per electric kilowatt-hour, to be compared with about three mills from coal at $8 per short ton.

Canada has access to such an abundance of coal, oil and natural gas that the competitive cost level for electric power is lower than in many other countries. Nuclear power plants of the types now under construction in Britain and the United States have been assessed as unable to reach a low enough cost level, at least until several successive plants have been built and operated to discover where economies are possible. Plants of the CANDU type do not promise to be significantly cheaper in total initial outlay, but the fuelling cost can be so much less that meeting the competitive target is a very real prospect.

The low fuelling cost derives as much from the details of the design proposed as from the general type of reactor chosen. Some of the important features seem worthy of mention. The full-scale plant will generate 220 megawatts with a steam-cycle efficiency of 33.3 p.c., so the reactor has to supply 660 thermal megawatts to the steam-raising plant. The reactor is essentially a tank of heavy water, 20 feet in diameter and 16.5 feet long, lying horizontally. It is penetrated by 306 fuel channels parallel to the axis on a 9-inch-square lattice. Each channel is a zirconium-alloy pressure tube of 3.25 in. inside diameter and about 0.16 in. thick. The fuel consists of bundles of 19 rods, 0.6 in. in diameter and 19.5 in. long, made of dense uranium dioxide in thin zirconium-alloy tubes. Heat is taken from the fuel directly by heavy water that passes at 560°F to the steam boiler, where normal water is raised to saturated steam at 483°F and 38 atmospheres. The heat developed in the heavy water moderator that is in the tank outside the fuel channels is not directly used and amounts to about 35 thermal megawatts. The over-all net plant efficiency is then 29.1 p.c. These details show that the design represents a very considerable advance over that originally conceived in 1956, and the improvement bears promise that continued progress will lead to costs well below the economic target. As examples of the advance, it may be noted that, for the same electric power output, the reactor power has been brought down from 790 to 700 megawatts and the length of fuel rod from 86 to 30 kilometres. The prospective fuelling cost has dropped from 1.85 mill/kwh. to 1.0 mill/kwh. On the other hand, no over-all reduction has been achieved in the capital cost estimates which remain in the range of $300 to $400 per electrical kilowatt for the whole plant. No reduction is expected until manufacturing experience has been gained that can be used in future construction, but thereafter appreciable reductions should be possible. A detailed breakdown of costs for CANDU was published during 1960. The conclusions are summarized in the following statement.