These figures will serve to explain why the first plants seem to find economic application in Canada only in the Ontario system, where annual charges on capital are low and coal has to be imported and costs about $8 a short ton. Moreover, the demand for electricity in Ontario is growing at more than 200 megawatts capacity per year. To build reactors for lower powers saves little in the cost, so the cost per kilowatt rises and becomes uneconomical. When confidence has been gained from the early plants, higher powers seem likely to be attempted and 400 electrical megawatts from one reactor may be attained.

Operating experience with the NRX and NRU reactors at Chalk River and with the many other types throughout the world has served to emphasize the great difficulty and costliness of making even minor operating repairs in the presence of the extremely high levels of radiation that are encountered around reactors. Directly and indirectly, this is responsible for the current hesitation to construct a number of large plants that for economic power cost no less than $40,000,000 or $50,000,000 each. With every new design it is necessary to acquire operating experience before the reliability and availability can be effectively estimated. Experience with defective fuel has been deliberately sought at Chalk River, because this is one of the difficulties most likely to be encountered. Appropriate techniques of locating the defective element, removing it and cleaning up the released radioactive fission products have been established and practised; at the same time fuel designs and ratings which lead to least difficulty in these operations have been studied. Experience of mechanical failures of control rods has lent weight to reactor designs such as NPD-2 where control rods are not needed. Temperature changes are likely to provoke mechanical failures, so design is aimed at keeping the reactor at power for all essential operations including refuelling and complete maintenance testing and readjustment of instruments and working parts of the control system.

These considerations lead to a vicious circle, for the quickest way to achieve reliability is to construct and operate a number of plants following these design principles, but until such plants have operated satisfactorily utilities are unwilling to take the risk of lost time for repairs. The same principles hold throughout the world. For example, Britain is following a program based on the Calder Hall type of reactor developed, not by a utility company, but by the government to serve a military requirement. Italy is purchasing three power reactors—one from Britain, one from the United States based on the Shippingport and Yankee reactors, and one from the United States closely following the Commonwealth Edison Dresden plant. Canada is pioneering another pattern financed by the government, and working at Chalk River to develop technical knowledge and experience that will give confidence to the utilities. The performance of the demonstration reactor (NPD) will tell whether the sought-for reliability has been achieved so that utilities can finance plants unaided.

Because the CANDU type of reactor is suitable only in large units, AECL is undertaking to study another type of reactor proposed by the Canadian General Electric Company that should have a lower capital cost. This is also a heavy-water-moderated reactor, but the heat is taken from the fuel by an organic liquid specially chosen for a high boiling point and minimum decomposition by radiation. This is a hybrid design that should utilize the Chalk River experience with heavy water and uranium oxide fuel and the experience of the organic liquid developed in the United States as a coolant and moderator for a nuclear reactor. Development of metals that are suitable for use in such a reactor is required and may take a few years to effect.

In the longer term, it is expected that heavy-water-moderated reactors would have two-zone cores. In one zone the heat required to evaporate water in the steam cycle would be supplied, and in the second zone the steam would be superheated to achieve a higher efficiency of conversion of heat to electricity. The heat for evaporation may be taken by an organic liquid or directly by evaporating wet steam, or possibly boiling water at high pressure. New materials are required also for this design and their development may be lengthy.