Let us now look at some of the engineering problems and the steps which we are taking to solve these problems.

While all of the reactors now in operation were designed either to produce plutonium for the military programme or for experimental purposes, the experience gained in their design and operation has demonstrated beyond question that a nuclear reaction producing heat can be achieved, and with a high degree of efficiency. Therefore, we are over the main hurdle - and in the brief space of fourteen years. This is not to suggest that we can now abandon research and development on what is known in the jargon of this business as "reactor cores" - even from a nuclear standpoint the ideal reactor has yet to be designed - but it does mean that we have sufficient information now available to prepare us for getting over the second hurdle - the engineering of a power reactor. To put it another way, we are now able to define the engineering problems which must be solved. This I regard as the most significant achievement of the past two years.

Our target of a kilowatt cost between 5 and 7 mills requires that certain conditions be met. First, the cost of the moderator and the uranium fuel must not be excessive. We see no difficulty on this score. Second, we must achieve an efficient utilization of the natural uranium fuel which is entered to the reactor. In order to do this, the uranium fuel elements must undergo long irradiation. In this respect we have already established some records with the NRX reactor. We must also be able to re-cycle the plutonium and depleted uranium which are extracted from the irradiated fuel elements. Finally, the power reactor must be capable of producing the kind of temperatures in a coolant which will permit the production of steam. These several conditions will give you some indication of the wide range of engineering problems which must be solved. I will mention a few of these. The reactor materials, especially the sheathing for the uranium fuel, must be resistant to high temperatures and corrosion, and at the same time must have the optimum neutron-capture characteristics. Sheathing materials now in use in the NRX reactor will not perform satisfactorily at temperatures in excess of 250°F. A cheap and efficient chemical process must be found for extracting plutonium, depleted uranium, and fission products from the irradiated fuel elements. While the generating equipment in the power reactor can be designed along conventional lines, the handling of the coolant in the reactor and the production of steam from the coolant will require a broad programme of engineering development in such fields as heat transfer, fluid flow, and steam cycles. As we have reason to know at Chalk River, a reactor can get out of control in a matter of seconds. Consequently, adequate instrumentation and control mechanisms are a prime necessity. Amongst other things, the advantage of an atomic power station, as compared with a conventional thermal power station, is the low annual fuel bill. However, the capital cost of an atomic station will undoubtedly exceed the capital cost of a conventional thermal station. Experience to date indicates that capital costs must be reduced very greatly, if the benefits of lower fuel costs are not to be offset entirely by capital charges.