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The promise of nuclear power for aircraft lies almost entirely in the enormous concentration of energy in nuclear fuel, which should make possible ranges of one or more times around the world with a single loading of the reactor.

Development of an aircraft reactor represents an exceedingly difficult technical assignment because due to the heavy shielding required, reactors are naturally large and heavy units, whereas an aircraft propulsion plant must be designed for compactness and minimum weight. The only reason they appear even remotely possible is that with nuclear reactors, no reserve fuel supply is required and the space and weight normally given over to the fuel load is available for the power plant, shielding or payload.

Numerous reactor cycles or designs for use in airplanes have been considered. The most appealing solution is the direct cycle approach whereby air is drawn in to the power plant at the leading edge of the wing, passed over metallic or other surfaces directly heated by atomic energy, and expended at high temperature as in the case of conventional turbo jets at the trailing edge of the wing or power plant. In principle, this is the simplest reactor design for it avoids the complexities of intermediate heat exchanger systems. It suffers from the difficulties of maintaining metallic fuel elements in an air stream at high temperature with the oxidation and mechanical vibration shortcomings.

A technically more conservative reactor approach is to build on and extrapolate beyond the basic reactor design used in the nuclear powered submarine wherein metallic fuel elements containing Uranium are allowed to react and heat water to a sufficiently high temperature and pressure to generate high temperature steam. This steam is then utilized to drive a turbine which in turn can be used to pump air through the power plant and generate thrust. The advantage of this design is that it minimizes the requirements on the reactor so far as high temperatures are concerned but leads to very difficult mechanical problems for, in order to be practical for aircraft, steam pressures in the neighborhood of 5,000 pounds per square inch will be required.

The third approach is a longer term one which seeks to avoid the difficulties of either of the first two. By utilizing the Uranium fuel in either a molten metal form or a molten salt form, high temperatures can be attained without the difficulties of the attendant high pressures involved in the water cycle, while at the same time, the more uniform temperatures which are inherent in this approach, should avoid some of the difficulties of local mechanical failure in the direct air cycle approach. However, a wholly new technology must be developed for continuing, circulating and controlling the red hot or white hot molten metals which are required in this approach.

These three appraoches, all experimental, were, at the request of the Department of Defense, retained in the program approved by the NSC. None of them entail the construction of a power plant at this time and the cost is not to exceed the amount mentioned in the basic letter of request written by Mr. Kyes.