FIRST NUCLEAR DESALINATION PLANT

In November this year an Agency symposium in Madrid will examine the latest developments and possibilities in the use of nuclear power for obtaining fresh water by desalination. A number of projects for this purpose have been announced, but the only one under construction is at Shevchenko, USSR, close to the Caspian Sea.

At Shevchenko a dual-purpose station will use a fast breeder reactor which will generate 150 megawatts of electricity and will at the same time produce 150 000 tons of fresh water a day. The plant is located 3 1/2 kilometers from the shore, from which it is separated by a sandy beach. It was chosen because it provided an adequate safety zone and at the same time ensured the requested water supply as well as prospects for future enlargement. The station consists of a reactor adjoining which are the desalination facility and the turbine hall. Enlargement is contemplated because owing to the development of industry in the area the electrical capacity will have to be complemented by an eventual thermal station, the main part of which will be alongside the reactor building so that the generating systems can be combined. The water supply systems are also being combined, using the direct flow system. Sea water will pass along an open channel by gravity flow into the pumping station which is within the precincts of the nuclear power station. It then passes through steel piping of large diameter to cool the turbine condensers and for other uses. For discharge the water passes through a screening system and then back to the sea through an open ditch.

The building containing the reactor also houses the main circuits and subsidiary systems and is divided into four parts. Of these the main section is 110 meters long and 45 meters broad. On one side is an annex containing the electrical controls, personnel services and other facilities. On the other side is an annex containing ponds for storing irradiated fuel elements and equipment for removing the elements as well as a ventilation centre with a ventilator station. Alongside this is a high stack through which low-activity air is discharged to the atmosphere.

The main part of the building, containing the reactor, is sunk 4 meters into the ground and its loading floor is 27.2 meters above the ground; the total height is about 60 meters. The lay out was largely determined by the arrangement of the main equipment for the primary and secondary circuits as well as of the auxiliary systems closely linked with these and with the reactor.

The main equipment of the primary and secondary circuits had to be arranged in such a way as to ensure natural circulation of the coolant, bearing in mind possible emergency cooling of the reactor. Liquid sodium is used and the length for its circuits had to be as small as possible but also to allow for thermal expansion. Maintenance equipment had to be placed to facilitate maintenance and replacement.

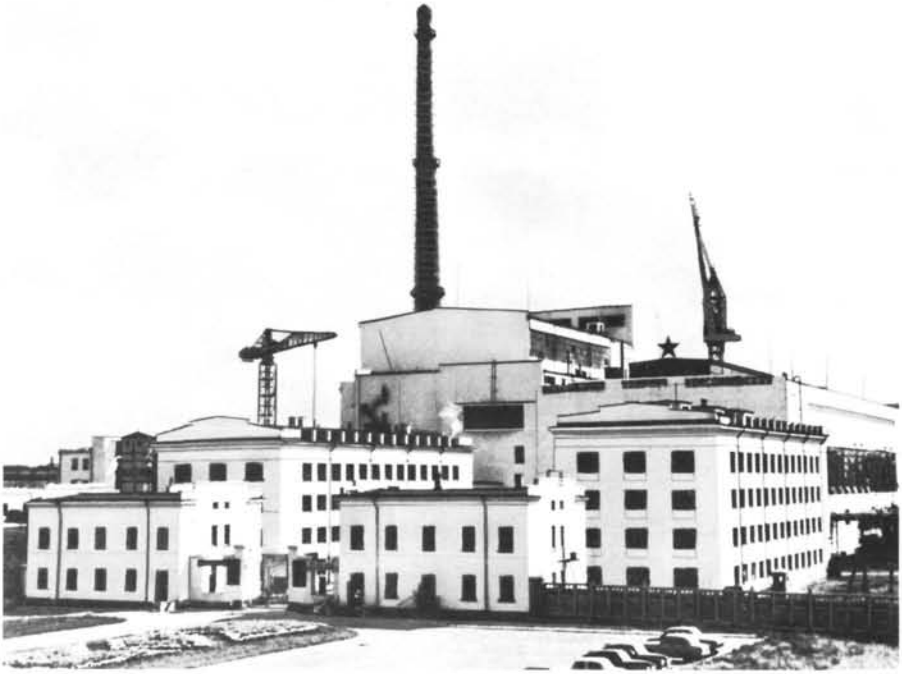
As might be expected, the reactor occupies the central position with its top 23 meters above the ground. Below this level there are eight compartments separated by concrete; of these six are associated with the primary circuit loops and the remaining two have machinery for removing fuel elements. The secondary circuit and steam generators are housed along the sides of the building.

The central hall has a bridge crane capable of lifting 125 tons and a traverse of 43 meters, this is for such operations as servicing, repairs and installation of equipment and all the main equipment is situated within the crane's zone of action. For the lower levels containing the auxiliary equipment there are loading facilities. In order that the height of the building should not be increased unnecessarily there is a small auxiliary crane of 5 tons for withdrawal of the operating and control rods in the centre of the hall.

The main civil engineering was completed by the end of 1966, the central section had reached a height of 22 meters and the staff annex 30 meters. Construction work with the ventilation unit was practically complete, as well as work on the long-term fuel storage ponds. The major equipment was being manufactured in factories and engineering plants. Work on the thermal power unit and on the desalination plant was in progress and some of the subsidiary buildings had already been completed.

Manufacture of the reactor unit called for extremely exact engineering. It is built as a single unit about 12 meters high with a maximum diameter of 6 meters. Since it will not be accessible during operation in fairly intensive conditions, stringent specifications have to be met and special techniques for quality control were evolved. Final assembly of the reactor vessel is to be carried out on site and for this purpose the vessel will be divided into nine large sections transportable by rail. Such operations as pressure checking and thermal stresses had been completed by 1967. Before transport to the site a complete trial assembly was performed at the factory to ensure that it could be repeated rapidly on site.

The reactor — BN-350 — has a core of hexagonal bundles of rod-type elements made of highly enriched uranium dioxide in stainless steel cladding. The core is to be completely surrounded by a blanket of fuel elements made of uranium dioxide depleted in uranium-235, here absorption of neutrons by other nuclei of uranium-238 increases substantially the production of plutonium. Heat is extracted from the core and blanket zone by molten sodium which passes into an intermediate heat exchanger, from this the heat is transferred to the secondary circuit. The sodium which is not yet exposed to neutron irradiation and is therefore not radioactive also serves as a coolant in the secondary circuit, where the heat is converted into steam for the third circuit and thence to the turbine.



The power station at Novo Voronezh, USSR, has an electrical output of 210 megawatts and has been operating since 1963. It has a pressurized water reactor. USSR, whose first power reactor started operating in 1954, is now building a fast reactor at Shevchenko, described in this Bulletin.

The power station is a big industrial experiment or pilot plant intended to obtain experience for reactors of this type and to evolve technology for large-scale desalination of sea water.