necessary to propose certain different considerations in view of the rapid increase in the number and importance of shipments of radioactive materials. In doing so, they have tried to avoid unnecessary restrictions while maintaining, and if necessary improving, the levels of safety achieved by the existing regulations. Moreover, an attempt has been made to frame and put together the provisions in such a manner that they could be applied, in their essence and as minimum safety requirements, to all modes of transport. The aim has been not only to elaborate but also to harmonize and simplify.

POWER PROGRAMMES REVIEW

POWER REACTORS IN THE FEDERAL REPUBLIC OF GERMANY

This is the fourth in a series of articles on the nuclear power programmes in the Member States of IAEA

Compared with work in some other industrialized countries, the atomic energy programme in the Federal Republic of Germany got off to a somewhat late start. Nevertheless, after about four years of research and training of scientists, the country is today on the threshold of a major phase in atomic energy development. While research and training are being continued, the first concrete steps are also being initiated for the commercial utilization of nuclear energy as a source of power. Several experimental nuclear power stations are being set up, designed or planned.

It must be pointed out, however, that the immediate plans for nuclear power reactors in West Germany have not been dictated by any urgent power requirements. The country has no cause for worry over lack of primary energy sources, at least not for the time being. The conventional resources of primary energy, especially coal, are enough to meet present as well as a good deal of future requirements.

The total electricity generation in the Federal Republic was some 52 000 million kWh in 1950, about 85 000 million kWh in 1955 and about 95 000 million kWh in 1958. Late in 1958 the total power output was made up as follows: pit coal 64 per cent, lignite 20 per cent, water power 14 per cent and other sources 2 per cent. It is estimated that the average rate of increase in power generation over the next few years will be approximately 7 per cent per year. Since it is not expected that power demands will increase at a rate out of proportion to this increase in generation, nuclear plants will not be required to make an important contribution before the end of the 1960s.

Guiding Considerations

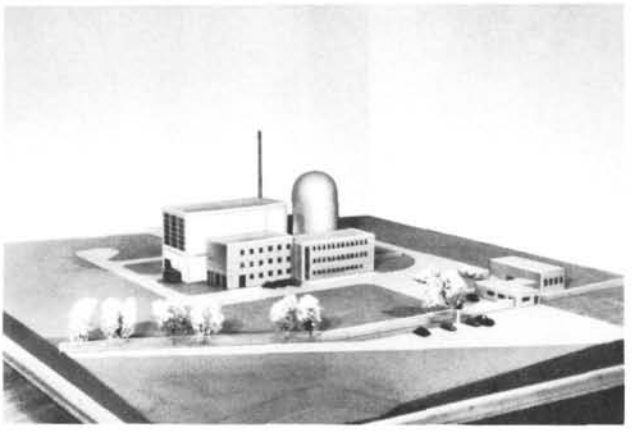
Despite this relatively favourable outlook for conventional power, the West German Government and industry have taken vigorous measures for the development of power reactors for two important reasons. In the first place, they recognize the role of atomic power in the country's economy in the more distant future and consider that the foundation of an adequate power supply to meet future needs must be laid well in advance. Secondly, they also recognize the immediate role of atomic power in certain other areas of the world and feel that as a highly industrialized country West Germany should master the new technology immediately so that it may be able to play an active part in international atomic trade.

It is these considerations that led the Federal Government to establish in 1955 a Federal Ministry for Atomic Affairs, redesignated in 1957 as Federal Ministry of Nuclear Energy and Water Economy. The Minister of Nuclear Energy and Water Economy is charged with the exploitation and utilization of nuclear energy for peaceful purposes and is advised by an Atomic Affairs Commission composed of scientists, economists and representatives of public institutions. The power reactor programme in West Germany is based on co-operation between Government and private industry; Government provides the initial scientific and financial assistance but it is left to the initiative of private enterprise to develop and carry out the actual projects. Several industrial reactor development groups and groups of power supply companies have started intensive preparatory work in this direction, and some major projects have already come into being.

Experimental Power Reactors

Among experimental power reactors, a 15 MW (e) reactor of the boiling water type is under construction near Kahl on Main. This reactor, which is based on plans of the General Electric Company (USA), is being built by the Allgemeine Elektrizitätsgesellschaft (AEG) of Frankfurt am Main and Hochtief AG of Essen on behalf of the Rheinisch Westfälisches Elektrizitätswerk AG of Essen, which has provided the necessary funds. Construction work is well advanced and the reactor is expected to go into operation in the second half of this year. It will provide operational experience from both technological and economic points of view; this will be of

use in larger projects in future. The reactor will also provide opportunities for the training of engineers for power reactors.



Model of the experimental nuclear power station at Kahl-on-Main

Construction of a high-temperature reactor, also of an output 15 MW (e), designed by BBC/Krupp (Brown, Boveri and Cie. of Mannheim and Friedrich Krupp AG of Essen), will shortly begin near Juelich. The construction order was placed by Arbeitsgemeinschaft Versuchsreaktor GmbH (Experimental Reactor Study Group) of Düsseldorf. The Federal Government will bear half of the total capital costs which are estimated at 40 million Deutsche Marks. At present, reactors of a similar type are being developed in the United Kingdom and the United States.

Design and Development

Early in 1959, the electric power industry in the Federal Republic decided to place orders for the development of three reactors of a 100 MW (e) capacity each. The Federal Government will give financial aid for these planning and designing projects.

Gesellschaft für die Entwicklung der Atomkraft in Bayern mbH (Company for the Development of nuclear Power in Bavaria Ltd.) of Munich has placed an order with the Siemens Schuckertwerke AG of Erlangen for designing, within three years, a heavy water - moderated natural uranium reactor of the pressure-tube system. Studiengesellschaft für Kernkraftwerke mbH (Study Group for Nuclear Power Plants Co. Ltd.) of Hannover has placed two orders for reactor development. One of them has gone to AEG of Frankfurt, which is to develop a boiling water reactor with nuclear superheating, in which saturated steam, produced by the reactor heat, is dried by having it circulated through the "hot" zone of the reactor or through another reactor. The other order, for the development of an advanced gas-cooled natural uranium reactor, has been placed with the German Babcock and Wilcox Co. of Oberhausen. By improvements in fuel elements cladding, it is planned to achieve in this reactor a better output than has so far been obtained from reactors of this type. There are also plans to use hollow fuel elements later on; this is expected to result in further improvement.

Whether or which of these reactors will be chosen for actual construction and operation will be decided after the design data have been studied on a comparative basis.

Ship Propulsion

Work has also begun on the planning and designing of reactors for ship propulsion. In February 1959, after several years of preparatory work, Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt mbH (Company for the Utilization of Nuclear Energy for Shipbuilding and Navigation) of Hamburg placed a one-year contract with Interatom of Bensberg for the development of an organic moderated and cooled ship reactor of 10 000 shaft horsepower output. It appears possible that a shipbuilding enterprise, taking the place of this Hamburg company will, as a partner of Interatom, continue the development work which is already under way.

Together with Siemens-Schuckertwerke AG of Erlangen, the Howaldtswerke AG of Hamburg is planning the design of a ship reactor of the pressurized water type. The Deutsche Werft (German Shipyard) of Hamburg is planning to develop - in co-operation with AEG - an experimental ship reactor of the boiling water type. Each of these reactors is scheduled for an output of 20 000 shaft horsepower. Blohm and Voss of Hamburg are negotiating with the German Babcock and Wilcox Co. of Oberhausen for the planning and design of a gas-cooled reactor of 20 000 shaft horsepower capacity, while Weser AG of Bremen and BBC/Krupp intend to develop a high-temperature ship reactor of 10 000 shaft horsepower.

Research Reactors

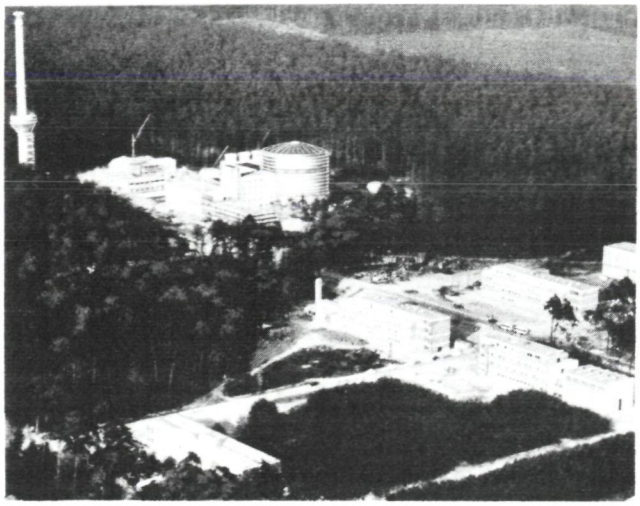
The design and development of power reactors are considerably helped by the experience gained from the operation of a number of research reactors in the Federal Republic.

Two main centres of research are being established near Karlsruhe and Juelich. The research facilities at Karlsruhe will be centred round the FR 2 reactor, which is expected to go into operation this year. This 12 MW (thermal) heavy water reactor is primarily designed to help the development of fuel elements for power reactors and the production of radioisotopes. Research facilities for neutron physics, reactor technology, radiochemistry, radiation protection and radiobiology have already been completed and a number of other facilities are being constructed or planned.

The establishment near Juelich will have two research reactors of British design, one of them a 5 MW (thermal) swimming pool reactor of the Merlin type, probably to be completed by 1960/61, and the other a 10 MW (thermal) heavy water reactor of the Dido type. At this centre also, a number of laboratories and other facilities are under construction or being planned.

Of the research reactors already in operation, a 1 MW (thermal) swimming pool reactor has been functioning at Garching, near Munich, since October 1957. At Frankfurt University, a 50 kW (thermal) water boiling reactor has been in operation since January 1958. A similar reactor has been operating at the Hahn-Meitner Institute for Nuclear Research in Berlin since July 1958. A fourth reactor, of the swimming pool type with a thermal output of 5 MW, went critical at Geesthacht-Tesperhude, near Hamburg, in October 1958. These four research reactors were supplied by US firms. Finally, a 10 kW Argonaut type reactor, located at Garching, near Munich, became critical in June 1959; this is the first reactor to be built, on the basis of American plans, exclusively by scientists and technicians of the Federal Republic.

For reactor fuel, the Federal Republic of Germany has to depend almost entirely on uranium supplies from abroad. Agreements for fuel supplies have been concluded with Canada, the United Kingdom and the United States. Uranium prospecting within the country has so far resulted in the discovery of only one small deposit. An experimental facility for ore dressing started functioning late last year.



Research establishment near Karlsruhe. In the background, towards the left, is the Reactor FR 2

NUCLEAR FUEL SUPPLIES

When the International Atomic Energy Agency was set up nearly three years ago, it was widely believed that it would soon become a world bank or broker for the supply of nuclear fuel. Some observers now seem to feel that this promise has been rather slow to come to fruition. A little closer analysis would, however, show that the promise can be fulfilled only in a certain objective context, and to the extent that this context exists, the development of the Agency's role has been commensurate with the actual needs of the situation.

If it was ever believed that immediately upon its establishment the Agency would start supplying nuclear fuel for a large number of projects in its Member States, the belief could only have sprung from certain assumptions which are not entirely tenable. One such assumption probably related to the world demand for nuclear fuel which is dependent upon the rate and volume of growth of the atomic industry. Generally speaking, the installation of atomic plants consuming large quantities of fuel (e. g. power reactors) has been somewhat slower than was anticipated by many people a few years ago. And since the countries which depend on nuclear fuel supplies from outside are often those which are less advanced in atomic technology, the development of projects involving such supplies must be preceded by a period of preparatory training, experiment and research. Furthermore, some of these countries had already obtained the supplies needed for their first reactors under bilateral agreements before the Agency's machinery came into operation; further requirements in most cases will arise after the initial supplies have been spent or after sufficient experience has been gained for the installation of new plants.

The rate and urgency of demand are also related to the volume of potential supplies. If the sources of supply are scarce or small, demand tends to be acute; in such an event the Agency would probably have been faced with more urgent and numerous demands than it has hitherto received. But it is now quite clear that so far as the source materials (e. g. natural uranium) are concerned, there is no danger of scarcity; in fact the world production is probably in excess of the present demand. Even as regards