Changing nuclear research

Making proper use of valuable national assets

by K.H. Beckurts*

The position of nuclear power and of nuclear research laboratories has greatly changed over the last decade. Many areas of nuclear technology have reached maturity, and the leading role has been taken by industry. At the same time, nuclear programmes have lost much of their initial momentum in many industrialized countries. Transfer of nuclear technology between industrialized and developing countries has turned out to be more difficult than expected, and the growth of nuclear power in many parts of the world has been delayed. It is quite natural that many of these developments have affected the nuclear laboratories. Much of the early glamour is gone.

Six nuclear research laboratories were founded in the Federal Republic of Germany in the 1956–60 period, i.e. immediately after removal of the post-war restrictions on nuclear research. Karlsruhe and Jülich were set up as large, broad and strongly fission-technology oriented centres; Geesthacht, Neuherberg, and Garching as medium-sized laboratories with special missions in nuclear ship-propulsion, radiation research, and plasma physics; finally the Hahn-Meitner Institute in Berlin was set up as a medium-sized centre for general nuclear research. In total, these centres now have some 9000 staff and an annual budget of about DM 1000 million, of which Jülich and Karlsruhe each absorbs about one-third**. These figures represent a considerable fraction of the total public r&d budget in the Federal Republic. They are comparable to the budget of the Max-Planck Gesellschaft, the country's leading organization for fundamental research, and of the Deutsche Forschungsgemeinschaft, which is the supporting organization for all university research. It is not surprising, therefore, that there is a continuing debate on the centres in the press, in parliament, and in the scientific community.

The initial phase of the laboratories' development was characterized by a rapid expansion and the need to close the gap due to Germany's late nuclear start. The centres worked intensely and in general successfully along the lines set out at their formation: Karlsruhe, jointly with industry, developed and built FR2, a large D_2O-cooled research and test reactor; the laboratory then initiated a major programme in fast-reactor physics and technology including work on plutonium fuel. At Jülich, the AVR pebble-bed experimental reactor was built, and a programme on gas-cooled high-temperature reactors, including work on the thorium fuel-cycle, was established. The Neuherberg laboratory investigated and demonstrated the concept of salt disposal of nuclear wastes in the Asse mine; and the Geesthacht centre, jointly with industry, developed the *Otto Hahn*, Germany's first nuclear ship.

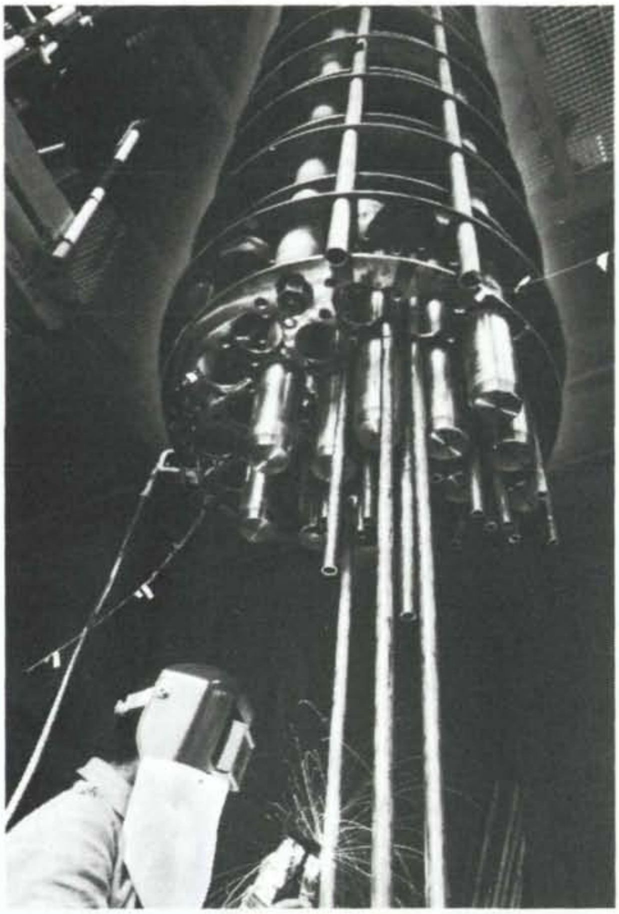
Branching out

Diversification became a major issue at the end of the 1960s. On one hand, it was felt that the centres had fulfilled their original mission, and that the responsibility should be gradually taken over by industry. On the other hand, it was hoped that their expertise could be used to solve other, non-nuclear, problems which were of interest to society. As a matter of fact, most fields were already taken care of by others: industry, universities, and other research organizations. It soon became obvious that new activities could be successful only where the general expertise and the specific facilities of the centres would permit them to compete successfully with other r&d organizations. A number of fruitful research activities were initiated in this period, and have been followed successfully since then. The main examples are:

- A low-temperature and superconductivity technology programme at Karlsruhe;
- A large research programme in solid-state and surface science at Jülich;
- A programme on marine technology at Geesthacht;
- Environmental research programmes at Neuherberg and Jülich.

* Mr Beckurts is former Chairman of the Board of Directors of the Jülich Nuclear Research Centre and is now Senior Vice-President of Siemens AG, Otto Hahn Ring 6, D-8000 München 83, Federal Republic of Germany. This article is based on a speech Mr Beckurts gave at the Scientific Afternoon of the 1981 IAEA General Conference.

** In February 1982, DM1 was worth approximately US $0.43.



The techniques and skills learned in nuclear research are applicable to non-nuclear problems. Here a technician is working on a large component for the EVA II test plant at the Jülich research centre.

The laboratories did not diversify on a large scale however. It was gradually realized that there were good reasons for a continuing strong commitment to energy and nuclear power questions. With the slowing of the pace of development of nuclear power the industry became more reluctant to take responsibility for developing advanced reactor systems. Some technical problems turned out to be more complex than expected, thus requiring additional r&d. This is particularly true for reprocessing and waste management, where new programmes were started, mainly at Karlsruhe. The increased political importance of environmental protection and nuclear reactor safety resulted in new research programmes at most of the laboratories. The nuclear centres were also challenged to contribute to the public debate on nuclear power. The 1973 oil crisis led to a major re-orientation of public r&d policies with strongly increased funding of conservation and non-nuclear energy programmes; this mainly affected industrial r&d programmes, but the nuclear laboratories took up some new activities in the field of energy system analysis, biomass conversion research, and solar energy (mainly at Jülich). This "consolidation" phase is still under way.

Five areas of work

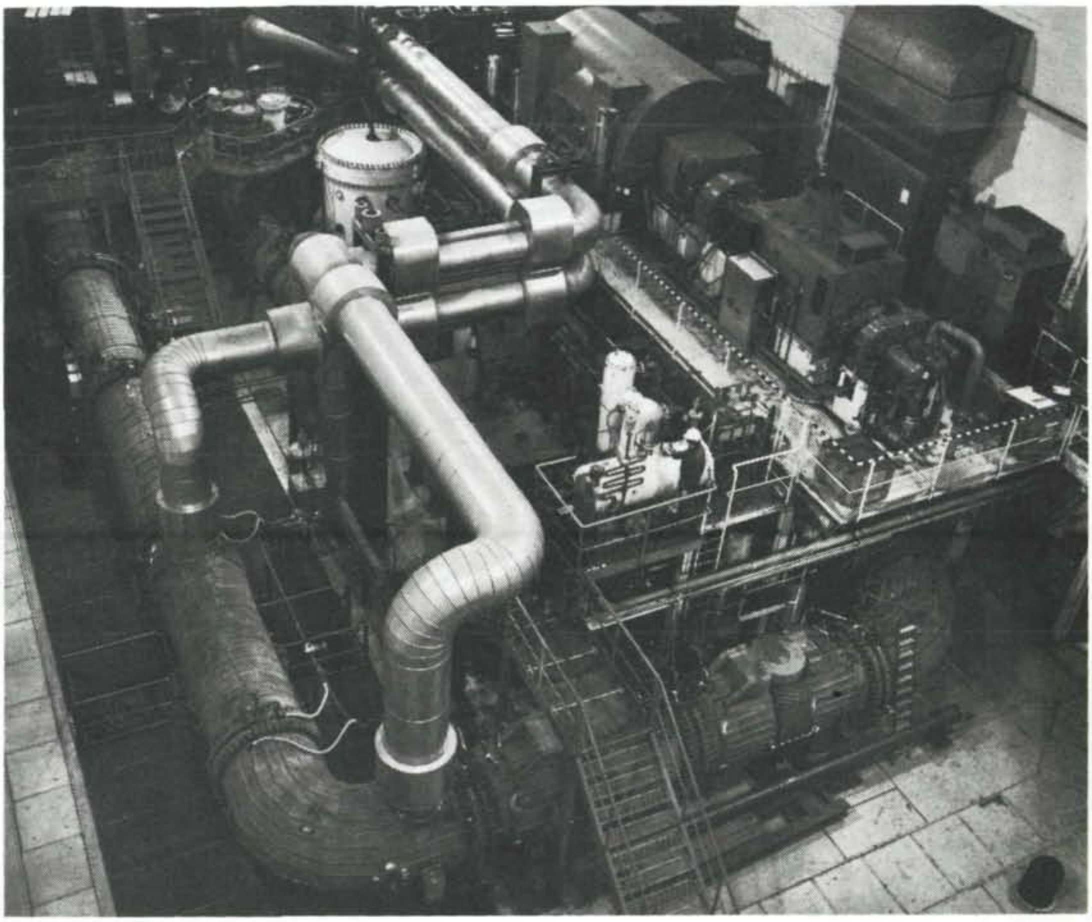
There are five important areas where large nuclear laboratories in an industrialized country can continue to play an important role. These are to support further the development of fission power; to develop fusion as a large power source; to study problems of very complex systems; to carry out fundamental research in selected areas; to support technology transfer to developing countries.

Supporting fission development will probably require the largest effort still for a considerable period. Topics are closing the fuel cycle; reprocessing and waste management technologies; nuclear safety; breeder reactors; and applying nuclear power for purposes other than electricity generation, especially for heat supply. There are also very important tasks in the field of safeguards development in which, within the framework of the IAEA support programme, many laboratories are involved. The physical protection of nuclear material is also a topic where research has still to be done.

Fusion research represents a particular challenge. Although it is hoped that the *physical* feasibility of fusion will be demonstrated in this decade, preparations for demonstrating its *technical* feasibility are only just starting. In addition to current activities on plasma physics, major efforts are required on the technologies of tritium, remote handling, superconducting magnets, fusion blankets, and advanced materials. The Intor study initiated and sponsored by the IAEA has given a clear picture of the present status of fusion research and has shown which technical problems have to be solved. Know-how from fission technology has to be introduced into the fusion field, and it is mainly in the nuclear centres that this can occur. I do not share the view of some fusion advocates who would like to see an immediate complete switch-over to fusion in most of the fission centres.

A quite different field is the analysis of complex systems. The laboratories' staff represents a very wide expertise. It should be able to carry out independent and objective systematic studies in fields like energy supply systems; impacts of energy use, or of industrial pollution, on climate; or studies of raw materials problems. The objective should not be prediction, but to establish basic relations, and from there to develop alternative "scenarios" of possible developments. Important political decisions – like the large-scale use of low-grade fossil fuels – have to be preceded by careful studies of the possible alternatives.

There is a good tradition of fundamental research in many of the nuclear centres. This is not an intrinsic task of these laboratories, but should be restricted to such fields which take immediate advantage of the available infrastructure or which are closely related to their applied research programmes. Of special importance is the development, construction and operation of large advanced research tools. Special attention will be required by future high-intensity neutron sources.



A view of the high-temperature helium test plant at the Jülich research centre.

It should be obvious that there is no lack of tasks, rather, there is a sizeable bundle of heterogeneous "old" and "new" tasks, as well as of work carried out in relation with quite different partners. The centres have to co-operate closely with industry. Since most of their results have to be transferred to industry, care has to be taken to achieve an efficient partnership including an effective exchange of know-how and of personnel. An interesting model which has been introduced in the Federal Republic of Germany is the r&d-consortium (Entwicklungsgemeinschaft): this is a joint venture between a laboratory and an industrial company aimed at pooling r&d efforts on specific projects like the fast breeder or the high-temperature gas-cooled reactor. It is early yet to judge whether this is a fruitful approach. Another facet of German r&d aswell as innovation policy is the Technology Transfer Centre whose aim is to introduce the results of r&d into traditionally small- and medium-sized enterprises without any proper r&d capability.

The laboratories have had to contribute to the public debate on nuclear power and, more generally, debate on technology and its impact on society. But the centres have an important mission also in manpower training and education which can only be carried out efficiently in close co-operation with universities.

Transfer of technology

Technology transfer to the developing countries is a very important function for the laboratories. Traditionally, relations between IAEA and the centres have been very close. Many of the joint activities of the Federal Government and IAEA are carried out with the help of the research centres. Some examples are:

- Joint programmes in the framework of technical assistance, mainly concerning isotope applications in the food and agriculture, life science and environmental sector.
- Missions of experts to the developing countries. About 50 experts are sent annually, most of them from research centres.
- The granting of fellowships in the Federal Republic of Germany. About 50 fellowships are granted annually, mainly by the research centres.

The laboratories frequently act as hosts for IAEA symposia and seminars. The Karlsruhe centre, in co-operation with IAEA, has held courses on nuclear technology for trainees from developing countries for a long time; it is intended to hold such courses not only at Karlsruhe but in the developing countries in order to intensify communication. In addition to this multilateral

A furnace used for the development of fission-product borosilicate glasses and glass ceramics at the Hahn-Meitner Institute for nuclear research.

co-operation through IAEA channels, there is an active programme for direct co-operation with developing countries. More than 20 developing countries co-operate actively with nuclear centres in the Federal Republic which have established "International Offices" in order to facilitate such contacts. This co-operation was started in the nuclear field, involving nuclear power, isotopic techniques and uranium prospection. Since then, more general programmes in fields like solar energy, environmental and life sciences, desalination, materials science and food technology have been progressing successfully. The main instrument to promote such joint programmes is exchange of information and of personnel rather than direct funding.

Future role for IAEA?

Enormous difficulties have to be overcome to achieve an efficient transfer of technologies, resulting in an economic break-through in the recipient country. Dealing with these difficulties represents one of the big challenges of our time. There is no doubt that the nuclear centres can make an important contribution, and it appears that their potential is not yet being fully utilized. This might be a field for further IAEA activities.