preparing for fast reactors

Experience with experimental fast reactors
and the construction of larger prototypes,
though limited to few countries, is supported by research
on specific aspects in a number of others.
Examination of results at an Agency symposium
in Monaco during March demonstrated confidence that
these reactors will come into use
after 1980, will lead to much cheaper
generation of electricity, and to much greater
economy in using the world's uranium resources.

The significance to the world's future nuclear programmes of the expected emergence of fast reactors was reflected in the attendance of close on 300 scientific and engineering experts from 27 countries and five international organizations; few of them missed any of the keen discussions and debates throughout a week of meetings.

The title of the symposium was "Progress in Sodium-Cooled Fast Reactor Engineering", an indication of the method generally preferred for removing intense heat from comparatively small nuclear cores by using sodium as a coolant. There are special problems associated with the handling of sodium in its liquid form, but so much experience has now been gained that the techniques are now regarded as acceptable for the industry and significant progress has been made in developing circuits, heat exchangers and steam generators. Related aspects of construction and operation of reactors and test rigs, of the design of cores, the evolution of pumps, the use of special materials to suit new con-

ditions of operation, the inventions of specialized equipment and knowledge of handling the concentrated fuel have all shown encouraging results.

At the opening meeting Dr Bernard Spinrad, Director of the Division of Nuclear Power, speaking on behalf of the Director General (Dr Sigvard Eklund) pointed out that only a few countries had yet been able to afford the major engineering programmes necessary to develop fast breeder reactors or to build prototypes. The information gained from such work would determine whether industrial fast reactors would be feasible, reliable, safe and economic. A very extensive programme of research and development had provided support for belief in their future.

The countries with operating experience are France, USSR, UK and USA, from each of which came reports dealing with overall experience and specific problems. Research information was also provided from Belgium, Italy, the Federal Republic of Germany, Japan and the Netherlands.

Survey of the week

In all some fifty reports were presented, which together with the discussions will be published by the Agency. At the closing session a summing up was made by M. L. Vautrey of the French Nuclear Energy Centre at Saclay. The value of the meeting, he said, had been that all concerned with fast neutron reactor engineering had been enabled to see where they stand, and to compare their ideas and knowledge with the work and results obtained by others. Since technology evolved slowly, they had not heard any sensational breakthrough announced. What they had done was to cover most of the branches of technology involved in the design of sodium-cooled fast reactors. The fact that fifteen out of the 52 papers had dealt with steam generators was an accurate reflection of the present stage of development. Reactors at present in operation were mainly for test and irradiation and had served, even if this was not the original intention, as a test bench for the fuel assemblies of larger reactors. Even where certain relatively old reactors were fitted with steam generators, it was soon found that the results could not easily be extrapolated. It was clear that the steam generators of the future would seldom resemble those with which the first reactors were fitted.

"At present" commented M. Vautrey "the most advanced countries are in process of constructing, or at least studying, reactors of higher capacity, up to 250 — 600 megawatts electrical. In such installations the steam generator becomes an essential component in the success of the undertaking. It is hardly surprising therefore that this subject is of such topical interest, all the more so since in various countries studies are already under way for the construction of large power stations of the order of one thousand megawatts electrical".

Steam generators

Diversity of opinion on steam generator design stemmed probably from the fact that the technology had not yet been verified experimentally either on the technical or economic side or in terms of reliability and safety. The range of alternatives was therefore very wide.

The majority of existing projects made use of steam superheated to approximately 510 — 540°C under a pressure of the order of 165 bars. Resuperheating was generally provided for and equipment was in almost all cases of the once-through type. There were variations in optimal size and geometry, flow sheet, water circuit and so on.

An essential question was the behaviour of steam generators in case of an internal leak and of the reaction between water and sodium. Whatever care was taken in design, allowance must be made for such leaks, though there was no cause for alarm and good reason for confidence. This problem was also closely linked with that of early detection and with possible methods of repairing the equipment. Certain detection systems appeared to be very effective but not all possibilities had been sufficiently explored. Repair facilities and methods also required practical investigation. The final answer would undoubtedly be provided only by a long-term experiment on actual reactors or at least on large-scale installations. The high cost of a day's shut-down in a large station underlines the importance of the problems. On the important question of materials, complete unanimity had not been reached on the value of stabilized ferritic steels and reference had been made to the promising qualities of other alloys. Here again the future would provide a final answer. For intermediate exchangers the problems posed had become to some extent conventional, and the same applied to pumps, where there seemed to be no major difficulties to be overcome. Stress had been laid on hydraulic and certain mechanical problems, the most difficult apparently being those caused by the temperature of the liquid.

Handling the fuel

In connection with fuel handling, the various projects or designs agreed in providing for fuel storage within the reactor vessel to allow a decrease in residual activity. Handling therefore related to transfer from the core to the internal storage system, and thence to the outside. For the internal transfer there was a considerable range of alternative mechanisms. At least eight papers had dealt with the subject, and different systems were undoubtedly valid provided they were in keeping with general reactor design. Frequency of fuel reloading and necessary shut-down times were important economically, as was the possibility of removing fuel from the reactor vessel without halting operation.

An important problem referred to only marginally had been the swelling of structural materials resulting from large integrated neutron fluxes. It was prudent to provide space for such swelling but for the long term it would be prudent to find materials less susceptible to swelling.

Reports on reactor operation or construction had shown that everything was not always perfect, but the overall balance appeared very much on the positive side, and encouraging films had shown that repairs could be carried out even in the case of serious incidents.

"I feel" concluded M. Vautrey "that the papers and discussions have shown that sodium-cooled fast reactors and their technology have now reached a stage of development where we can look forward with confidence to the industrial phase now starting. I do not think that any of the participants will need further convincing of the future possibilities".