Pakistan's ambitious nuclear power programme

from Azim Kidwai, Karachi

TWENTY-FOUR nuclear power plants operational in a developing country by the end of the century seems too ambitious a programme in the present global context, but that is the plan at the drawing-board stage in Pakistan. Work on a second nuclear plant, at Chashma Barrage, on the river Indus, 150 miles south of Islamabad, starts in a few months' time. The project is estimated to cost Rupees 527 crores (527 million dollars). The 137-MW nuclear power plant at Karachi has been in commercial operation for the past five years. The Chairman of the Pakistan Atomic Energy Commission (PAEC), Mr Munir Ahmad Khan unfolded the revised crash plan for 24 nuclear power plants recently, in the wake of a bilateral agreement with France that includes the offer by the French of a nuclear reprocessing plant (cost 150 million dollars) for Pakistan.

The rationale for such an unorthodox accelerated nuclear power programme can perhaps be found in the poor energy resources of the country, coupled with the present very low *per capita* electrical energy consumption.

The known fuel resources in Pakistan have been estimated to be only 13 tons coal equivalent (TCE) *per capita*. The figure presents a dismal picture when viewed against the world average *per capita* resources of 1,200 TCE. Similarly, the *per capita* electrical power consumption in Pakistan at present stands at 140 kWh as against 1,360 kWh world average, which has been extrapolated to be 6,500 kWh by the end of the century.

The requirements at the close of the century have been estimated at 27,000 MW (current production is only 2,570 MW, and the huge Tarbela Dam will soon add another 2,000 MW). Hydropower and gas—the only two energy sources of consequence in Pakistan — could only supply 13,500 MW. There seems not much of an option left, since planning on imports of huge quantities of oil would be hazardous. The main argument of PAEC, though, is that "the nuclear power plant's fuelling would be much cheaper than those of oil fired plants. The generation cost of a nuclear power plant would be 33% cheaper than that of a conventional power plant". In the long run, seen against the recent oil crisis, the argument appears to have validity even taking the higher capital costs of nuclear power plants into consideration.

All this planning on nuclear power may undergo revision if oil is struck in large quantities in Pakistan. Tremendous efforts are on the way as the 1976-77 budget on oil exploration at Rupees 42 crores (42 million dollars) testifies. The allocation has been more than doubled as compared to the figures in the current year. But without oil, the main plank of energy strategy in Pakistan will have to be nuclear because of the good deposits of uranium discovered recently in Pakistan and soon to be exploited. Concerted efforts to locate more uranium deposits also continue. Some of the areas have also been found with sizeable extents of thorium-bearing mineralisation—this fits into Pakistani nuclear think-tank schemes which envisage branching off to thorium.

One nuclear plant each year, on average, is planned after the early 1980s. The scheme includes dual-purpose nuclear plants as well. For instance, feasibility studies on such a dual-purpose nuclear plant for Karachi were mounted some time back in which the city could add to its grid another 400 MWe by the early 1980s and could also augment its water supply by 100 million gallons of sweet water from the sea daily.

Such a vast programme of nuclear power development calls for considerable manpower with sophisticated technical know-how. The PAEC has been training a large number of scientists and engineers for the last decade to meet the present situation. There are already some 350 scientists and engineers trained abroad on the rolls of the PAEC and a large number have been or are being trained at the Reactor School at Nilore near Islamabad. Another big nuclear power training centre which will cost Rupees 2.5 crores is being planned. Based at Karachi, and designed to train about 200 persons including technicians and operators annually, the centre would fill the gap on the technical manpower requirements of the PAEC in the coming years.

USSR's polar research

from Vera Rich

ARCTIC and Antarctic research has long been a major field of Soviet research. Indeed, the establishment of the first *Severnyi Polyus* (North Pole) drifting ice-floe research station and the forcing of the North East Passage by an icebreaker in the 1930's had at that time much of the prestige value now associated with the space programme. This sense of the spectacular is still sometimes apparent in the announcement of new Soviet Arctic projects.

The "Polar Experiment North-76" from April to July this year, for example, was announced as the "largest comprehensive expedition in the history of Arctic exploration", involving ten research vessels (including the flagship *Professor Vize*), aircraft, and upper atmosphere probe rockets. According to Professor A. Treshnikov, Director of the Arctic and Antarctic Institute (Leningrad), the principal aim of the expedition is to calculate the thermal balance of the Arctic icecap simultaneously on land, in the ocean, in the atmosphere and on the drift-ice (including observations at the North Pole itself). The data gathered during the 100-day expedition will be used to formulate mathematical models of hydrological and meteorological processes for use in weather forecasting. The expedition is envisaged as the first in a series to take place at one- and two-yearly intervals as part of a programme sponsored by the World Meteorological Organization.

Results of the previous voyage of the *Professor Vize* are meanwhile being processed. That expedition, during the Antarctic summer of 1975–76, produced data indicating that the Antarctic circumpolar current is "equal in flow to six Gulf Streams". The research vessel *Dmitrii Mendeleev* also visited the Antarctic during the same summer on its first biological expedition. According to the expedition leader, Dr L. A. Ponomareva, its programme included research into the fauna of the ocean bed, the sampling of water from the bottom layers of the Macquarie complex, study of the Macquarie and Hjort trenches, the collection of sedimentary and geological material and the construction of plankton profiles south from New Zealand and Tasmania to the Antarctic ice.

Also back from the Antarctic is the Twentieth Soviet Antarctic Expedition. The programme of this expedition appears to have followed the usual pattern of meteorological and glaciological observations. Innovations included the automated processing of data obtained from upper atmosphere rockets—the first time, it is claimed, that this has been done under Antarctic conditions—and a new way of drilling glaciers using a borehole filled with a "non-freezing liquid". Drilling at the Vostok station was carried out to 450 m, and at the Novolazarevskii station (where no previous bores had been made) to 357 m—the total thickness of the icecap at this point. The TASS agency hailed this expedition as a notable achievement in international cooperation: it included medical workers and geodesists from East Germany; an American geologist

wintered at the Molodezhaya station; and a Soviet glaciologist wintered at the US McMurdo base. A regular exchange of information was maintained with the British, Australian, US and Japanese Antarctic stations.

In contrast to these large-scale undertakings, a modest expedition of six skiers set off at the end of April from Wrangel Island to make their way over the ice to the drifting *Severnyi Polyus*-23 icefloe station. This expedition was somewhat misleadingly described by TASS as a "sports expedition", and although its close association with the newspaper of the young Communist movement at first suggests heroic adventure rather than serious research, this was not the case. One of the main aims of the expedition was the study of problems of psychological compatibility in a small team working under extreme conditions. The rations of the party were based on those of cosmonauts, and the results of the project may be intended for use in the study of the potential personality conflicts and stresses which may arise aboard a space-station or in long space flights. □

correspondence

More on Paradisia

SIR,—It is good to see you airing the Paradisia/Dominatia relationship in your columns (May 20, page 178). As a labourer in a different corner of the vineyard from Professor Brock, I find myself with another perspective. My concern is the training given to young Paradision Scientists (PhD students and post-doctoral fellows) when they visit Dominatia.

I think it is fair to assume that most Domination Scientists would like to help Paradisia develop and operate a self-supporting research effort—suited both to the intellectual and the material needs of the country—as soon as possible. I sometimes wonder, however whether they set about things the right way. There may be States where the system to be aimed for closely resembles one to be found in Western Europe or the USA, but such places must form a small minority.

The normal situation is one where at no time in his working life is today's young Paradisian academic likely to have the resources either of time (because of a heavy teaching commitment) or money to undertake research in a way comparable with his Domination counterparts. His high intelligence, diligence and determination cannot alter this fact, and it does no-one any good to attempt to ignore or disguise the situation. The ideal training for an individual of this kind is therefore different from that generally offered to natives of Dominatia. It needs, above all, to encourage independence and self-reliance (hard these days when research projects are often scarcely comprehended by a student before he starts to write his thesis). Experimental ingenuity with scarce resources and self-criticism allied with the optimism which attempts to cut a coat according to cloth (rather than weeping and complaining that good cloth is unavailable) are also essential.

In all of this Dominatia can help, but to be really useful involves more than treating students from Paradisia in the same way as their British counterparts. Doing so sometimes produces a fine scientist by Domination standards, but also someone who is discontented and unwilling to adapt to a different environment in the Paradisia to which he returns. Ideally a Domination supervisor will take the trouble to learn about Paradisia—its scientific research facilities, the peculiarly Paradisian problems which science might help to solve, even the government policies relevant to science and higher education. He needs to view the collaboration as part of the continuing development of his Paradisian colleague's life, as well as a contribution to his own research group's output. He should even, perhaps, begin to question whether his own view of the purpose of research, and what is worthwhile research, is the only tenable one. It may be that work which is not publishable in his own favourite journal can nonetheless provide important answers in a different context. In our joint efforts to help Paradisia, it is not only the Paradisians who need to learn.

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PhD in evolution

SIR,—Your Editorial "PhD in evolution" (May 27) seems in its penultimate paragraph to reveal a general misconception about the purpose and nature of PhD research. It is assumed that PhD research should provide training for scientists going into industry. This, however, is not the case. The chief motive of a student going to a university science department to do research should be a desire to take part in the advancement of science. If he really wants to be trained for industry, he should go into industry, where he will receive a better training for that particular job than universities can provide. It is true that industry sometimes, not to say often, finds that PhD research has provided skills and attitudes which are useful to it, but this is not the primary purpose of PhD research.

Distorting university postgraduate research to provide a training explicitly and directly useful to industry will harm the progress of fundamental science and, conversely, a postgraduate research student entering a science department should expect to learn about fundamental research and the particular activities that entails. If he expects a course aimed at preparing him for industry he is embarking on university research with the wrong motive.

It may be said that, if PhD research is not providing a training for industry, there should not be many science research students. I think this view is correct; I believe university scientists should take on a research student only if he has a genuine desire to carry out original work in science and recognises that this may not help him to get a better job outside university.

These comments apply to PhD research in "pure" science departments; I believe the situation may be different in engineering and technological departments.

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The real AI

SIR,—Whilst bemoaning the antihumanistic potential of artificial intelligence (May 13, page 171), it is particularly inappropriate to make use of the long established and well recognised acronym for artificial insemination.

Yours faithfully,

DARRELL H. THORPE

London, UK