efficient thermal reactor system until well into the next century.

If demand continues to grow so that it becomes impracticable to rely on thermal reactors, fossil fuels, and renewable resources for power generation, the breeder reactor would have an important contribution to make. It is against this scenario that the development of breeder technology could be considered a valuable assurance of adequate electricity supplies.

After the turn of the century, it is expected that crude oil and natural gas production will begin to decline. This, because of the unique advantages of fossil fuels, will encourage substitution either directly or indirectly, by coal. For that to occur most efficiently, new technologies for the combustion of coal and its conversion into substitute hydrocarbon fuels are required.

The development of coal conversion processes and breeder technology have certain similarities. In both cases, the construction of demonstration scale plants will soon be required. The earliest times by which each technology need be applied in the UK are similar, although both could, if required, be introduced before they become economic in order to forestall sudden increases in energy prices. Once the technology has been demonstrated,

however, the rate of commercial exploitation of coal conversion processes is not limited as for the fast breeder reactor, and a significant impact on energy supplies should be possible in a comparatively short period of time. Furthermore, the UK is already in a strong position on coal technology and the export potential of coal conversion processes should be no less than that of breeder technology.

The size of the relative contributions of breeder technology and coal conversion processes depends on whether electricity will continue to penetrate the energy market as prices increase. It is probable that substitute fuels from coal will be most effective competitors for nuclear electricity in the heating market. The estimated capital cost per unit of energy output of, for example, a plant to convert coal to substitute natural gas is about one third that of a nuclear power station, and the thermal efficiency is approximately double. Furthermore, the low load factors associated with the heating demand do not affect the economics of coal conversion as much as electricity generation. The use of nuclear energy for other than electricity generation does not look attractive at present, and would require considerable technical problems to be solved.

In conclusion, breeder reactors are capable of making a substantial contribution to energy supplies by using the uranium rejected from the thermal reactor programme. The availability of plutonium is likely to limit the rate at which breeder reactors can be built for several decades. If a vigorous development programme enabled breeder reactors to be introduced commercially by the 1990s, even although they would probably not be economic by this date, they would be unable to insulate the UK effectively from the need for expensive uranium imports until well into next century. The need to develop and demonstrate breeder technology can therefore be compared with the development of other medium-term energy options. Coal conversion processes, in particular, will be required to play a vital role in this timescale and merit no less attention and priority than breeder technology. □

I thank Mr L. Grainger, National Coal Board Member for Science, for guidance and encouragement, and the NCB for help with the preparation of this article. The views expressed are, however, my own and not necessarily those of the NCB.

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Dolphin dissonance

Colin Norman reports from Washington on the threat that tuna fishing poses for dolphins

IN the past 15 years, between 5 and 6 million dolphins are believed to have drowned in the nets of tuna fishermen. The slaughter of these highly intelligent, friendly mammals has sparked one of the most bitter and complex conservation battles ever waged in the United States. A number of environmental groups, backed to some extent by the federal government, are fighting to protect the animals, while the tuna industry, according to its spokesmen, is fighting for its own survival. The battle is now focused on regulations, due to take effect in January, which conservationists say are vitally needed to protect the dolphin schools, but which the tuna industry claims will put the United States tuna fleet out of business.

The dolphin owes its plight to the fact that, for unexplained reasons, some species frequently swim with yellowfin tuna—a type of tuna which is in high demand and which fetches the highest prices. Because the air-breathing dolphins swim on the surface, they have for decades provided

tuna fishermen with a convenient guide to the location of schools of yellowfin. Until the late 1950s, tuna fishing was mostly done by hook and line, and the dolphins lost nothing by showing fishermen the way to yellowfin schools. But a technological innovation in the industry rapidly changed all that.

The innovation was the development of a massive net, called a purse seine, which tuna fishermen spread around dolphin schools and then draw in to land the yellowfin beneath the dolphins. It is a very effective way to catch tuna, but the problem is that dolphins frequently become entangled in the nets and, when they can't get to the surface to breathe, they drown. During the 1960s, an average of about 400,000 dolphins a year were dying in tuna nets; since they have no commercial value, they were thrown overboard.

Because the dolphin schools play a valuable role in leading tuna boats to yellowfin, it is in the fishermen's interest to try to preserve the animals by reducing the slaughter. They began to experiment with various manoeuvres

and changes to the nets in the 1960s, but the killing continued virtually unabated until 1972. At that point, Congress stepped in.

Public concern

Public concern over the killing of marine mammals had been aroused by the plight of many species of whales, which had been hunted virtually to extinction, and the needless slaughter of dolphins by tuna fishermen consequently became an emotionally charged issue in the early 1970s. Congress responded to the concern by passing the Marine Mammal Protection Act (MMPA) in 1972.

A compromise between the argument that the tuna industry would be wiped out by a total ban on the killing of dolphins, and the need to protect the animals, the act essentially gave the industry a two-year grace period. By October 1974, the act said, the killing of dolphins by purse seiners must be reduced to "insignificant levels approaching zero".

Congress had been led to believe that such a requirement could be met. During testimony before a House committee in 1971, Joe Medina, a tuna boat captain, reported that trials with a modified purse seine had reduced the kill of dolphin in a 'set' to insignificant amounts. "This new net has been a

salvation for us, and I think we have the problem licked", he said. Unfortunately, his optimism was unjustified.

According to a study by a panel of experts last July, the total number of dolphin killed by all tuna fishermen, including non-US operators, dropped from 348,000 in 1972 to 217,000 in 1973, and it dipped again to 120,000 in 1974. But it increased last year, reaching 181,000. Clearly, the requirements of the MMPA were not being met and the Commerce Department, which was supposed to be enforcing the Act, wasn't doing much about it.

In December 1975, the Commerce Department moved. It announced that it would permit fishing of yellowfin associated with dolphins in 1976, provided estimates made in the first quarter of the year indicated that the total 1976 dolphin kill would be less than 70% of the 1975 kill. The announcement raised a storm of protest from environmentalists, who went to court to try to force sterner measures on the industry. On May 11, 1976, Judge Richey in the Federal court in Washington DC set the tuna industry back on its heels.

In an unprecedented decision which minced few words, Judge Richey ruled that the Commerce Department's proposal violated the MMPA. The act, he said, places the interests of marine mammals above the economic interests of the tuna industry, and he ruled that all killing of dolphins by US fishermen must cease by the end of the month. The prohibition, he said, should stay in effect until the Department of Commerce can determine "that such killing is not to the disadvantage" of dolphin stocks. The decision was upheld by the Court of Appeals, but a delay in implementing it was granted until January 1, 1977.

In the meantime, the Department of Commerce came up with some new regulations for 1976. It said that tuna fishermen could continue to fish for yellowfin associated with dolphins until the total dolphin kill for the year reached 78,000. That level was reached on October 19, and after the tuna industry had exhausted its legal appeals, all killing of dolphin by US fishermen supposedly stopped in mid-November.

Conference of experts

In July, the department called a conference of experts in marine resources to try to ascertain present population levels of various dolphin species. The panel was asked to determine whether any species is in danger of falling below the so-called optimum sustainable population (OSP) level, and to try to estimate the impact on each species of various levels of kill next year.

Tuna fishermen at work

The conferees reported that the spotted dolphin population—the species most often caught in tuna nets—has been reduced to about 64% of its original level since the introduction of the purse seine. The eastern spinner dolphin—one of a number of types of dolphin which twist in the air when they jump out of the water—was reckoned to be in the worst shape; it has declined to nearly 50% of its original population level. The conferees said that a 50% decline in the population of any species would put that species below its OSP level.

One of the conferees, Dr William Aron, Director of the Office of Ecology and Environmental Conservation in the National Oceanic And Atmospheric Administration, testified last month that "while I do not contend that any of the (dolphin) stocks under consideration are presently endangered or threatened with extinction, past history indicates that a cautious approach is warranted". Aron argued that the unhappy experience with whale populations "suggests that a reduction in cetacean populations to much under half their original stock size may present a significant threat to survival of those populations".

On the basis of the conference report, the Department of Commerce issued in October regulations for 1977 which are designed to ensure that the number of animals of each species of dolphin will increase or at least remain within their OSP levels, an objective consistent with Judge Ritchie's ruling. The department essentially took the maximum kill levels which would still allow numbers of each species to increase, estimated the likely kill by non-US fleets, and set quotas for US tuna fishermen accordingly. The proposed regulations sent the tuna industry running for its lawyers and, if the industry's figures are accurate,

fighting for its survival. The industry is appealing the regulations in a lengthy public hearing.

The regulations would limit the total dolphin kill next year to some 61,400 animals, of which US fishermen would be able to kill some 29,900. In particular, the regulations would prohibit US tuna boats from setting their nets around dolphin schools containing any spinner dolphin.

Welcomes and worries

The proposed regulations have been welcomed by environmentalists. Christine Stevens, secretary of the Society for Animal Protective Legislation, calls the proposed quotas "a tremendous step in the right direction", though she points out that they are still some way from the MMPA's goal of insignificant mortality. And environmental groups, led by William Butler of the Environmental Defense Fund, have generally argued in favour of the proposals in the public hearings.

Nevertheless, the regulations will clearly have a severe economic impact on the industry. Even the Commerce Department's environmental impact statement on the proposals notes that the effect "may be severe". Unless the industry can reduce the number of dolphins killed per ton of tuna, the impact statement suggests that the US catch will drop by about one-third, which "could lead to the collapse of the US fleet if exvessel prices do not rise proportionately".

Industry spokesmen are now less restrained in their views. Frank Alverson, vice-president of Living Marine Resources, a research organisation supported by the tuna industry, claims that the total prohibition on netting spinner dolphin alone will "automatically deny the US fleet access to 68,000 tons of fish", valued at about \$45 million. That figure represents the

amount of yellowfin caught this year in association with spinner dolphin.

Environmentalists tend to take some of the industry's dire warnings with a pinch of salt, however. In particular, Butler has pointed out that tuna taken in association with dolphin actually account for a relatively small fraction of the total tuna catch. The Japanese tuna fleet, which is one of the largest producers, does not fish on dolphin at all. And a study done last year by Gordon Broadhead, president of Living Marine Resources, found that nearly 60% of the US tuna catch in 1975 consisted of skipjack or yellowfin caught when swimming in schools separate from dolphins. It is therefore argued that the US fleet will simply turn its attention to those other sources of tuna. Industry spokesmen counter, however, that such a switch would send the US fleet into areas already heavily fished by foreign vessels, and they argue that next year's skipjack catch is likely, on the basis of past trends, to be below average.

The industry therefore claims that the regulations will cause heavy losses among tuna boat operators, many of whom are already on the verge of bankruptcy. The industry is therefore fighting the regulations on several fronts. One line of attack is to challenge the estimated population levels, particularly that for the eastern spinner dolphin. Another is to argue that the regulations will penalise US tuna fishermen while allowing foreign fleets to fish at will.

Troublesome problem

The problem with non-US fleets could be troublesome. There is no mechanism available to reduce dolphin kills internationally, and thus, in meeting the

court requirement that there should be no detrimental impact on dolphin stocks, the Department of Commerce had to focus its attention entirely on the US fleet. The upshot is that if the regulations are put into effect, US fishermen will be denied access to tuna which could be available to other fleets and if the effect is to increase foreign fishing on dolphin, the net result could be disastrous.

The Department of Commerce estimates that the kill rate among foreign vessels fishing on dolphin is more than twice as high as the kill rate of US vessels. Thus, if foreign vessels move in on yellowfin schools denied to US vessels, the net effect could be to increase dolphin mortality.

There is, however, a way in which the United States government could exert leverage to prevent such a situation. The US is now the world's chief importer of tuna—domestic supply accounts of only about half US consumption. The MMPA gives the government power to insist that imported tuna is caught in accord with US regulations, and if such a requirement is enforced, a large switch in the operation of foreign fleets may be avoided.

The industry is also arguing that it has made considerable progress in reducing the mortality of dolphins per ton of tuna, and that if it is allowed to continue fishing, further progress can be anticipated. For years, tuna vessels have used a procedure known as backing down, which essentially causes part of the net to drop below the surface, enabling most of the dolphin to swim free. Another improvement, the so-called Medina panel, consists of a strip of fine mesh around the top of the net to reduce the chance that dolphins

will become entangled in the webbing, and other gear alterations are under test. According to Alverson, the tuna fleet has so far spent about \$1.7 million in gear modifications to reduce dolphin mortality.

Nevertheless, there is good reason to believe that the industry has not been as generous in funding research as it likes to suggest. It was not until December 1975, three years after Congress passed the MMPA, that the industry established a research body to study methods to reduce the dolphin kill. Known as the Porpoise Rescue Foundation, it is being funded only to the tune of \$250,000 a year. The federal government is funding at least three times that amount of research.

Though most of the studies are concentrating on gear modifications, two projects are focusing on different approaches. One, which is being tested on captive tuna in Hawaii, consists of trying to separate the tuna from dolphins by chemical attractants, and the other, which is much further from field testing, attempts to do the same thing by acoustical means.

Whatever the success of those methods in reducing dolphin mortality, it is clear that the industry will not be able to comply next year with the MMPA's goal of near zero levels. Consequently, the Department of Commerce will be hard put to justify relaxing its proposed quotas. The result, forecasts Lewis Regenstein of the Fund for Animals, is that the industry "will be breaking down the doors of Congress" to seek legislative relief. It will be a tough fight, but if the tuna fishermen get their way, environmentalists are already talking about the possibility of a boycott of tuna. □

White hope or white elephant?

What is happening at the European Molecular Biology Laboratory? Walter Gratzer looks at its first annual report

COMING at so bleak a juncture for European science, the 1975 annual report of the European Molecular Biology Laboratory (EMBL) strikes a brave and heartening note. To readers in Britain, who have seen the traditional patrons and defenders of molecular biology, the Research Councils, cringing under the lash first of Rothschild and now of the Treasury, a refreshing feature of the report is that it makes no effort to propitiate the avenging taxpayer: not once in its 50 pages is there even a token mention of heart disease, tooth decay or lower back pain.

The laboratory was conceived at the height of what Stent has called the Golden Age of molecular biology, when it was bliss to be alive, and its ten-year gestation period has seen many changes. A document published in 1966, when the project was still in the womb of time, asserted that for the undertaking to be worthwhile a multidisciplinary structure would be essential, and that all major areas of molecular biology would have to be represented; so grand a design, it suggested, would be outside the compass of any single European national institution. The laboratory would be a

major centre of scientific excellence and a nucleus for postdoctoral training, and it would nourish the university departments of Europe with a supply of the kind of young men then appearing in such profusion in America—minted at Harvard or MIT, and finished to a high radiance at NIH or Stanford. In this way Europe would regain the initiative that had by then passed to the Americans. The EMBL therefore must be large (150 scientists, 15–20 of them permanent). In contrast to CERN its object would not be to provide plant too expensive for the individual member countries to set up; in biology, the report affirmed, the plant consisted of interacting groups of scientists with outstanding and complementary talents.

Well, circumstances, as they say, alter cases and as Thurber observed, there is no safety in numbers or in anything else. The projected size and