

have longer than a weekend to read and digest appendix M. This week's opening of the inquiry was purely formal, designed to give Sir Frank Layfield, the inspector, statutory powers to request documents before hearing the first evidence on 11 January 1983 and to deal with procedural matters (see box).

Although making up the tail of CEGB's case, appendix M is by no means insignificant. It is concerned with the probabilities and consequences of major accidents resulting in the melting of the reactor core. CEGB commissioned studies from the Westinghouse Electric Corporation, the company from which the basic PWR design is being licensed, on the probability of degraded core accidents, and from the British National Radiological Protection Board (NRPB) on their radiological consequences.

The risk analysis is similar to that pioneered by Rasmussen in his 1977 study of fault sequences in PWRs. Thus the Westinghouse analyses are based on event trees which trace the probability of minor faults leading through a chain of further incidents to core meltdown. The NRPB study assesses the risk to individuals living near a reactor of each type to 12 types of release considered by the Westinghouse Corporation.

The errors in the analyses are themselves uncertain, says CEGB. Nevertheless, it draws conclusions. Degraded core accidents are expected to occur 1.16 times every 10^6 years, near enough to CEGB's own limit of frequency of 10^{-6} severe accidents per reactor year. But 97.5 per cent of core meltdowns would not breach the containment, says the appendix, so that the estimated frequency of core meltdown accompanied by containment failure or bypass is 3×10^{-8} per reactor year. But CEGB admits that one of the most uncertain aspects of the studies is the frequency of core meltdown resulting in containment failure.

According to NRPB's analyses of the consequences of core degradation the risk of early death to an individual living near the reactor is 10^{-9} per year, says the appendix. An accident resulting in no more than one death would be expected about every 10^6 years. But an accident involving 1,000–6,000 deaths, the largest number considered, would be expected only about once every 10^{10} years. Similarly, the risk of cancer directly attributable to the reactor is found to be very low, 40 million times less than the general risk of contracting cancer.

CEGB believes these analyses are more refined and accurate than those used by Rasmussen. The probability of a core meltdown is within the bounds of acceptability, it says, although it is asking for further assessments of the uncertainties. Whether CEGB's confidence will convince those who are sceptical of the value of risk analysis must remain until 11 January to be seen.

Judy Redfearn

Academy rebuts Idso on CO₂ research

Washington

A new National Academy of Sciences (NAS) study* has upheld the conclusions of an earlier one in concluding that a doubling of carbon dioxide in the atmosphere will cause a warming of the globe's mean temperature by $3^\circ \pm 1.5^\circ$ centigrade. The conclusion, which is based on computer models, came as no surprise, as a consensus on this point has been building among scientists for some time.

But the NAS study did raise eyebrows by singling out for rebuttal the views of Dr Sherwood Idso. Idso has been a vocal minority, of virtually one, in dissenting from the generally accepted view of the effects of carbon dioxide increases.

Dr Idso, a physicist at the Department of Agriculture's Water Conservation Laboratory in Phoenix, Arizona, asserts that his "natural experiments" show that the prediction of the modellers is too high by an order of magnitude. The NAS study attempts to rebut his conclusions by showing how Idso's experiments are "on time and space scales clearly inappropriate to the carbon dioxide problem and do not involve the components of the climate system that are important for long-term climatic change".

The panel was apparently split over whether to single out for criticism Dr Idso (and, to a lesser degree, two other

researchers, Drs R. E. Newell and T. G. Dopplick). A minority on the panel had felt, as one participant put it, "that we shouldn't dignify the arguments of Idso with a comment". But the panel eventually decided that Dr Idso's findings needed to be answered to set the record straight. "Policy makers were getting confused", says Dr Joseph Smagorinsky of the Geophysical Fluid Dynamics Laboratory at Princeton University, the chairman of the academy panel. Dr Stephen Schneider of the National Center for Atmospheric Research, whom the panel had called in as an "invited expert", pushed hard for an official rebuttal of Dr Idso's conclusions. "I think there was a period of about six months when my phone rang every hour with someone wanting to know why" there was this difference of opinion between Dr Idso and everyone else, he says.

As for Dr Idso? "I am a very small minority sill," he admits. But he appears undaunted: "The model results are far from conclusive". He says the modellers themselves admit their inability to include many important factors, for example cloud feedback and aerosol effects. "When you read their caveats, it seems to me that anyone who put faith in the models is foolish, really."

Stephen Budiansky

*"Carbon Dioxide and Climate: A Second Assessment", National Academy Press, Washington, DC.

French robotics and engineering

More, please

Paris

Jean-Pierre Chevènement, the French minister of state for research and industry, fired a broadside at his critics last week in a major speech outlining his policy for the robotics and mechanical engineering industries. "I am not a technology fanatic", he said. "We do not choose technology; it imposes itself on us." France must compete in the world economy and so must automate and modernize as fast as her competitors. "France is not on the Moon; it is on Earth."

Chevènement said that change would have to be fast. The productivity of French industry would have to increase by 7 per cent a year for the next ten years, to double over the decade. The social consequences of this change would be vast: as great as the historic shift of labour from the land to the cities. But the change would be democratic: efforts were already under way to establish "contracts for progress", outline development plans for industrial sectors to be signed by industry chiefs, trades unions and government, which would take into account the fear of automation increasing unemployment.

In reality, the minister said, automation need not increase unemployment at all. Japan, through the automation of the car industry, had opened up new markets in

Europe and America, and so had increased (Japanese) employment in that area. France could do the same in other sectors, and could also increase employment in the industries that must supply the hardware and software (for example robots and control systems) which will re-equip the rest of French industry.

Chevènement has even introduced a new word to the French language to describe these industries: "*productique*", a word that — for the moment — lacks the resonance of unemployment and de-skilling which attaches to "robotics" and "automation". *Productique*, as Chevènement defines it, is the industry of advanced (typically electronically controlled) machinery, robots, industrial software, computer-assisted design and systems engineering. It employs 20,000 people and has a total turnover of FF8,000 million (£700 million) (see Table). This group of industries, together with electronics, will transform the whole of the rest of French manufacturing industry. It will "reduce human intervention" in systems of production. It will also "modify the balance between capital and labour, and increase the role of intelligence as a productive factor". Thus "tens of thousands of workers" must retrain, and means must be found to re-educate them and to shift France's system of professional education towards new forms of employment.

But for the present, the state of auto-

mation and the productivity of French industry were "disturbing". Management had often preferred to avoid the risks of industrial conflict over automation, and capital investment since 1974 had been small. The result was an "obvious under-equipment" of French industry. For example, France has only half as many robots per worker as Sweden or Japan, and the mean age of industrial capital equipment had increased in France from 14 years in 1974 to 16 years now.

What's to be done? As usual, M. Chevenement prescribed massive financial intervention by the government: FF2,500

million (£200 million) over 3 years for the machine tool industry (following a plan established by his predecessor at the ministry of industry), the launching of a robotics research programme involving 300 researchers and other such grand concepts.

Last week, however, a new note was struck. Part of the investment must flow from a reflation of the home market, said Chevenement, who thus offered a strong hint to the finance minister Jaques Delors that the recent freeze on French wages must not last too long. "The issues at stake are so important we cannot waste time" he said.

Robert Walgate

Indices of world robot production, according to figures contained in a French government report on robotics released last week

Country	Annual production (no. of robots)	Cumulated production	Cumulated production of robots each worth > £12,500	Current turnover	Cumulated turnover	No. of workers building robots
Japan	11,000	43,000	4,750	£65m	£217m	3,750
USA	8,130	19,000	3,800	£82m	£192m	3,420
West Germany	1,600	4,800	1,200	£16m	£58m	—
Italy	1,300	3,900	1,000	£16m	£49m	—
France	1,037	3,815	687	£16m	£52m	838
Switzerland	800	2,400	—	£1.2m	£4m	—
Scandinavia	560	2,060	1,600	£16m	£57m	700
UK	80	300	30	£0.5m	£2m	—

UK plant biotechnology

ARC joins in

The British Agricultural Research Council seems well on the way to joining up with a new biotechnology company specializing in plant genetics. The new company is being organized by the British Technology Group, the product of the *de facto* merger a year ago of the National Research Development Corporation and the National Enterprise Board. The group is expected to provide about a third of the initial capital of the new company, in which a total investment of between £12 and £15 million is being sought.

The new company is thus closely analogous to the British company Celltech, established in 1980 by a group of city institutions in partnership with the then National Enterprise Board. Part of the intellectual capital of Celltech is an agreement with the Medical Research Council under the terms of which the company has the first refusal to exploit discoveries arising in council establishments.

While the agricultural proposal has been in the air since the beginning of the year, it seems to have come to life only in the past few weeks, with an expression of firm interest from the British-based international oil company Ultramar. The intention now is that the British Technology Group will be drawing up a firm prospectus and business plan for the new company, which should be formed before the year is out.

There appears to be little danger that the new company will conflict with Celltech, which has apparently taken a policy decision not to engage in plant

genetics. Celltech's chief executive, Mr Gerald Fairtlough, said last week that his company welcomed the proposed company linked with the Agricultural Research Council and thought there might be opportunities for collaboration.

At this stage, none of the backers of the proposed company is willing to speculate about the directions in which its research and development may lead, although it does seem to be understood that it will not venture into the veterinary field, in which Celltech has declared an interest. The British Technology Group, destined to be a shareholder in both companies, says however that competition between the two would not be unduly worrying.

As yet, the Agricultural Research Council has not seen a formal version of an agreement for its participation in the company, which is nevertheless likely to be for a limited span of time in the first instance. The Medical Research Council's commitment to Celltech was for an initial period of five years.

The new company will be principally concerned with the genetic manipulation of plants, in which the council's Plant Breeding Institute at Cambridge and its John Innes and Rothamsted stations are involved together with research groups such as that concerned with nitrogen fixation at the University of Sussex. But Dr Ralph Riley, the council's secretary, says that the new company will also use other techniques for producing new strains of plants, including the propagation of plants from single cells by "conventional" cloning techniques. He says that the new company will aim not merely to carry out research and development but that it will also market new products. ●

Win for whales

Conservationists are jubilant. Last week the annual meeting of the International Whaling Commission (IWC) voted 25-7 in favour of phasing out commercial whaling by 1986. In view of the uncertainty over the numbers of whales and condition of stocks, the decision was taken to be safe rather than sorry. Meanwhile whaling nations now have a three-year breathing space in which to decide whether to accept the ban or to go their own way. Interim quotas have been allocated and fishing will continue until 1986.

Obstacles to an effective ban still remain. The motion, moved by the Seychelles, did not call for a ban or moratorium by 1986, but for zero catch limits. If new scientific evidence were to emerge that stocks were in a better condition the decision could be reversed. Whaling nations have 90 days to lodge a formal objection which under IWC rules would allow them to carry on fishing whales. By taking up such a position, whaling countries would keep their options open and it is a likely course of action for the majority.

The vote on fishing quotas was taken at an extended session of the meeting. Peru is to be allowed to take 165 bryde's whales in the 1982-83 season from a population that best estimates put at 1,000. Spain, which voted for the ban, was given a quota of 270 fin whales for the phasing-out period, with a maximum of 120 per year. Some estimates put the stock as low as 800. Japan can take 450 sperm whales this season and 400 next.

Many participants felt that in view of the phasing out of whaling such quotas would not have a serious effect on whale stocks. Some conservationists, however, viewed the quotas as a sell-out. They had hoped that the conservationist countries would stick together not only to impose a total ban but also to push through protection for the bryde's, fin and sperm whales.

Although after years of campaigning the conservationists have persuaded the IWC plenary session to vote for what is in effect a total ban, the outcome depends entirely on the Japanese. The other whaling nations will be swayed by the stand Japan takes. If Japan carries on whaling, IWC will have no further control over catch limits. The whaling nations will simply set their own. While environment groups are growing in Japan the fishing industry remains a powerful lobby. It is by no means clear that the United States has the political will to impose unilateral fishing and trade sanctions against Japan in the event of a decision to continue hunting. There is no other restraint — except Japanese good sense.

Jane Wynn