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 CO_2 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 $3° \pm 1.5°$ 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 effexts. "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 Chevenement, 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 deskilling 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-

0028-0836/82/300411-02$01.00