nature

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Supporting international safeguards

The US State Department must now persuade Congress to back the international safeguards system — and then worry about what will happen a decade hence.

Not before time, the United States is edging in the right direction in its policy on the proliferation of nuclear weapons. Almost two years have gone since President Reagan, then merely a candidate for his office, began promising that he would repeal President Carter's Nuclear Non-Proliferation Act, passed by Congress in 1978. Now, it seems, the Administration is planning to do what it can, within the framework of the act, to remove some of the sillier restrictions on the supply of nuclear equipment from the United States made necessary by this unfortunate legislation (see page 279). But there is still no sign of when it plans to carry the fight to Congress, seeking at least to amend the Carter act. Mr James Malone's departure from the State Department (*Nature*, 18 March) may be a sign of impatience, but mere irritation is not a substitute for action. Part of the trouble seems to have been that the Reagan Administration, while staunchly opposed to the Carter act on the doctrinal grounds that it needlessly restricted the freedom of American suppliers to sell nuclear equipment overseas, has not fully understood why the Carter act is self-defeating. Now, to judge from the good sense of what the State Department was saying last week about the problems of nuclear proliferation, enlightenment is at hand.

How can a piece of legislation with such laudable objectives have the opposite effect, of assisting the proliferation of nuclear weapons? The explanation, now familiar, is not all that complicated. Between 1965 and 1970, the United States took the lead in persuading non-nuclear powers to sign the Non-Proliferation Treaty, then offered as the best way of controlling the spread of nuclear weapons. Persuasion was necessary because, to many non-nuclear powers, it was not self-evident that a treaty that did not restrict the right of nuclear powers to keep on making nuclear weapons could serve the stated purpose. Against the odds, however, persuasion worked. More than a hundred non-nuclear powers have ratified the treaty and have agreed to put up with repeated and unavoidably irksome visits by inspectors from the International Atomic Energy Agency.

The Nuclear Non-Proliferation Act, especially as interpreted by the Carter Administration, was a shock to this system because it signalled that in the opinion of the United States, even strict compliance with the terms of the treaty would be insufficient. The act was also a unilateral denial of the promise in the treaty that the nuclear powers would help with the free flow of nuclear technology. And by implicitly asserting that compliance with the international safeguards system would not be taken as an assurance that a signatory of the treaty was not making nuclear explosives on the sly, the act undermined the credibility of the safeguards system as a whole. No doubt the consequences would have been more serious if the civil nuclear industry had not been in such doldrums in the past few years.

The new enlightenment that has overtaken the United States Administration, well put by Mr Eugene Rostow last week, is that technical devices such as the safeguards system operated from Vienna are necessary but not sufficient means for controlling the spread of nuclear weapons. Now, as since the invention of nuclear explosives, the decisive determinants of the spread of nuclear weapons are likely to be political — that is, governments' perceptions of the international dangers that confront them and their calculations, never straightforward, of whether nuclear weapons would help or, by provoking imitation, hinder. So governments such as that of the United States seeking to limit the spread of weapons can hope to accomplish more by diplomacy than by tinkering with the Vienna safeguards. After all, the non-nuclear powers best placed to make nuclear weapons for themselves — India, Israel, Pakistan and South Africa, for example — are not even signatories of the treaty. In this sense, the preoccupation of the United States Congress (and of two unreflective members of the Nuclear Regulatory Commission) with the supposed loopholes in the safeguards system are strictly speaking irrelevant, and should be recognized as such. Luckily, the Administration seems to have accepted the point. Its task now is to persuade those who continue to grumble that even though it is not feasible to make the safeguards system strictly watertight, that does not imply either that the system is without value or that it should be scrapped.

No safeguards system can be perfect. The Vienna system now in force cannot, for example, guarantee that some signatory of the Non-Proliferation Treaty has not built clandestine nuclear plants in some remote part of its territory. (Surveillance satellites, however, can.) Nor can it prevent a government that has privately decided to make nuclear explosives from taking advantage of the intervals between physical inspections secretly to divert fissile materials to some hidden bomb-making plant. It is, however, unthinkable that any government would invite the trouble that would follow when it could achieve the same objectives by withdrawing from the treaty at three months' notice. Then even the best-designed monitoring instruments can break down, and the most alert inspectors be misled. The pursuit of perfection is therefore pointless. So long as the chance of the detection of violations of the rules is substantial, the international community has a reasonable assurance that signatories of the Non-Proliferation Treaty are not breaking the rules.

None of this implies that the safeguards system needs no attention. But its most serious weaknesses are not technical but administrative and financial. The new director-general of the international agency, Dr Hans Blix, has been stressing in the past few weeks that the technical qualifications of his small but rapidly growing staff of inspectors should be improved. But where will these people come from? As things are (or were at the end of 1981), 130 qualified inspectors were required to inspect a total of 850 nuclear installations, but were able to carry out only half as many inspections as they should have done. What will happen when the number of nuclear installations under safeguards has grown by an order of magnitude, and when inspections will have to be more frequent because the quantities of fissile material involved will be much larger? On the face of things, the international inspectorate will need several thousand skilled people. Is it sensible to think that they will materialize, or that their work could be organized effectively?

The danger that at some point in the future the safeguards system will collapse under its own weight is thus perhaps the most serious threat to the integrity of the whole system. What can be done to head it off? In the short term, technology has much to offer. Automatic devices for monitoring what happens in nuclear plants have been installed within the safeguards system, and will no doubt be improved (see page 279). Devices that could sample data from a distance would be potentially invaluable. There is also some reason to believe that inspection could be simplified if those

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who operate reactors, for example, would agree that a continuous and incorruptible record should be kept of, say, neutron flux or some other physical quantity sensitive to the movement of nuclear material within them. The safeguards system now in use, devised merely to account for quantities of fissile material in the input to and the output from a reactor, does not require the collection of such data — which would in some places be regarded as an infringement of national sovereignty. It is not too soon to plan for a return of this provision at the next meeting of the signatories of the treaty three years from now.

Further ahead, there is a strong case for planning for a much more radical simplification of the safeguards system. Even as things are, governments with nuclear installations on their territory will, if they are prudent, take steps to make sure that fissile material is not spirited away. These domestic interests thus coincide with those of the international safeguards inspectorate, but the work is duplicated. The ideal, then, would be that self-policing should be done in such a way that it could be unambiguously and internationally verified. (Some concessions to this notion are already made within the Euratom system, which has its own set of safeguards.) The sooner this goal is recognized, the more likely it is to be attained. And that, in the long run, will be the best assurance that this important instrument in the non-proliferation system remains intact.

Problem not for now

Is it too soon to be worrying about who should operate the shuttle system?

If this week's space shuttle, diverted by the aftermath of heavy rain from California to New Mexico, returns successfully, the chance that it will become a white elephant will substantially have diminished. The first two flights have shown that the machine will function as intended. This time there should be information bearing on its potential usefulness. But it will be a long time before anybody will known that the shuttle will do the job for which it has been built — to put large satellites cheaply into orbit. The immediate need is to reduce the intervals between successive flights of the one machine in service — an interval artificially lengthened by the need to return it from its landing site to its launching pad in Florida but also by the need to replace whatever ceramic tiles have fallen off in flight. The plan is that the next flight but one should take off from and land in Florida, but only when there are four machines in service will it be possible to tell whether the turn-round time is really as short as planned.

So why is the United States government already in a tizzy trying to decide within what legal framework the shuttle should be operated in the closing years of this decade? It is not even as if the problem is all that novel. The development of telecommunications satellites in the 1960s is an obvious precedent. Then, as with the shuttle, there were three kinds of customers in sight — the US Department of Defense, potential users of communications satellites in the United States and customers from elsewhere, principally the international consortium of communications authorities called Intelsat. The largely successful solution was to leave the launching of military satellites to the Pentagon and to set up the corporation called Comsat as an organization independent of the government for launching and managing communications satellites.

Operating the shuttle commercially will be more complicated only in two respects. It may turn out to be uneconomic to have separate spacecraft for civil and military launchings, while, for a time at least, whoever owns the first four spacecraft will enjoy a monopoly of some kind. But there is no reason why a corporation along the lines of Comsat should not occasionally work for the military, and no reason why the temptation to make outrageous profits should not be restrained by a modicum of regulation. These difficulties will be clarified only several years from now. In the meantime, it might be thought, the US government has more urgent problems crying out for its attention.

Europe in the doldrums

Could science and technology help the EEC to a second twenty-five years?

What is to become of the European Community, which will be celebrating its twenty-fifth anniversary this week? On recent form, member governments will use what energy they can spare for the Community on now-familiar disputes about the prices that farmers should be paid for various foodstuffs or the shares to which they are entitled from this and that central fund. In their defence, governments will say that in the middle of a recession and with more than 10 million people unemployed in Europe, this cannot be the time for pausing in the pursuit of self-interest. They will also rightly say that a great deal has been accomplished in a quarter of a century. There is a customs union which works reasonably well. The Community has been enlarged (from six to ten, but Greece is shaky). And there is a sense that Europe is culturally more of a piece than it was. The snag is that the benefits are intangible, so that it is the public quarrels that stick in people's minds.

That things should have come to such a pass is easily understood. The treaty signed in Rome on 25 March 1957 was necessarily a blend of idealism and practical politics. The earlier collapse of the plan to set up a European Defence Force had warned the negotiators that even the tiniest infringement of national sovereignty would have to be made explicit and agreed in advance. Although there has recently been some talk of concerted action on defence the European Community is unlikely to be chosen as the vehicle.

The tentativeness of the past quarter of a century means that even now the Community does not enjoy economic cohesion. While private companies are required to compete with each other freely, governments can and do bias their purchases in favour of their own national suppliers, thus denying all members of the Community the benefits of scale and of an economic division of labour in some of the most important fields of technology. There was a minor sensation when British Telecom ordered new exchange equipment from a non-British corporation, but nobody appears seriously to have suggested that the British Central Electricity Generating Board should order the pressurized water reactor it wants to build from say Framatome (see page 299). Yet the European Commission in Brussels is wringing its hands over what used to be called the "technology gap" and seeking some way of strengthening the industries that its members have themselves weakened by their purchasing policies. Would it not be more productive to work out some set of inducements for persuading the member governments that they must give up their technological chauvinism?

Much the same question should soon be asked about the support of Community governments for research. Over the past quarter of a century spending by the European centre on research has if anything been set back. At the outset there was Euratom, but now there is merely the Joint European Torus and a miscellaneous programme of research at the old Euratom laboratory in Italy. Otherwise, governments deal independently with their spending on research, making separate decisions about their membership of international organizations or their spending in their domestic laboratories.

Up to a point, all this is justifiable. Governments responsible for universities also have to equip them for carrying out research, but even here there is scope for planning on a European basis complementarity between the centres of excellence that different governments support. Elsewhere, it is shocking that so little has been done to coordinate research on problems or fields of common interest. Should not, for example, something be done to concert the very considerable efforts in agricultural research, not so as to save money but in the hope of becoming more effective? The stock answer, that coordination works only inefficiently, is another way of saying that Europe is better balkanized. It would be better to devise machinery that made efficient collaboration possible.

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US backs nuclear safeguards

Rostow hints at new policy on plutonium

Washington

The Reagan Administration rallied behind the International Atomic Energy Agency (IAEA) last week, claiming that a strong international safeguards system was essential for the development of nuclear commerce. It argued that weaknesses in the safeguards system should be remedied by greater support for IAEA programmes, not by changing their basic objectives.

The Administration's views were given in testimony to two subcommittees of the House of Representatives' Foreign Affairs Committee. One issue was the adequacy of the Administration's proposed contribution to IAEA in the 1983 budget. Although the increase over the 1982 contribution is larger than that for any other international organization, it will still not be enough to keep up with inflation — a source of concern to some State Department officials faced with rapidly growing demands for IAEA inspection procedures.

The hearing was also an opportunity for the State Department to rebut some recent criticisms of IAEA, in particular complaints about its admission last year (in connection with a reactor in Pakistan) that it cannot always assure member countries that nuclear materials are not diverted from peaceful to military purposes.

Such criticisms, State Department officials argued last week, are not only misdirected but also potentially harmful, tending to undermine the credibility of IAEA. Mr Richard T. Kennedy, Under-Secretary of State for Management and head of the delegation to IAEA, angrily rejected charges by Congressman Richard Ottinger that the agency had been involved in a "cover-up" by not making public its concern about the possibility of the diversion of nuclear material in countries such as Iraq and Pakistan.

Mr Kennedy was accompanied at the witness table by Ambassador Richard Kirk, deputy US representative to IAEA, and Dr Eugene Rostow, head of the Arms Control and Disarmament Agency. Each spoke strongly on the theme that the agency requires as much support as possible from the industrialized nations, and that the adequacy of safeguards should not be considered in isolation, but merely as one element in the control of nuclear proliferation.

Thus Mr Rostow told the subcommittees that halting the spread of nuclear explosives was "inconceivable" without IAEA safeguards, but added that they did not prevent diversion since, for example, they did not permit searches for clandestine materials or facilities. "In my view, it is just as wrong to overestimate the importance of safeguards in nuclear commerce as it is to denigrate the system for not accomplishing objectives for which it was not designed," Mr Rostow said.

The State Department's consensus on IAEA, however, was not shared by all members of the Nuclear Regulatory Commission (NRC). Under the terms of the Nuclear Non-Proliferation Act of 1978, the commission is responsible for checking that safeguards are applied to any foreign nuclear installation to which nuclear materials are being exported from the United States.

Mr Peter Bradford, on his last day as one of the five members of NRC, was outspoken about the difficulties experienced by both NRC and congressional committees in obtaining data by which to assess the effectiveness of the safeguards. At one point, he accused the State Department of unnecessarily censoring NRC's reply to questions submitted by Congressman Richard Ottinger.

Mr Kennedy refuted the charge of censorship, pointing out that the information was being withheld at the request of the Central Intelligence Agency — which has since offered to brief Mr Ottinger on the subjects that he had inquired about. Both he and Dr Rostow, however, declined to say whether the State Department has evidence of the diversion of nuclear materials.

Both Mr Bradford and a second NRC commissioner, Mr Victor Gilinsky, expressed reservations about the adequacy of IAEA inspection procedures for warning about the diversion of weapons-grade plutonium from reprocessing or enrichment facilities — concerns which led the Carter Administration to attempt to dissuade other countries from adopting such technologies.

Dr Rostow in reply criticized the previous Administration's approach, suggesting that attempts to impose unilateral controls could backfire by encouraging the spread of reprocessing while making less likely the agreements on a common policy with other nuclear suppliers. The Administration's policy is soon to be defined in a new executive order which Mr Reagan is to sign; Dr Rostow said it was important to acknowledge that civil reprocessing in the stable industrial democracies did not in themselves present a proliferation risk.

On the IAEA safeguards, Dr Rostow urged that member states should provide the international safeguards system with the resources needed. Mr Kirk, however, told the subcommittees that as the number of installations under IAEA safeguards had risen from 560 in 1977 to 850 in 1981, even though the IAEA budget allowed much faster growth for safeguards than in other activities, its expansion of the safeguards system had caused "a resources pinch, growing pains in IAEA's administrative structure, and a lag in IAEA safeguards coverage".

David Dickson

Nuclear monitoring by telephone

Washington

A scheme for collecting nuclear safeguards information by means of telephone lines is to be discussed at a meeting planned for Vienna in June this year. The system, called the Remote Continual Verification programme (or "RECOVER"), which was given a systematic trial in the autumn of 1980, has grown out of the technical proposals for the remote verification of arms control agreements in the draft of the Comprehensive Test Ban Agreement, uncompleted since the end of 1980.

In evidence to the House of Representatives last week, Dr Eugene Rostow said that on the basis of a cost-benefit study carried out at Brookhaven National Laboratory, the Administration was now hoping that the system could be put into service soon, and that it might even be valuable in the verification of treaties (yet to be negotiated) on chemical and biological weapons.

In the nuclear context, the new system is a means of making sure that automatic monitoring equipment does not break down between visits by inspectors from the International Atomic Energy Agency (IAEA). This is done by the repeated but irregular interrogation of monitoring equipment by means of signals transmitted on the international trunk telephone system. So that the authorities responsible for safeguarded nuclear installations cannot corrupt the signals received and sent, signals are encoded by means of an unbreakable code of the type developed for use in what is now called public-key crytography.

The Brookhaven study has apparently shown that the new monitoring system is potentially most valuable in nuclear installations such as reactors which can be refuelled on load and in fast critical assemblies, to which frequent visits from inspectors are at present required. One critical assembly in Japan, containing a fixed quantity of 300 kg of plutonium and 200 kg of enriched uranium, has on present criteria to be inspected every week or two.

The new monitoring system, by reducing the frequency of inspections, would save an estimated $200,000 a year at that installation alone. The system is, however,

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unlikely to be used at separation plants (where inspectors are virtually permanently in residence) or in light-water reactors (where redundant monitoring equipment is probably cheaper).

In Japan, the system is also being advocated as a means of safeguarding the sea transport of fissile material, providing a means of making sure that cargoes are not illicitly diverted on the high seas. In such an application, communication would be by means of Earth satellites of the kinds being developed for marine navigation. The effective use of the system for the inspection of nuclear installations on land is thought to require the development of a network of IAEA field stations (of which there are at present only two, in Toronto and Tokyo) and the existence of an efficient trunk telephone system (found wanting in Bulgaria during the 1980 trial of the system).

The application of the system to the monitoring of agreements on chemical and biological weapons presupposes the design and installation of effective automatic monitoring equipment at plants covered by an agreement.

Sticky problem over Iraq fuel supplies

Two French nuclear physicists, backed by three prestigious members of the Académie des Sciences, have warned President Mitterrand in a report that there would be no easy way to stop Iraq making bomb-grade plutonium — if France rebuilt the Osirak reactor destroyed in a bombing raid by Israel nearly a year ago.

This is the second report condemning the reactor sale to be prepared by the two physicists and to be sent — unsolicited — to the president who is said to be sympathetic to the arguments but to be short of apolitical technical advice.

What stung the physicists to produce a second report were widely-reported claims that "caramel" — a low (7 per cent) enriched uranium oxide fuel — was the answer to the problem. If caramel were sold to Iraq to fuel the reactor, in place of the 95 per cent enriched uranium for which it was originally designed, the claims went, Iraq would have no quick route to the atomic bomb.

However, this misses the point, the new report stresses. The caramel fuel would still produce the same neutron intensity in the large pool around the reactor, where test materials are placed to investigate their reaction to neutron bombardment. If these test materials were replaced by depleted — or natural — uranium (of which Iraq is believed to have supplies) plutonium would be produced in the uranium, and could be extracted chemically.

The only advantage of caramel is that it cannot be used directly to make bombs, whereas 95 per cent enriched uranium is more easily converted. But, the reports point out, four years ago Giscard d'Estaing set limits on deliveries of enriched fuel to Iraq. Fuel would be sent in single reactor-loads of 13 kg, each of which would be loaded into the reactor under supervision and promptly irradiated making diversion technically very awkward. From that time, the diversion of the fuel itself ceased to be a problem — so the use of caramel solved nothing.

The production of plutonium by neutron bombardment, however, could amount to 3.3–8 kilogramme per year (to quote the assessments fo both the Commissariat à l'Energie Atomique and the International Atomic Energy Agency). The amount of plutonium required for a bomb is generally taken to be 6 kg, although under certain circumstances 1-2 kg could be enough. Thus, say the two reports, Iraq could have the capability (in plutonium, at least) of producing a bomb within six months of beginning irradiation, whatever fuel the reactor was loaded with. IAEA inspection, however, might interfere considerably with this rate of production.

France has said it will help rebuild Osirak, provided Iraq guarantees that the reactor will be used entirely for peaceful purposes. The new report may make this politically more difficult for the president.

Robert Walgate

Soviet nuclear power

Signs of caution

The Soviet nuclear energy programme is running into difficulties. In spite of the high priority given to power station construction, last year's targets were not met. And although no specific reference has been made to the need for greater standards of safety, Pavel Falaleev, first deputy Minister of Energy and Electrification, has said that the safety requirements of power stations were being tightened despite the radiation around them being "considerably below the permissible limit and practically no different from natural levels". In a Soviet context such a remark is sufficient to indicate considerable high-level rethinking.

The discussion of the nuclear programme began about six weeks ago, with a meeting of the Central Committee of the Communist Party to review shortcomings, where the emphasis was on the logistics of construction although inadequacies in the design sector were noted.

Three weeks later, the theme was taken up in a leading article in *Pravda*. This at first followed the line of the central committee meeting, noting that production-line nuclear power units had already been developed, and that supply problems could be dealt with by economic sanctions to penalize those who held up the plan. *Pravda* then went on, however, to suggest serious deficiencies in the design sector.

Here, it was claimed, the Ministry of Energy and Electrification had failed to exercise its supervisory duties. Changes in materials and specifications had been made without either proper justification or the apparatus for selecting the "most progressive" solution to engineering problems. In particular, a proposal put forward by the *Atomenergostroiproekt* design trust, for a change in the structure of the "protective shells" of power stations, was turned down without being studied by the necessary multi-disciplinary panel of experts. The scientific council of the ministry, *Pravda* said, must bear greater responsibility for such decisions.

This reference to protective shells is significant. If, as seems likely, this refers to the concrete containment vessel common in Western power stations, it reflects a change in Soviet policy. Until recently, such vessels were dismissed by Soviet designers as unnecessary, and a capitalist ploy to raise construction costs. Demands from the Finns and Hungarians led them to introduce containment vessels into reactors designed for export. The remark in *Pravda* suggests that they may now have been introduced into reactors for home use whereas previously it was thought sufficient to surround reactors on the outskirts of major cities with a kilometre or two of parkland or playing fields.

Vera Rich

Intelligence testing

Soviet inequality

The Russians have finally "come out" on the subject of intelligence and other objective tests of performance and personality. The January/February issue of *Voprosy Psikhologii* (Problems of Psychology) contains three papers endorsing such tests in principle.

The papers are printed prominently at the front of the journal, preceded only by a major statement on future psychology services policy, based on the decisions of the November plenum of the Soviet Union's ruling communist party. The journal quotes President Brezhnev himself in support of a call to concentrate on "scientifically-based solutions to the problems of the nation's education in the service of the scientific and technological revolution".

This is a startling but unequivocal *volte face* by the Soviet authorities, who have until now (in public at least) regarded "testology" as an instrument of class warfare in the hands of the ruling capitalist élite. Testing was even made illegal

Taking a nuclear power lead

"ONE reactor, one producer, one seller": that is the structure of the French nuclear industry, and according to one observer it is a prime example of how France has managed to mobilize its technical resources towards particular goals. Whether this technocratic centralism will survive a socialist government has yet to be seen, but the nationalization of large sectors of industry, and the grand "mobilization programmes" of the minister for research and technology smack not so much of a change as a clarification of previous government positions.

The reactor is the pressurized water reactor (PWR), built under licence from Westinghouse in the United States; the producer and seller the 5,000-strong company Framatome, now geared up in its pressure vessel and steam generators shops at Le Creusot and Chalon to produce six 1,300-MW reactors a year. Mitterrand did not nationalize Framatome. It was already in effective government control through its sole French customer, Electricité de France (EDF) and its principal collaborator in research, the Commissariat à l'Energie Atomique (CEA).

The main impact on the Framatome programme has been the reduction in the EDF order from a possible nine reactors over the next two years to six, which leaves Framatome with a large surplus capacity and a hunger for export orders. Framatome has sold one reactor a year for export over the past eight years: two to Belgium, both to come into operation this year, two to South Africa (to operate next year), two to Iran (although the orders were cancelled by Khomeni with the plants half-completed) and two to Korea. The sale to Korea was a considerable achievement because Korea's previous reactors had been constructed by US companies.

Nucléaire, s'il vous plaît!

A SLIGHT majority of the French people is in favour of nuclear power, a poll conducted just before the October 1981 energy debate indicated. Some 45 per cent are in favour, compared to 40 per cent against and 15 per cent who don't know, in a sample of over 2,000 people. On the extremes, 16 per cent were "definitely" favourable, and 17 per cent "definitely" unfavourable.

One surprising result which might give the government pause, however, was that 64 per cent were in favour of a referendum on nuclear power — an election promise that was subsequently dropped. Another surprise: nuclear power is more supported on the political left than on the right. Compared with the average 45 per cent in favour, 51 per cent of those who voted communist and 52 per cent of those who voted socialist favour nuclear development.

Framatome has also put in tenders for two reactors for Taiwan and two for Mexico — and if it were not for the world recession would be confident of orders. The dollar rose by nearly 30 per cent against the franc during 1981 (from FF 4.5 to FF 5.8), giving Framatome a distinct price advantage — which is enhanced by the company's ability to spread its overheads over a large national programme. However, Mexico, at least, concerned about its economic situation, is beginning to have doubts about whether it needs the 20 reactors it was planning to build by the year 2000, and the same fear appears to be gripping other developing states interested in nuclear power. So Framatome may be forced to look to the home market.

Pride and glory reflected — four of France's "production line" PWRs, at Tricastin

In France, Framatome is now building 26 reactors with a total power of 28.6 GW electric, 16 at a nominal 1,300 MW and 10 at 900 MW. Another thirty units, accounting for 21.8 GW, are already in operation. The smaller reactors are effectively the original Westinghouse design, as modified by Framatome; but the 1,300-MW plants are almost completely French, and a new 1,400-MW design, called "N4" and now on offer to EDF, is totally so.

Going it alone

The Westinghouse licence expires this year and then Framatome will be officially on its own — apart from certain research agreements which will continue — but already the sluggishness of the US nuclear programme has given Framatome a commanding lead. According to Framatome's technical director, M. Michel Coudray, the company began work on the 1,300-MW design in 1975. By then Westinghouse had already sold two 1,300-MW systems to a Texas utility, and Framatome believed that it would be able to benefit from Westinghouse experience before putting the final touches to its own 1,300-MW plants. But in the event, construction of the Texas reactors has ground almost to a halt, due to quality control problems on site and concern on the part of the Nuclear Regulatory Commission. The result, said Coudray, is that while the Texas reactors are not likely to go critical before 1984 (three to four years late), the first Framatome 1,300-MW reactor — at Paluel — should be connected to the grid early next year. Framatome will thus have taken less than six years to build it, whereas Westinghouse will have taken more than ten years for a similar reactor.

In part, this achievement can be put down to standardization. Framatome has not had to make substantial changes in design in mid-stream to meet changing safety regulations. Apart from the first five reactors, which were fairly variable — Framatome was on its learning curve — there have essentially been only three designs: a group of 16 reactors of 900 MW which began construction in 1974–76; a second group of 12 begun in 1977–81; and the 1,300-MW reactors, begun in 1977 in parallel with the second tranche of 900-MW systems. The result has been that Framatome has been able to place long orders for components, which gives a guarantee of supply, and streamlines production processes. (One danger, however, is that mistakes, once made, are propagated over many systems; see p.301.)

With this powerful production system now established, Framatome would, of course, like a long list of orders; but even under the unbounded nuclear enthusiasm of the previous government, orders came only in occasional handfuls. Furthermore, EDF is now producing 40 per cent of its electricity from nuclear power, and while it aims for 60 per cent nuclear by 1985 (compare Britain's present meagre 11 per cent contribution), there is finally a limit to the proportion of an electric power network that can be driven by nuclear systems. The reason is that national power demand fluctuates by as much as 40 per cent during a working day, and nuclear power stations are not easy to turn on and off: they are said to provide "'base-load power". So already, EDF has insisted that Framatome consider the problems set by imposing a ten per cent peak to peak fluctuation on demand.

This so-called "daily load follow and frequency control mode" leads to a number of new technical problems, caused by the high frequency at which the control rods have to be driven in and out (up to

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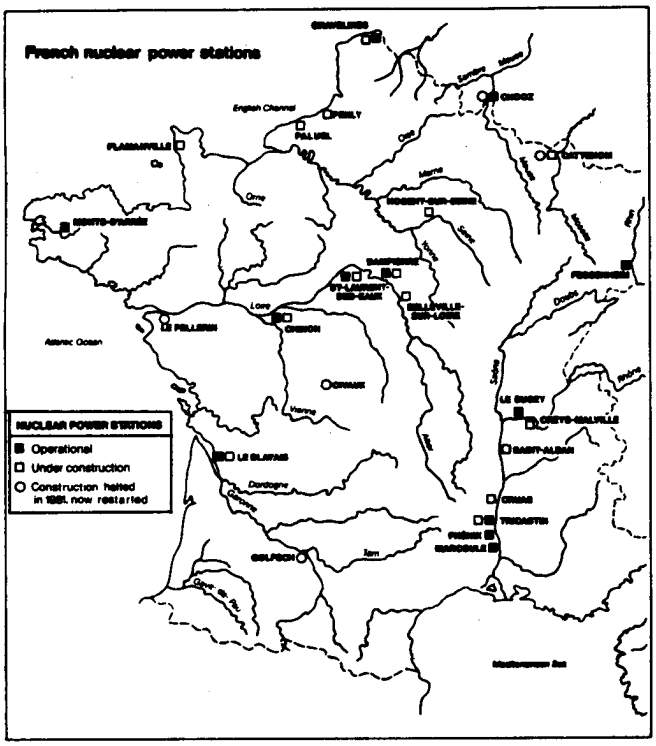

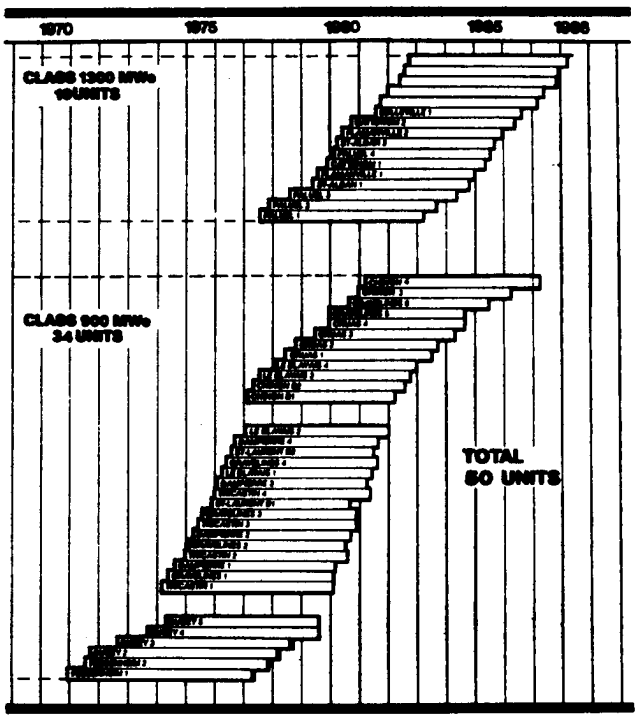

The map shows the sites of the French PWRs, filling many of the suitable sites on France's rivers. The figure on the right illustrates the pace of the PWR construction programme since the early 1970s. The boxes extend from the start of construction to connection to the grid.

1,000 times a day according to some estimates) and by the thermal stress on components as the core heats up and cools.

Nevertheless, Framatome has undertaken an extensive test programme at Cadarache, in conjunction with EDF and the CEA, to discover the behaviour of the reactors under such conditions, and the company believes it is now in a position to make the necessary design changes.

By 1990, French orders may be down to two reactors a year. Outside France, Framatome has sought to sell in many countries — including Britain, whose rejection three years ago of a possible arrangement with Framatome is still a bitter memory in the company. The UK Central Electricity Generating Board was said to be quite enthusiastic about an agreement with France over PWR construction, but the Atomic Energy Authority (AEA) was cool. "Britain could have had an industrial agreement, or a research agreement or both but she decided to go with Big Brother [the United States]", said Coudray recently. "Once again Britain has preferred America to Europe" he said, reflecting a feeling in France that Britain is on all fronts a reluctant European partner.

In the United Kingdom, the chairman of the UKAEA, Dr Walter Marshall, sees things slightly differently. At the time of the French approach Framatome was still bound by the terms of the licence with Westinghouse, Marshall points out — so Britain would have had to "throw out Westinghouse", with whom negotiations were well advanced, without being able to sign up with Framatome until this year. Also Britain would have found it difficult to modify the French design to suit British conditions, for that would have been an implied criticism of French safety judgements, Marshall argues. Westinghouse itself, however, was more sanguine about design changes because it could always claim that in the United States its designs were bound by the rules imposed by the Nuclear Regulatory Commission, which might or might not be considered sensible. In France, by contrast, the close-knit character of the nuclear establishment implies that changes are a challenge to the whole system. The Framatome PWR is the world's safest, cheapest and best PWR: so why change it?

Another, purely commercial reason for rejection of the French deal was that there has been a recognition in Britain that Westinghouse, in the past at least, has been the world's most successful reactor vendor: and that on the other hand its credibility as a fuel supplier was severely damaged by President Carter's retrospective legislation on the supplies of enriched fuel. That leads to a natural partnership between Westinghouse and British Nuclear Fuels Limited (BNFL) whereas in a French deal BNFL would have been in competition with the French fuel company, Cogema.

Nevertheless, Britain's nuclear power capability would certainly have grown

My steam generator's better than yours

A KEY problem affecting the running of pressurized water reactors is corrosion of the steam generators — the massive heat exchangers that transfer heat from the primary coolant to boiler water which, as steam, will then be used to drive turbines.

Any boiling kettle makes a lot of noise and bubbling vibration, and the same is true of steam generators. So the tubes which carry primary coolant through the steam generator must be clamped firmly to stop them vibrating and working loose. Tight clamping leads to corrosion at the clamps. Loose clamping, as originally adopted by Framatome, leads to tubes working loose. (Fessenheim 1, the first French PWR, suffers from this.)

So steam generator design is something of a black art, and the engineers at Framatome think they've mastered it and that Westinghouse has not. Britain, for its PWR design, has adopted the Westinghouse "F-type" steam generator. Framatome analysed the basic design of the model F in 1977-8 and was not impressed. The F-type is still just a design — it has never operated anywhere — and the previous model on which it was based had major problems. Westinghouse has solved some of the problems, but nothing like all of them, according to Framatome engineers. "We believe in rugged systems" said one. "The Westinghouse model is more of a watchmaker's approach, with smaller tubing of which there is no experience."

Westinghouse, however, is unperturbed. The company believes Framatome is wrong on water chemistry, and that the French steam generators will corrode within four years. However, EDF, the operator, is proud of the chemical control procedures. "We are keeping our fingers crossed" say Framatome's engineers.

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much faster with Framatome, ... now France can gloat over the difficulties facing the British nuclear industry — particularly over the design and cost of safety systems. "We are very sorry for the British" said Coudray. "You can increase the cost of a plant by a factor of two if you are not careful with what you do about safety". According to M. Rémy Carle, a director at EDF, the cost of a Framatome 1,300 MW PWR station is now about FF 5,000 per kilowatt (that is, about £600 million in total) — a price that does not include decommissioning, and assumes a reactor on the coast, but includes all other costs. By contrast, at the recent announcement of the completion of the work of the British PWR task force, whose objective was essentially to reduce the cost of safety systems on the PWR, the figures being quoted were more like £1,000 million.

According to Coudray, the problem is that the British have adopted a four-loop, independently pumped emergency core cooling system (for use in the event of the most serious possible emergency, a "loss of coolant accident" or LOCA). Such a system is easier to explain, and "nicer

Coudray of Framatome — unlike the British, not troubled by a suspicious public

intellectually" that the French safety system, says Coudray. The British system takes five minutes to explain whereas the French takes 3-4 hours — but the French system will do everything the British one will do a much lower cost. Britain has probably adopted the "transparent" system for political reasons, thinks Coudray, to satisfy a suspicious public.

How then has France got so far ahead with its nuclear programme? The research programme undertaken by Framatome in the early 1970s, and which was in full swing by 1975, was crucial to success. A licence brought information; but understanding requires research, said Coudray. Research enabled Framatome to move away from and improve on the Westinghouse design. The exact scale of the French research programme has not been revealed, but it matches anything that Westinghouse has done in the United States.

The company does its research under four framework agreements which allow very rapid changes of direction and commitments of money without the need for constant negotiation and renegotiation. Framatome has its own unique programme at Creusot-Loire, mainly on materials; a "very privileged and active" programme with the CEA (which is, incidentally, a 30 per cent shareholder in Framatome); a quadripartite agreement, under which one-third of the work is done in the United States and two-thirds in France; and a tripartite agreement among the French partners. Corrosion problems in the primary circuit and steam generators, among the main causes of the low availability of the Westinghouse reactors, were studied under the quadripartite agreement; but surprisingly Westinghouse and Framatome then diverged over steam generator design (see page 300).

The principal reason Framatome has been so successful, though, lies in the extraordinarily tight organization of the nuclear industry in France — a legacy of the work of the previous industry minister, André Giraud. After the battle between CEA and EDF over whether the French gas-cooled or American pressurized water reactor should be chosen — a battle in which de Gaulle championed the CEA, which he had himself set up in 1945, and its gas-cooled system, and which was only won by EDF after de Gaulle resigned — Giraud picked up the pieces of the industry and dried the CEA's tears, giving it total control of the fuel cycle and the development of the fast breeder. He thus created the stable, three-legged organization — CEA, Framatome, EDF — which has put French nuclear power in a world-commanding position. □

All they're cracked up to be?

YOU couldn't really have a better recommendation. "Now's the time to buy from the French" said Dr Walter Marshall, chairman of the United Kingdom Atomic Energy Authority, recently, when describing the French design for a pressurized water reactor (PWR). Dr Marshall heads the PWR task force which recently tidied up the design for a British PWR, built under licence from the American company Westinghouse. However, the recommendation is somewhat backhanded.

"The French have been caught with their pants down", said Marshall, referring to a series of cracks discovered in the reactor pressure vessel and steam generators of a number of plants three or four years ago. The result is that the manufacturers, Framatome, are now taking every possible precaution to avoid such potentially dangerous flaws, even though their own "pessimistic" calculations had shown the existing cracks to be unimportant.

Marshall says he has every confidence in Framatome's calculations and experiments, and believes that it has done a "very thorough job". French safety authorities will impose a requirement to inspect existing cracks every time a reactor is shut down for servicing (perhaps every 2–3 years), and Marshall — who made a deep study of the problems of cracking in reactor pressure vessels — believes this will be quite sufficient to prevent accidents.

This is despite the fact that some of the cracks, which appear in the black steel under the stainless steel cladding of the primary containment system, are difficult to observe. They are the ones in the shoulders of the inlet nozzles of the pressure vessel, where cool primary circuit water enters to extract heat from the core: it is simply physically difficult to reach them with the usual ultrasonic and eddy current detectors, unless the whole of the core is removed first. But Marshall believes it would be adequate to monitor frequently only the cracks in the hot outlet nozzles, which are accessible, as a kind of statistical sample of crack growth, while inspecting the inlet nozzles less frequently — say every ten years — a policy which Framatome and EDF will probably follow.

Around 25 of Framatome's earliest reactors are affected by the underclad cracking problem — an example of how design continuity can lead to problems if the design or manufacturing process has a hidden fault. But the cracks may prove to be a very minor hitch compared with another problem which became apparent only this January — faults in the "broches".

These are spring clips which grip and support the fuel cans at the top of the core, and some three years ago in Japan it was discovered that they can be subject to embrittlement caused, perhaps, by neutron bombardment. Until January there had been no evidence of this in Framatome reactors, but then a loose part of a broche was found circulating in the primary coolant in one of the Gravelines reactors. Now the loading of the latest Framatome reactor, at Chinon, has been delayed — according to some reports to test and inspect or even to change all the broches before the reactor is started.

Framatome staff do not understand yet what caused the Gravelines broche to break, and whether it was a unique or general fault. But if it was the latter, 37 reactors would be affected, so a crash programme on broche design and testing is now under way. The problem is compounded by the fact that the broches on working reactors will be highly irradiated and so very awkward to replace; but if faulty, they will have to be replaced, for broken broches could jam and interfere with the movement of control rods.

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Superphénix — great white hope

THE world's first commercial-scale fast-breeder reactor, Superphénix, should be generating 1,300 MW of electrical power for the French national grid by 1984. But is it, or will its successors be, economic? And will EDF order Superphénix II, which is already being designed?

Superphénix is in fact owned by an international consortium, NERSA, which is 51 per cent French with the rest largely divided between Germany and Italy (which has the larger share). NERSA is the customer of Novatome, a kind of fast-breeder companion to Framatome (which constructs the PWR). Framatome in fact now controls Novatome, which is also held 34 per cent by the CEA.

Superphénix is expensive: estimates vary, but the price is usually put at around twice that of the equivalent PWR. Of course, it is a prototype; it is alone on its site (PWRs are usually built in fours); and PWR construction is well-developed (Framatome is on the fortieth of its series). But there are some fundamental reasons why Superphénix should be more expensive: it has an extra cooling circuit — the second sodium circuit; safety systems are more complex, having to deal with the possibility of sodium fires as well as almost instantaneous nuclear shutdown in the case of coolant loss; and the reactor vessel is stainless rather than ordinary black steel.

Superphénix nears completion

In the long run, the fuel cycle costs should be lower because the fast breeder can generate its own plutonium by neutron bombardment of waste uranium from enrichment plants and depleted gas-graphite fuel.

This would also give France a degree of security in uranium supply. French-controlled uranium production is expected to peak at around 4,500 tonnes a year by the mid-eighties, but the PWR programme is expected to need around 8,500 tonnes a year by 1990 and 12,300 tonnes a year by the year 2025 (according to CEA figures). So France is in danger of becoming almost as dependent on foreign uranium supplies as it is at present on foreign supplies of oil. The introduction of fast breeders, the CEA argues, could reduce this demand to as low as 8,000 tonnes a year in 2025 — provided a fast breeder programme were started soon.

There are two arguments for the fast breeder, says the CEA: that at a certain uranium price the fast breeder will become cheaper per kilowatt hour than a PWR, because of the former's breeding capacity; and that it represents an insurance against loss of uranium supplies. "And you expect to have to pay an insurance premium if you want insurance," says Michel Rapin, CEA director for nuclear applications.

The question of what balance should be struck between these two arguments is ultimately a matter for government and the electricity supplier, EDF, but neither shows any desire for haste although, says the CEA, France needs "a significant programme" of fast breeders by the end of the 1980s to make any impact on French uranium needs by the second decade of the next century.

Moreover, the reprocessing and other pieces of fuel-cycle plant necessary for a fast breeder programme are uneconomic unless built very large. So the CEA is looking for two options: first, a French programme of seven or eight fast breeders, the first of which should be ordered in 1986–87 or, perhaps more practical, an international collaboration on fast breeder construction on about the same scale.

Of course it would appeal to France if the international reactor were close to Superphénix II, and the CEA has already been looking for partners. In Britain, UKAEA officials also believe in international collaboration on fast breeder programmes, and are contemplating agreements with either France or the United States. However, France was reported two years ago to be asking a price of £20–25 million for access to Superphénix technology, a price which Britain at the time rejected.

The reprocessing technology, whose efficiency in extracting plutonium is critical to fast breeder operation, is not seen to be much of a problem at the CEA. Already 15 tonnes of fast breeder fuel have been reprocessed through small fast breeder plants at La Hague (now closed) and Marcoule, and 380 of Superphénix's 400 or so fuel assemblies have been made of plutonium extracted through reprocessing. "We have closed the fuel cycle" says Rapin.

Moreover the breeding efficiency was "sufficiently positive". In recent years CEA scientists — 1,000 of whom work on reprocessing technology — have reduced plutonium losses during reprocessing by a factor of five. "But that is not exactly the problem" says Rapin. To get a lot of plutonium bred by a fast breeder, a thick depleted uranium blanket is necessary. But the thicker the blanket, the less the concentration of plutonium produced in the outer layers of the blanket. And a low concentration of plutonium means a high reprocessing cost. So the best balance has to be struck between the reactor breeding ratio and these costs. Costs, yet again, come back to the centre of the fast breeder stage, and there are certainly some in France who look at Superphénix and think of another costly marvel — Concorde. □

Nuclear power — how committed?

WHEN François Mitterrand was elected president of France on 10 May 1981, the nuclear establishment was worried. His socialist party, a relatively new and unknown force in French politics, had committed itself to a fairly strong anti-nuclear policy. Paul Quilès, the architect of the socialists' plan, was effectively seeking a halt to the construction of new nuclear power plants. If this plan had been implemented, the monopoly electricity supplier (Electricité de France, EDF) would have had only 39 GW of nuclear electricity available in 1990, compared with the 59 GW planned by the previous government, and EDF's supplier of nuclear steam supply systems — Framatome — would have found itself with (to say the least) an embarrassing overcapacity. With the export market also sluggish, this would probably have meant the collapse of the French nuclear industry.

However, six days after the presidential election, a strange thing happened. Giscard d'Estaing's centre-right government was in its last few days of limbo, before the elections to the National Assembly (parliament) and the establishment of the new government. Usually, no major decisions or commitments are taken at such times. But Raymond Barre, Giscard's Prime Minister, unexpectedly announced that the reprocessing facility for spent nuclear fuel at Cap de la Hague, near Cherbourg, was to be massively extended — at an estimated cost of FF 20,000 million (£2,000 million) — to cope with 1,600 tonnes of fuel a year. Some of this capacity was to honour contracts already signed with Belgium, Germany and Japan; but the rest implied a strong national nuclear programme. The decision could hardly have been taken without the tacit agreement of Mitterrand, who would have to carry the policy through. So what exactly was the new government's position on nuclear power?

Initially, it seemed as if the Quilès policy might be adhered to. One of the Mitterrand government's first acts was to "freeze" construction on five nuclear sites — Chooz, in the Ardennes near the Belgian border, Cattenom, Civaux, Golfech near the Pyrénées and Le Pellerin. Plans for a nuclear plant at Plogoff in Brittany were

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shelved, at least temporarily.

But then other notes were sounded. Jean-Pierre Chevènement, the minister of state for science and technology and a powerful figure in the new government, declared himself solidly behind the French nuclear programme, and all but described the small French environmental movement as "anti-scientific".

Discarding the chaff

Speaking cynically, it is as if Mitterrand had used the environmentalist tendency in his socialist party only so far as was necessary to help build the party and gain power. Now it was possible to let such chaff blow away. The environmentalists do feel themselves hard done by. Giscard had not even lent them an ear. Mitterrand had appeared to listen, and then ignored them. Recently there was a rocket attack on Superphénix, the world's first commercial-scale fast breeder power station. Nobody has claimed responsibility, but there are fears at EDF that this means that an extreme section of the environmental movement has now gone underground.

Although the Mitterrand government can in no sense be called "green", it is showing itself to be sensitive to arguments for more democratic control of technical choice. Mitterrand is emerging as a social democrat, although he would not dare to use this label within his party.

In the energy sphere, the evidence for the socialist government's liberalism came first with an energy debate in the National Assembly last October. In contrast to the Quilès policy, the energy policy revealed by Prime Minister Pierre Mauroy and the junior minister for energy, Edmond Hervé, was very mild. It was forced through against the Quilès faction on a vote of confidence. Instead of 59 GW nuclear in 1990 there would be 56 GW. Instead of nine new reactor starts in 1982–83, there would be six. The La Hague development would go ahead. The fast breeder was not debated. The frozen reactor construction sites would be reopened, if a local vote approved; if it did not, it would be up to the regional council (a higher elected authority) to decide; if the regional council did not approve, the matter would come before the National Assembly — a mechanism designed, it seemed, to get a "yes" vote at some level or other.

The environmentalist lobby looked on the black side — this was just the old centralist technocracy by another name. But there is another view, which as time passes comes more and more to the fore. The Mitterrand government is fiercely realistic — while at the same time wanting to make historic and lasting changes in the nature of French society. It is not going to compromise either on economic development or on a slow, emphatic shift of power away from the Paris-based élite, towards the regions, towards the small enterprises rather than the giant conglomerates.

Realism leads the government to understand that a country 70 per cent dependent on foreign fuel, whose healthy non-oil trade balance is wrecked by the cost of oil imports (99 per cent of oil is imported), must attempt to internalize the costs of energy production. Nuclear electricity is part of the solution. The government is also realistic enough to know that the wholesale destruction of the nuclear industry would be immensely demoralizing to French people — who, while being as suspicious of nuclear power as the next nation, see its success as one of the great symbols of French strength. France has been overrun by a foreign power three times since the Revolution, and no Frenchman is going to let it happen again — either militarily or economically.

Handling the public

On the other side of the equation, the small group of men at the head of EDF, the CEA and Framatome, who effectively control the nuclear development of France, are gradually being forced to pay serious attention to the general concerns of the public and the particular demands of the regions where nuclear facilities are being sited.

For example, when the government says it will "reinforce the independence" of the Conseil Supérieure de la Surété Nucléaire (the senior nuclear safety council) and "modify its composition", it means that it really will attempt to detach the safety council from its tutelage to the nuclear establishment. The proposal to create a "safety director" under the control of EDF may be looked at a little askance, as may guarantees of the independence of the Institut de Protection et de Surété Nucleaire, the technical safety assessment body which exists under and has constant exchange of staff with the Commissariat à l'Energie Atomique; but the establishment of local information commissions on each nuclear site could be taken more seriously.

These commissions are proving slow to set up (so far there is one at La Hague and another at Nogent-sur-Seine) but, according to commitments made by the government in the energy debate, they will be pluralist, "contradictoire" (in other words allowing serious debate and close questioning), independent and permanent.

Media plug in here

JUST to the side of the Electricité de France (EDF) edifice in Paris is an unobtrusive set of doors. In the case of a major nuclear accident at one of the EDF power stations it is through this door that most of the world's (official) information about it will come.

For behind this door is a FF 4-million (£400,000) communications suite, the brain-child and pride of EDF's chief public relations officer, Mme Marie-Claude Vigna. Mme Vigna began to plan the suite after a French power black-out in 1979 had led to a great press of journalists in a tiny room in EDF headquarters, all attempting to use five telephones at once. If it was like that for a mere power breakdown, what about a "Three Mile Island", Mme Vigna reasoned?

The consequence is that EDF now has probably the most sophisticated "press office" in France. At street level, television vans can simply plug in to a series of channels giving television output from the suite above. Within the suite, sound-insulated rooms take tapes direct from the major wire services such as Agence France Presse and Reuters, so that journalists — and EDF staff — can monitor media output by the minute. There are of course more than five telephones; a television studio, executive briefing room; and literally every known form of video recording and playback equipment. And officials being interviewed can be relayed information over private monitor screens which are within their vision but not that of the journalists interviewing them (see photograph below).

Outside Paris, hundreds of EDF officials throughout France will be kept in touch by a private videotext signal, sent through the French ANTIOPE system.

A French prefect (regional head man) who was responsible for the region around the Dampierre nuclear power station recently sent out a notice to his constituents telling them what to do in case of a nuclear accident. Don't panic, he said. Keep your children indoors. Don't eat apples from the garden. And, mysteriously, don't telephone. Well, there'd be no need to with what EDF has in Paris, would there!

Energy minister Edmond Hervé confronts the press in EDF's media room

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Hard bargaining at Golfech

The apparently anodyne decision to subject the five frozen construction sites to a hierarchy of democratic assessments, from local to national level, until at some stage somebody said "yes", has also proved a thorn in the EDF flesh. The votes went in favour of continuing construction at Chooz, Cattenom and Civaux. But at Golfech, near the border with Spain, and Le Pellerin, there were marginal local votes against. So the question went to a higher level — the regional council. The Le Pellerin council voted for the reactor. But Golfech, while eventually agreeing, drew blood from EDF in the process.

The "blood" took the form of a contract with EDF — the first ever such binding arrangement between EDF and a region — which guarantees the locality 40 per cent of the jobs that will eventually be created at the power station, a large fraction of the construction work and EDF support for amenity development. EDF is currently seeking sites for five reactors at 1,300 MV and one at 900 MW — the programme agreed at the National Assembly for 1982–83 — and the Golfech deal may prove to be an awkward model. EDF, however, argues that it has always tried to place jobs and contracts around the region of a nuclear site. The real difficulty, says EDF, will be to find 40 per cent of its nuclear engineers in the Midi-Pyrénées.

Michel Rapin of CEA says the nuclear programme is stronger under Mitterrand

The latest twist in the tail is literally there — at the tail end of the nuclear fuel cycle. Waste disposal has been neglected in France (although the Marcoule process for the vitrification of highly active waste has been adopted by Britain). Edmond Hervé, minister for energy, has asked the CEA to provide, within a few weeks, an outline plan for the management of nuclear wastes. No such plan exists at present, it seems. Within 18 months, two or three disposal sites must be selected, promising a new political problem for nuclear power.

Some in the nuclear establishment, however, are quite sanguine about the developments. Michel Rapin, director for nuclear applications at the commissariat, believes the new political approach will actually strengthen the nuclear programme, by providing a degree of democratic assessment. Once there has been a vote, who can disagree? All very well, while the votes are "yes". . . □

Trebling renewable energy by 1990

ONE of the most surprising but rational moves made by the Mitterrand government in the energy field has been its appointment of Michel Rolant, a union activist in his late 40s, as the head of a completely revamped organization to promote renewable energies in France.

Rolant was an agricultural worker who took a strong interest in labour relations, and early on became general secretary of the federation of agricultural workers, a branch of the liberal union, CFDT. But his attention shifted to industry and employment, and he established a reputation, among the pro-nuclear lobby, of being totally anti-nuclear. Certainly, as CFDT's number two, Rolant moulded the union to form effectively the only organized opposition to the nuclear establishment — a position which it will retain despite Rolant's departure.

Electricité de France is turning a rather jaundiced eye on Rolant's appointment — the cosy club of grandes écoles men at the top of the ministries and the great industries is being jostled these days by one or two workers with some peculiar ideas — but for the government the move is really a master-stroke (and, by the way, one long advocated by CFDT). For, from the nuclear point of view, one of the principal irritants has been mollified: he is now part of the government club and must be expected to obey the rules. And from the alternative energy point of view, here is a man who is a passionate and serious advocate of such forms of energy who must now turn his dreams into reality. If they work, well, that means more energy for France.

In fact the government's energy plans for the next decade are extraordinarily ambitious both in respect of their nuclear component and their renewables (see table). The energy supply from renewables — such as solar power and biomass — is expected at least to treble by 1990 compared with 1981, and M. Rolant will be presiding over that growth. Rolant will have available to him COMES, the commission for solar energy, and the AEE, the agency for energy saving, which will be formed into a new organization whose exact definition and scale have yet to be determined. The CFDT recommends a balanced regional and central organization, with 22 regional branches each with perhaps 50–100 staff, and a 600–700 strong national body. (By comparison, COMES and AEE presently have about 500 staff mostly in Paris). The new body should also be capable of doing research on its own behalf, together with the major research organizations.

Moreover if capital loans could be arranged on the kind of terms on which they are offered to Third World nuclear purchasers — terms such as 8 per cent interest to begin five years after completion of a reactor as were offered to Korea, for example — then wonders could be worked, say the enthusiasts.

In fact COMES announced an objective at the end of last year: to treble the funds devoted to solar energy between 1981 and 1985. The most promising areas for development were the production of petrol and methane from biomass, particularly wood waste of which France has a particularly good supply. But Rolant will want to see all alternatives, including energy saving, in perspective, and perhaps COMES's priorities will not be his. The government is certainly committed in principle to a trebling of funds for renewable energy projects, although the allocation of the cash will not be known until mid-1982.

No doubt Rolant will have considerable influence on this, and perhaps his agricultural background will influence him (his colleagues at CFDT deny it); but it has been clear for some time that in renewables France is concentrating on the conversion of biomass. Of the 10–14 million tonnes of oil equivalent expected from renewables in 1990, half will come directly from the use of wood, and a further 2 million tonnes of oil equivalent from wastes. Surprisingly, however, of FF 35.2 million (£3.5million) research ministry funds available for renewables research in 1981, only FF 0.2 million (£20,000) went to support biomass research. The largest sum (around half) went to coal. COMES spent FF 50 million (£5 million) on biomass development in 1981, but only a small fraction of that went on basic research. This may change.

Consumption of primary energy: evolution and objectives*

	1970	1974	1980	1981	Plan 1990
Coal	38.1	31.6	34.0	33.5	35–40
Petrol	87.5	113.2	102.1	93.0	70–75
Gas	9.3	16.0	23.6	24.6	31–40
Hydroelectrics	12.4	12.5	16.0	15.0	14–15
New energies	2.0	2.1	3.2	3.4	10–14
Nuclear	1.2	3.1	12.9	19.5	60–66
Total	150.5	178.5	191.8	189	232
Proportion from indigenous sources (%)	65.6	75.0	71.0	68.0	45–50

*Values are in million tonnes of oil equivalent

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