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The Technological Demands of Nuclear Power

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In the summer of 1977, a young New Yorker scaled the entire 110-storey vertical exterior of the world Trade Centre. His exploit confirms that human beings have never refused to do anything merely on the basis that it is too risky. Nothing is too difficult if it is thought to be worth doing. However, what an individual considers worth doing may not be what the whole society would consider worth doing. As members of the community we do not - or should not - pursue a course of action simply 'because it is there'. We have to decide what is worth doing by comparison with other courses of action.

When we consider the 'The Technological Demands of Nuclear Power' we must do so not 'because it is there' but to fulfill some agreed objective.

Let us at the outset discard as spurious the belief that nuclear technology is inherently arcane, requiring understanding vouchsafed to only a handful of initiates. It is long since clear that nothing about nuclear technology is in itself more esoteric than, say, computers or colour television. The nuclear mystique arose rather from the secrecy which shrouded the weapons programmes, and was carried over from them into the civil programmes.

The development of civil nuclear technology within the weapons programme was prompted at least in part by the desire to demonstrate that nuclear discoveries would ultimately benefit - not threaten - humanity. As an objective, this implied a powerful emotional commitment to nuclear technology, a commitment which still persists. Under such a stimulus, civil nuclear development was pursued for its own sake, and the pursuit was premature, both in time and scale. In Britain the initial civil nuclear policy proposals of the mid-1950s received only limited discussion, on the basis of even more limited information, largely provided by the interested parties. It was accepted then that the nature of nuclear technology required highly specialised expertise for its evaluation. The same pattern of nuclear decision-making behind the scenes has prevailed ever since. Only in the past two years has it begun to alter, with consequences as yet unclear.

The original decision to establish civil nuclear techology in Britain was taken by the government, which provided all the necessary support, financial and otherwise, to meet the 'technological demands'. The transition from military to civil was gradual, via the Calder Hall and Chapelcross stations, built to produce weapons plutonium, generating electricity as a by-product. The civil Magnox stations, in their early years, were likewise credited with the plutonium they produced, although it had no civil application at the time. The government also provided all the necessary back-up, technical and financial research and development, fuel cycle services, insurance, regulation, and safeguards. As a result, the technological demands of nuclear power were tackled in a context of economic unreality. Without the nuclear weapons programme, and if normal commercial criteria had been applied, it is doubtful if a civil nuclear industry would ever have arisen. It seems profoundly improbable that private finance and industry would have been willing to undertake the necessary commitments to launch a nuclear programme. Only a government could have pressed on along the nuclear route when there were easier avenues to similar goals. Nevertheless, despite delays, cost over-runs, technical lapses, and commercial disappointments, and although some unfortunates fell by the wayside, nuclear optimism remained unshaken, for more than two decades, sailing blithely above the trammels of everyday economics.

It is ironic that most of the recent public reaction against nuclear technology has likewise ignored the usual economic ground-rules. Public concern about nuclear hazards has tended to couch itself in absolutes: insistence on absolute safety of plant, absolute assurances against environmental degradation by radioactivity, absolute guarantees of eternal isolation of high level wastes. This reaction is doubly ironic since it is undeniably true that nuclear planners in Britain have always been acutely conscious of the potential hazards involved. The evidence on public record supports the view that exemplary foresight has always been exercised by nuclear designers and engineers in Britain. The availability of unstinting government support made it possible to take a 'belt and braces' approach wherever designers thought it necessary. Nuclear technology now in place in Britain may well be massively overdesigned, with working margins unnecessarily generous. From the standpoint of safety, such scruples are obviously welcome. They do, however, complicate matters when the economics of the real world begin to intrude. Any attempt to reduce tolerances and eliminate margins now deemed superfluous is bound to evoke qualms in some places.

It is the view of Friends of the Farth that there is only one hazard of nuclear technology which is qualitatively different from hazards arising in other industries, and that is that no absolute barrier can ever be erected to separate civil nuclear activities from their military counterpart. In the words of the Fox Commission, 'The nuclear power industry is unintentionally contributing to an increased risk of nuclear war. This is the most serious hazard associated with the industry' It is a hazard for which no technical solution exists. A determination to pursue other technical objectives in the civil nuclear field may bring this hazard to its catastrophic culmination - within our lifetimes.

The other hazards presented by civil nuclear activities, while often distinctive, are not in essence different in kind from hazards posed by other forms of industrial activity; but this does not dispose either of nuclear hazards or of others. The summary of this session refers to 'problems . . . encountered and satisfactorily solved elsewhere'; but there is an alarmingly wide spectrum of present environmental problems which few would consider 'satisfactorily solved', non-nuclear and nuclear alike. If there were a direction patently free of problems, gatherings like this would be unnecessary.

The attribute unique to the nuclear industry is, of course, the radiation and the quantity of radioactivity produced by the fission process. The biological effects of radiation have been intensively studied for decades; it is probably true to say that much more is known about the consequences of exposure to radiation than about most other environmental hazards. It does not, however, follow that we know all there is to know about radiation hazards. On the contrary, much of the information we would like to have may be inherently unattainable. For some pathological effects, the latency period may be more than twenty years; such effects may be impossible to identify, either individually or statistically. Genetic consequences of low-level exposure of large populations may likewise be impossible to identify. Certainly if they are identified it will be much too late to rectify them. It is true that other environmental hazards may have similar effects; indeed it is possible that such hazards may interact synergistically with radiation exposure. To suggest that other environmental insults are not blameless is not to exculpate radiation, merely to compound the problem.

In the nuclear industry as in others, routine procedures once in a while go awry. The radioactive inventory of an operating power-reactor, reprocessing plant, or waste facility could cause death and injury, immediate and delayed, over a considerable area if it were to escape. It is thereore necessary to be assured that such escape will not occur. This is the category of hazard which has caused most controversy, with bitter disagreement about the probability and consequences of a major nuclear accident.

The most serious nuclear accident which has occurred in Britain was the fire which destroyed the Windscale Number One plutonium production reactor twenty years ago this week. It was of course not a civil facility. Neither, strictly speaking, is the Chapelcross nuclear station in Scotland, one of whose reactors experienced an expensive and messy fuel channel meltdown in 1967. Even the 1973 ruthenium blow-back in Building B204 at Windscale took place in a converted weapons-programme plant. The civil nuclear programme in Britain, however, has a site safety record which many other industries should envy.

But, as an industry, it is still young; it will only attain its calendar majority next week, on 17 October, the twenty-first anniversary of the Queen's formal opening of Calder Hall in 1956. The body of experience thus far acquired, both here and abroad, is a limited data base on which to prognosticate future performance. Designs have changed too fast to permit much extrapolation from one to another; and the increase in scale of nuclear facilities has been breath-takingly swift. The generation of gigawatt-plus reactors now being commissioned internationally has recorded as yet only a few reactor-years of operation, by no means all of it reassuring.

The British programme has thus far been less headlong than most; scales and power densities have increased only comparatively gradually, with the exception of the leap from Oldbury to Wylfa, which led to five years of headaches. The debacle of the Advanced Gas-cooled Reactors has been a sobering lesson for more recent policy. Accordingly, Friends of the Earth have always been less concerned about the safety of British thermal reactor designs than about light-water reactors. Again, however, it is necessary to add a proviso. The evaluation of the safety of British designs has always been carried out behind closed doors, in secret discussions between the builders, the customers and the Nuclear Installations Inspectorate. It would be easier to be reassured about the soundness of safety analyses if they were made public.

This past summer we have had the opportunity, unparalleled in Britain, of the Windscale inquiry, offering for the first time a detailed insight into the way the British nuclear industry approaches technical and economic issues. It has been a fascinating and illuminating experience. To Friends of the Earth the most striking aspect of the inquiry has been the asymmetry of the evaluations applied by British Nuclear Fuels Ltd, depending on whether they do or do not wish to do something. If they wish to do it, they exude confidence that all the technological demands can be fulfilled. They wave aside any inferences from the past unimpressive record. On the other hand, if they do not wish to do something, in their view it presents almost insuperable technical obstacles. Similar asymmetries have arisen concerning comparative economics, political implications, indeed virtually at every stage of the inquiry. It is conceivable that BNFL, Japan, and the British electricity supply industry might all be able to fulfill the purely technological demands of oxide fuel reprocessing; however, it remains far from clear why they should want to.

We know now that we face yet another inquiry, into the future of the fast breeder reactor. In safety, as in other aspects, the fast breeder reactor is a different kettle of sodium. Again it is not easy to assess the present status of FBR safety analysis in Britain; too much takes place out of public view. But analyses and correspondence made public in the US indicate that there remains a stubborn expert disagreement about the severity of possible accidents in an FBR. Such hazards are not the primary cause of Friends of the Earth's opposition to the fast breeder reactor; its plutonium-based fuel cycle is, in our view, a more fundamental and intractable problem. I

It is now regularly said that we should proceed forthwith to the construction of a full-scale reactor demonstration plant, in the attempt to resolve these uncertainties. However, at this point, the discussion of 'technological demand' purely in terms of 'risk' becomes inadequate. It is necessary to step back and survey the broader context. It should not be assumed that we need to resolve the issue of fast reactor safety simply 'because it is there'. We have to ask whether this is really a problem worth solving.

Indeed, we have to ask whether all the problems of technological risk and hazard arising in civil nuclear technology are worth solving. If we were to solve them one and all, to the universal 'satisfaction' of the populace, what would we have accomplished? What goal would we have attained? Would this goal universally satisfy?

It is becoming evident that the technology of energy use and supply exercise a profound influence on a social system. In June of this year, I published a study of the nature of a society in which nuclear grid electricity is the major form of energy supply. *The Fissile Society* (Earth Resources Research/FoE 1977) began to take shape in my mind in 1974, while I was still completing the writing of my earlier Penguin book on nuclear power. But it continued to elude my grasp. I had assumed that I was attempting to delineate developments still to come, if Britain moved in the direction of progressively greater reliance on nuclear electricity. However, it gradually came to me that all the material I had assembled was *historical:* describing not what might happen in the future, but what had already happened. I was studying, not some debatable hypothesis, but actual developments already underway.

One of the most immediate 'technological demands of nuclear power' is that it can be conveniently used only to generate electricity in very large baseload stations for distribution by a grid. Increasing reliance on nuclear power therefore implies increasing reliance on grid electricity; the 'technological demands' of nuclear power thus encompass the technical demands of grid electricity supply.

Electricity is not a fuel - it cannot be stored. An electricity system is a means of delivering to customers the energy from other sources - falling water, coal, oil, uranium, and so on. An electricity system is a natural monoply like water supply or main drainage. Electricity suppliers and customers now expect a guaranteed supply of electricity at power points and switches at all times. Since the amount of electricity being used must match instantaneously the amount being generated, the system must be able to vary its output continuously throughout the day and throughout the year - a criterion to which nuclear generation is ill-adapted. To meet the brief annual peak of demand at a cold dinnertime in January with some capacity out of service, the system must have generating capacity which will lie idle much of the rest of the year, plus additional redundancy throughout the system. Electricity suppliers have always accepted this costly aspect of their operation, a direct result of the inability to store electricity; it is in passing curious that they should lay so much stress on the storage problems arising from postulated interruptions of solar, wind, or wave energy.

The trend in electricity supply has been toward increasing centralisation coupled with pursuit of 'economies of scale' .The result has been more monolithic inflexibility, beginning with the planning process and extending throughout the development and operation of the system. Because grid electricity is a monopoly providing an essential commodity, it escapes the ultimate sanction of bankruptcy, however disastrous its planning. Nevertheless, faulty decisions in an inflexible system are stubbornly difficult to rectify; their effects may persist for decades.

The sorry record of electricity demand forecasting for the past two decades underlines an important corollary: policy influences forecasts, has long done so and - if present plans are fulfilled - will in the future do so definitively. It now takes ten years to plan, construct and commission a new base-load station of the size considered 'economic' .Even the Electricity Council would probably admit that forecasts of demand more than six years hence are not much better than guesses. It is thus necessary to order a station four years or more before anyone can be sure it will be required. Planning becomes not an act of foresight but an act of faith.

The side-effects are also hard on the construction and engineering suppliers for the system. Low growth and large increments are difficult to reconcile - as we are presently witnessing in the battle over Drax B. However, if the electricity system embarks on a programme of regular, time-tabled orders for new base-load plant, to keep power station builders busy, the technology will thenceforth reproduce itself by its own rules.

The civil nuclear establishment is used to such a state of affairs. Nuclear policy has always been made by government edict, with only the most tangential reference to prevailing economic criteria. The one major exception to this dictum occurred in 1973-74, when the Central Electricity Generating Board suddenly decided to order, in the ensuing decade, some 41 gigawatts of American-designed light-water nuclear reactor stations. The government, to its credit, said 'No' It is remarkable how rapidly that episode has since submerged. As an aberration of planning it would have dramatically outdone any previously committed. Imagine the state the electricity industry, and the country, would now be in if such a commitment had been undertaken.

Yet the UK Atomic Energy Authority continues to put forward programmes for future nuclear electric generating capacity, which they are almost forthwith compelled to disown as an embrarrassment. The basis of such projections seems to be the technological demand of keeping the nuclear industry busy. The next time such a projection is presented, it might be a salutary exercise to insist that it be accompanied by a financial statement of the investment implication and related matters. The industry is fond of adducing back-of-the-envelope numbers. Perhaps one of these days we will be given a detailed breakdown of nuclear industry costings - with, for the first time, the accounting basis fully explained. Until such explicit discussion is available, it would be advisable to treat allusions to 'cheap nuclear electricity', past as well as future, as propaganda, not as fact.

In any case, the time-scale implicit in the philosophy underlying current electronuclear technology is such that financial analysis is likely to become a matter of purely historical interest. Forward commitments will be too inflexible to permit feedback to adjust for changing financial circumstances. Policy will lead to plans; plans will be executed and paid for; and the money will come from electricity users and taxpayers, whether they like it or not. Tariffs are set unilaterally, with the sanction of unilateral disconnection for failure to pay - and the grid electricity system is technically all too well suited to the use of such sanction, with unceremonious abruptness and finality. The nature and scale of the enterprise also means that the electricity system can get ready access to capital in staggering amounts, with firm governmerit backing - from the taxpayer. The taxpayer has no such amenable source of capital for his own energy-related endeavours, but has little say in the support he gives the electricity system. If, in due course, this support places too severe a burden on the rest of the economy, it will be too late to rectify the position. Collapse of the grid electricity system would by that time translate into collapse of the entire economy.

However, long before such a denouement, the effects of the dislocation would be felt, especially as regards employment. A great deal of nonsense has lately been expressed about the relationship between jobs and electricity supply. Let there be no misunderstanding. The technology of large-scale grid electricity supply, especially nuclear power, does not demand people. On the contrary, it replaces people.

The electricity supply industry is the most capital intensive industry in Britain, and growing more so. Its employment structure has been undergoing a striking shift, from long-term jobs operating power stations to short-term jobs building them. The 'technological demands' of a gigawatt-plus generating station, especially a nuclear station, imply building it on a remote site, and importing workers for jobs which may last five years or less - compared to the 25 years of an operating job. Such projects are often touted as beneficial to local economies. The benefits, such as they are, are likely to be both disruptive and short-lived; and the after-effects now regularly include a worsening of local unemployment.

It is also claimed that nuclear electricity will be needed to 'provide jobs' in other industries. The evidence directly contradicts such a claim. At a time of capital shortage the diversion of capital to the electricity system may starve other sectors of industry. Furthermore, grid electricity, far from adding places for shop-floor workers, is likely to supplant them. Other ways of providing industrial energy, such as on-site cogeneration of electricity and process heat, would create far more jobs, both on the site and in the plant construction industry.

The inflexibility of electronuclear technology means that management can much more readily adjust the job structure than the capital structure of the industry. The constraint with which they must reckon is that of the trade unions. But the union leadership is centralised and remote from its shop-floor members, making control of shop-floor discipline difficult. In an industrial dispute the high 'productivity' of electricity supply workers can be matched by an equivalent high 'unproductivity'; a few dissatisfied workers may be able to cause a sudden and widespread interruption of the entire grid supply. The nature of the technology - the impossibility of storing electricity and the need to maintain continuous guaranteed supply - thus comes up against a fundamental vulnerability which might in due course present a desperately unpleasant problem in industrial relations, expecially if the country were to become dependent on grid electricity for most of its energy supply.

'Security of supply' has become a key ojective of energy planners, in response to the cut-off and price increases imposed by OPEC. But it must be remembered that 'security of supply' of electricity is a much more immediate requirement. The consequences of interruption are severe, as New Yorkers had occasion to realise this past summer. If our dependence on the grid is to be extended, interruption of supply - by mishap, misjudgement or malevolence - could be devastating. The risks involved are genuine, serious, and already documented by experience; and they are risks that would be aggravated by overcoming the technical risks of nuclear power.

Central authority, faced with the responsibility to forestall such eventualities, will have to take a variety of measure affecting planning, finance and employment, to minimise the risks. These measures will be difficult and expensive, and probably unpopular - and they may not work. If, as many still advocate, we move yet a step further and incorporate not only thermal but also fast reactors into the supply, and establish a national and international traffic in plutonium by the tonne, the problems become yet graver.

Electronuclear advocates may be correct. It may be possible to move toward an energy supply predominantly generated by base-load nuclear stations and delivered as grid electricity. It may be possible to do so without exposing the population to insidious injury from radioactivity in the environment, or to the consequences of disastrous nuclear accidents. But is it worth attempting? The technological demands of nuclear power make the electronuclear route a perversely difficult, expensive and potentially dangerous way to reach a destination we may deeply regret reaching - and there may be no way back.