FROM NPT TO INFCE: DEVELOPMENTS IN THINKING ABOUT NUCLEAR NON-PROLIFERATION

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FOR those concerned with the non-proliferation of nuclear weapons, 1980 was a busy year. February saw the final plenary conference of the International Nuclear Fuel Cycle Evaluation (INFCE); July and August saw the meeting of the UN Committee on Disarmament; August and September saw the second review conference of the Nuclear Non-Proliferation Treaty (NPT), and scheduled for later in September were the annual General Conference of the International Atomic Energy Agency (IAEA) and the first meeting of the IAEA's new Committee on Assurance of Supply. Throughout all these meetings there continued the tripartite negotiations on a Comprehensive Test-Ban Treaty.

The failure of those final negotiations to make further progress as 1980 drew to a close, coupled with the failure of the Carter administration to secure the ratification of the SALT II treaty and the debate about the NATO theatre nuclear force modernisation programme were symptoms of a switch in the emphasis of nuclear politics from the horizontal back to the vertical dimension. This eclipse of non-proliferation policy by the problems of controlling the super-power arms race was endorsed by the attitudes of the incoming Reagan administration. Then, in June 1981, non-proliferation returned to the centre of the stage with the Israeli attack on Iraq's nuclear complex outside Baghdad.

Evaluating these developments is likely to be a protracted business to which this article seeks to contribute by focusing on INFCE. We begin by reviewing briefly the history of the NPT, then outlining the context in which INFCE arose, examining several of the major conclusions with an eye to the political differences which underlie some of them, and hence reaching some conclusions both about INFCE and the question of how far international thinking about non-proliferation had developed between the negotiations which led to the NPT in 1968 and the events of 1980-81.

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The NPT

After the initial unsuccessful attempts by the United States to control the spread of nuclear weapons by maintaining absolute secrecy over nuclear technology, there followed a reversal of policy in the form of the 'Atoms for Peace' programme outlined by President Eisenhower in 1953. The new approach emphasised controlled dissemination of civil nuclear technology: civil nuclear power and other peaceful uses of nuclear energy were to be promoted (from 1957 by the IAEA), but under safeguards (that is, legal undertakings about the use of plant and materials and the conditions under which such use might be inspected or otherwise verified by the supplier or, later, by the IAEA).

In the 1960s, as the day approached when nuclear technology would be widespread around the globe, interest grew in various countries in the problem of curbing nuclear weapons proliferation. The prospect of several NATO countries having access to nuclear weapons, not of their own manufacture, was also opened by plans for a NATO multilateral force. One outcome at this time, though one which owed more to fears of radio-active contamination of the atmosphere than to non-proliferation *per se*, was the Partial Test-Ban Treaty of 1963.

The momentum behind what became the 1968 NPT dates from about 1961.[1] Both super-powers began to look favourably at proposals for a treaty as they began to appreciate the problems of managing international relations in a world of multiple nuclear weapons powers, and as they realised also the advantages of a treaty in dealing with requests from allies for assistance with weapon programmes. In addition, the Soviet Union was particularly concerned about the prospect of West Germany, in or out of a multilateral force, having access to nuclear weapons. It perhaps also saw propaganda gains in that acceptance of a treaty by the United States might increase tensions within NATO, though by the same token the Soviet Union might incur disfavour in, for example, Egypt, India, and Cuba.[2]

The terms of the NPT are well known.[3] They involve a bargain between the nuclear weapons states (NWS) and the non-nuclear weapons states (NNWS) in which the latter gave up the right to seek to acquire nuclear weapons and undertook to accept IAEA safeguards on their peaceful nuclear activities in

1. Elizabeth Young, *A Farewell to Arms Control?* (Harmondsworth: Penguin, 1972), p. 84.

2. George H. Quester, *The Politics of Nuclear Proliferation,* (Baltimore, London: Johns Hopkins University Press, 1973), especially chs. 2 and 3.

For further commentary on the circumstances in which the NPT was negotiated, see: John Simpson and Peter Anderson, 'Developed States and Article VI of the NPT', paper presented to the BISA Arms Control Study Group Seminar on the 1980 NPT Review Conference, Chatham House, London, Sept. 21, 1979; Leonard Beaton, *Must the Bomb Spread?*) (Harmondsworth: Penguin, 1966); William Epstein, *The Last Chance: Nuclear Proliferation and Arms Control* (New York: Free Press 1976); Alva Myrdal, *The Game of Disarmament: How The United States and Russia Run the Arms Race* (Manchester: Manchester University Press, 1977); Georges Fischer, *The Non-Proliferation of Nuclear Weapons* (London: Europa, 1971).

3. For commentaries on the text of the NPT, see Young, *op. cit.;* Epstein, *op. cit.;* Fischer, *op. cit.;* and Mason Willrich, *Non-Proliferation Treaty: Framework for Nuclear Arms Control* (Charlottesville, Va: Michie, 1969).

return for undertakings by the nuclear weapons powers that they would not provide nuclear weapons-related aid to NNWS, that they would provide peaceful nuclear technology (under safeguards), and that they would engage in a serious effort to curb the nuclear arms race. The treaty came into effect in 1970, and had 115 signatories in June 1981.

A number of difficulties attended the treaty from the outset.[4] First, two nuclear weapons powers, France and China, refused to sign, as also did a number of countries presumed to be interested in nuclear weapons. These included India, Pakistan, Israel, Egypt, Brazil, Argentina, and South Africa. The principal reason given for not signing was that the NPT did not deal adequately with the arms race between the superpowers. A second difficulty was that the treaty discriminated politically and commercially against non-nuclear weapons powers—politically, because of the implied legitimation of the division between nuclear weapon 'haves' and 'have-nots', and commercially, because of the cost and inconvenience of safeguards and the risk of loss of commercial secrets by those non-nuclear weapons powers which were also civil nuclear suppliers. These political and commercial prices were thought by signatories to be worth paying provided that peaceful nuclear technology became available, and provided also that the nuclear weapons powers took seriously their commitment towards nuclear arms control. That judgment began in time to be tempered, however, by the realisation that signatory non-nuclear weapons powers appeared to be incurring disadvantages in the conditions of nuclear trade as compared with non-signatories.

1974–1977

For all its faults, the NPT was the major instrument of global non-proliferation policy from 1970, supplemented in their respective regions by the Treaty of Tlatelolco and the Euratom Treaty. But with the Indian nuclear explosion in 1974, followed in 1975 by the sale by the Federal Republic of Germany of reactors, enrichment and reprocessing technology to Brazil, and the proposed sales of reprocessing plant by France to Pakistan and South Korea, considerable fears were aroused that a new wave of proliferation might be breaking.

Reactions to this concern took various forms. One was the formation in 1975 of the Nuclear Suppliers Group (NSG) (or London Club), designed to restrain the commercial rivalry of the nuclear suppliers where this might lead to the export of sensitive parts of the nuclear fuel cycle. The group agreed on a 'trigger' list of sensitive items and on guidelines to govern trade therein. An advantage of this approach was that it circumvented two of the difficulties with the NPT (the non-signature of France, which did join the NSG; and the appearance that signatory NNWS incurred disadvantages in nuclear trade as

4. Sources for this paragraph include those given in note 2, together with: John Maddox, *Prospects for Nuclear Proliferation* (London: IISS, Adelphi Papers No. 113, 1975); and Ryukichi Imai and Robert Press, *Nuclear Non-Proliferation: Failures and Prospects* (New York, London: Rockefeller Foundation and the RIIA, Working Paper of the International Consultative Group on Nuclear Energy, 1980).

compared with non-signatory NNWS). A major disadvantage, however, was that it was seen by the customer nations as an unfair cartel and, in the case of customers who were parties to the NPT, as an unreasonable addition to the constraints already imposed by that treaty.[5]

A second reaction was a flurry of activity in academic quarters, think-tanks, the nuclear industry and semi-independent governmental bodies on such questions as intrinsically proliferation-resistant fuel cycles (especially the possible use of the thorium-uranium 233 cycle), improvements in safeguards, international plutonium storage, regional fuel cycle centres, and more general problems of nuclear diplomacy.[6]

A third response was unilateral action by the United States.[7] First, in 1974 the United States imposed a temporary moratorium on new contracts for enriched uranium, followed later by offering some foreign customers new 'conditional' contracts. Second, non-proliferation was made a feature of the 1976 presidential election by the Democratic candidate, Mr Jimmy Carter. His opponent, President Ford, announced towards the end of the campaign that the United States government would henceforth not regard reprocessing and plutonium recycle as necessary and inevitable parts of the fuel cycle, and that the commercialisation of such activities in the United States would be deferred until the government was satisfied that the proliferation hazards attendant upon the 'plutonium economy' could be dealt with. Thus not only was the supply of enriched uranium from the United States called into question, but Washington's approval for reprocessing by other countries of spent fuel of American origin was also held up. After the election, Mr Carter underscored this position by calling for indefinite deferral of commercial reprocessing and plutonium recycle, and a slowdown and redirection of breeder development away from the plutonium-fuelled cycle. Appropriate action was taken on an American reprocessing plant and breeder reactor project. Even though Mr Carter also announced that the United States would again fulfil its role as a reliable supplier of nuclear fuel, the effect of this sequence of events

5. See, for instance, Steven J. Baker, 'Monopoly or Cartel', *Foreign Policy,* Summer 1976, pp. 155–201.

6. For example, and in no particular order:
Royal Commission on Environmental Pollution, 6th Report, Nuclear Power and the Environment (London: HMSO, 1976), Cmnd. 6618, chs 4 and 7; *Ranger Uranium Environmental Inquiry (First Report)* (Canberra. Australian Government Publishing Service, 1976); Ford Foundation, *Nuclear Power Issues and Choices* (Cambridge, Mass.: Ballinger, 1977); The United States Atlantic Council's Nuclear Fuels Policy Working Group, *Nuclear Power and Nuclear Weapons Proliferation* (Boulder, Col.: Westview, 1978); Uranium Institute, *Government Influence on International Trade in Uranium* (London: Uranium Institute, 1978); Electric Power Research Institute, *Technology of Nuclear Fuel Cycles Pertinent to Material Division* (Palo Alto, Ca; Electric Power Research Institute, 1979); Albert Wohlstetter *et al.,* 'The Military Potential of Civilian Nuclear Energy: Moving Towards Life in a Nuclear Armed Crowd?', *Minerva, XV* (1977), pp. 387–538 (an abridged and revised version of a monograph prepared by Pan Heuristics, Los Angeles, California, 1975); Ted Greenwood, Harold A. Feiveson and Theodore B. Taylor, *Nuclear Proliferation: Motivations, Capabilities and Strategies for Control,* Council on Foreign Relations 1980's Project (New York: McGraw Hill, 1977); *Report of the International Consultative Group on Nuclear Energy* (New York, London: Rockefeller Foundation and the RIIA, 1980); and George H. Quester, 'Nuclear Proliferation: Linkages and Solutions', Review Article in *International Organisation,* Vol. 33, No. 4, 1979, pp. 541–66.

7. This paragraph is largely based on Bertrand Goldschmidt and Myron B. Kratzer, *Peaceful Nuclear Relations: A Study of the Creation and the Erosion of Confidence* (New York, London: Rockefeller Foundation and the RIIA Working Paper of the International Consultative Group on Nuclear Energy, 1978).

was to generate world-wide concern about the reliability of the United States as the world's major supplier of enriched uranium and—in those countries which had made serious plans to introduce breeders—about the long-term consequences of America's actions for their energy policies. This concern was compounded later in April 1977 with the President's submission to Congress of his proposed Nuclear Non-Proliferation Act which, as enacted in 1978, required recipients of American nuclear fuel to give further non-proliferation undertakings in the form of full-scope safeguards (that is, the placing of *all* their civil nuclear activity, not merely the activity for which the fuel was required, under IAEA safeguards).[8]

INFCE: origins and immediate outcome

It was in this context that Mr Carter proposed in late April 1977, and then in May at the London Summit, that there be set up an International Nuclear Fuel Cycle Evaluation Programme to re-evaluate all aspects of the nuclear fuel cycle, with emphasis on alternatives to an economy based on the separation of pure plutonium and the presence of highly enriched uranium, on methods to deal with spent fuel storage, and on methods to improve the safeguards for existing technologies. An organising conference was held in Washington in October 1977 at which forty countries and four international organisations were represented. America's motives and intentions were under considerable scrutiny since, by now, the United States had called for an international moratorium on reprocessing and the fast reactor until the results of the evaluation were known; while at the same time the Non-Proliferation Act before Congress, American pressure on West Germany and France to break their agreements with Brazil and Pakistan, and further efforts to renegotiate existing bilateral supply agreements, all suggested that the United States was prepared to pre-judge the results.[9]

Nevertheless, the evaluation went ahead. It was agreed at the organising conference that the word 'programme' be dropped from the title of what now became 'INFCE', that INFCE was to be a technical and analytical study and not a negotiation, and that its results would not be binding on the participants. It was also agreed that all interested states and relevant international bodies might participate, and that the evaluation would be carried out in 'a spirit of objectivity, with mutual respect for each country's choices and decisions in this field'.[10]

The evaluation was based on three premises.[11] First, that the participants

8. On the Nuclear Non-Proliferation Act (1978), see Warren H. Donnelly, 'Application of US Non-proliferation Legislation for Technical Aspects of Fissionable Materials in Non-military Applications', in Stockholm International Peace Research Institute, *Nuclear Energy and Nuclear Weapon Proliferation* (London: Taylor and Francis, 1979).

9. The origins and early work of INFCE are analysed in Steven J. Warnecke, 'Non-proliferation and INFCE: an Interim Assessment', *Survival*, XXI: 3, 1979, pp. 116-24.

10. *Final Communique of the Organising Conference of the International Nuclear Fuel Cycle Evaluation* (Washington, Oct. 21, 1977).

11. International Nuclear Fuel Cycle Evaluation, *INFCE Summary Volume* Vienna: IAEA, 1980), p. 1.

'were conscious of the urgent need to meet the world's energy requirements and that nuclear energy for peaceful purposes should be made widely available to that end'. I will not discuss this premise further here, except to note that since participants in INFCE were invariably supporters of nuclear power, the debate within INFCE was limited in terms of the range of possible views on the subject.

The second premise was that the participants

> were convinced that effective measures can and should be taken at the national level and through international agreements to minimize the danger of proliferation of nuclear weapons without jeopardizing energy supplies or the development of nuclear energy for peaceful purposes.

Since the main focus of this article is on non-proliferation, those aspects of INFCE's work which derived from this premise are considered below.

The final premise was that participants recognised that 'special consideration should be given to the specific needs of and conditions in developing countries'. Detailed discussion of the outcomes of this premise would be inappropriate here, but we may note that representatives of several less developed countries expressed dissatisfaction with, as they considered, the lack of attention given to this aspect of the evaluation.[12] It is not clear, on reading the INFCE reports, that this criticism is fair; at the very least, one may say that frequent reference to the conditions in and problems of developing countries may be found in the reports.

The work of INFCE was organised through eight working groups, each co-chaired by two or three countries from a total of twenty-two, and each dealing with a particular aspect of the fuel cycle. The activity of the working groups was co-ordinated by a Technical Co-ordinating Committee (TCC), which met nine times. The eight working groups held 61 meetings on 174 days, in which a total of 519 experts, representing forty-six countries and five international organisations, participated and produced more than 20,000 pages of documents. A first plenary conference was held in Vienna on November 27-29, 1978 and the final plenary conference, also held in Vienna, took place on February 25-28, 1980. Fifty-nine states and six international organisations took part in the final conference, and indeed sixty-six states participated overall in the study in one way or another. They included developed and developing countries, countries with various scales of nuclear energy programmes, countries from East and West, suppliers and consumers of materials, technology and equipment, nuclear weapons states and non-nuclear weapons states. The reports of the working groups and the TCC were published in March 1980.[13]

12. See, for instance, the speeches at the Final Plenary Conference of INFCE, held in Vienna on Feb. 25-28, 1980, of the heads of the delegations from Yugoslavia, Brazil, India, and Argentina.

13. Details in this paragraph are from *INFCE Summary Volume, loc. cit.*, pp. 2-3. The working groups (each of which published a report) were on:

1. Fuel and Heavy Water Availability; 2. Enrichment Availability; 3. Assurances of Long-Term Supply of

In terms of immediate outcome, therefore, the two-and-a-half year lifetime of INFCE represents a unique and unusually harmonious international effort. The reports constitute an authoritative review of the state of knowledge of the nuclear fuel cycle, and will be a valuable resource for students of energy policy, nuclear technology and non-proliferation. Delegates at the final plenary conference spoke warmly of how participation in INFCE had led to enhanced understanding of each other's positions. The involvement of many states not parties to the NPT (Argentina, Brazil, India, Israel, Pakistan, South Africa), and the sucess of INFCE in bringing some of these to the point where they are willing to discuss the proliferation implications of nuclear power, has been an important gain. Finally, the tense relations between the United States and most other countries were considerably relaxed, and the climate in which INFCE concluded restored hope that a workable non-proliferation regime, consistent with each nation's energy policy, could be established. The head of the British delegation to the final plenary conference, Sir Hermann Bondi, offered the following judgment on the exercise:

> INFCE has been a great success. . . . We have produced eight agreed reports, and an agreed summary, with no minority reports. That is an achievement which not all of us would have thought possible two years ago. It is a considerable achievement that so many countries with varying interests in the nuclear fuel cycle—suppliers and customers, industrialised and developing countries—have been able to sit down together to produce this result.[14]

Nothing in what follows should be taken as decrying this achievement.

The politics of a technical evaluation

Nevertheless, and despite the high degree of consensus that was undoubtedly achieved, it is clear from the speeches of the delegates at the final plenary conference, and from other participants in INFCE, that significant differences exist between certain groups of countries on certain issues. It is worth identifying these differences, partly to illustrate the political limitations to technical evaluation in this field, and partly so that as debate shifts from the relatively technical back to the relatively political aspects of non-proliferation, we do not mislead ourselves about what to expect.

Technology, Fuel and Heavy Water and Services in the Interest of National Needs Consistent with Non-Proliferation; 4. Reprocessing, Plutonium Handling, Recycle; 5. Fast Breeders; 6. Spent Fuel Management; 7. Waste Management and Disposal; 8. Advanced Fuel Cycle and Reactor Concepts. The ninth volume of the reports, the *INFCE Summary Volume,* comprised a summary and overview prepared by the Technical Co-ordinating Committee, together with summaries of the working group reports.

14. INFCE Final Meeting, UK statement made by Sir Hermann Bondi. See also Sir Hermann Bondi, 'No Technical Fix to a Political Problem', *Nature*, 284, March 6, 1980, pp. 7–8.

It is worth adding that although there were indeed no minority reports, the Indian Delegation appended a statement to the Report of Working Group 5 in which it objected, *inter alia,* to the use in the report of the words 'nuclear explosive' synonymously with the words 'nuclear weapons'.

The phrase 'relatively technical' was used because, of course, INFCE was not—nor could have been—a wholly technical exercise. It is by now a truism that with most highly political issues it is impossible to isolate a purely technical component. This truth was well illustrated at INFCE. Thus, at one level, an Italian participant, Farinelli, noted that since countries rather than individuals were represented at INFCE, and since the choice of representatives was made by governments, then even though most of the participants were scientists (others were diplomats), 'it was obvious that they would be chosen to represent their nations' predominant view and would be given political instructions'.[15] (There arises, therefore, the possibility that the INFCE conclusions will be heavily criticised by non-governmental, particularly anti-nuclear, groups, but at the time of writing, sixteen months after INFCE ended, no sign of such criticism was apparent in or from the United Kingdom.)

More fundamentally, Farinelli also noted other factors which made unbiased technical discussion difficult.[16] He considered that the novelty of INFCE lay in its introduction of proliferation-resistance into the consideration of fuel cycles. However, proliferation-resistance is hard to quantify; indeed, 'it is often difficult to agree on whether a certain solution is more or less proliferation-resistant than another, let alone how *much* more or less.' An even more difficult problem, in his view, was the establishment of guidelines for evaluating fuel cycles from all points of view:

> The emphasis on different aspects varies substantially from one country to another, and it is therefore impossible to arrive at some sort of 'weighted evaluation' that takes into account all the different aspects: the relative weights, for, say, the economics, fuel availability and technological difficulty of a certain cycle are vastly different from one country to another. In practice, each participant . . . tends to start from a predetermined viewpoint . . . on which his choice of fuel cycle is based, and to present those arguments that support those cycles that are 'good' in his judgement and that show weak points in the others.

In similar vein, a participant from the United States, Peter Clausen, has observed of INFCE that 'The vocabulary may be largely technical, but the message and stakes are highly political'.[17] Like Farinelli, he identified the question of proliferation-resistance as one 'political thicket', and then listed several other politically laden questions:

> What is the potential for improving the efficiency of the existing generation of light water reactors (LWRs), thus extending their lifetime

15. U. Farinelli, 'A Preliminary Evaluation of the Technical Aspects of INFCE', in Stockholm International Peace Research Institute, *Nuclear Energy and Nuclear Weapon Proliferation, loc. cit.*, pp. 261-69. p. 261.

16. *Ibid.*, pp. 261-62.

17. See 'Nuclear Conference Yields Potential New Consensus', *Arms Control Today*, 9, 1979, pp. 2-3. For similar arguments about the polarisation of the nuclear debate, based on a study of a sample of US experts, see Alan S. Manne and Richard G. Richels, 'Evaluating Nuclear Fuel Cycles: Decision Analysis and Probability Assessments', *Energy Policy*, 8, January 1980, pp. 3-16.

> against the time when depletion of uranium resources calls for a shift to plutonium fuels? . . . Does reprocessing make the ultimate disposal of nuclear wastes easier, or can spent fuel be disposed of with no technical or environmental penalty? At what uranium price does the shift from LWRs to breeders become economically compelling? National positions on these and similar issues can be deduced in fairly linear fashion from their holders' place in the general debate on the plutonium economy.

The way in which prior political positions influenced the treatment of such apparently technical questions as these, leading to differences in the emphasis placed upon parts of the INFCE reports, may be illustrated by considering some of the INFCE conclusions and points which were made about them by delegates during the final plenary conference.

Differing interpretations of some conclusions of INFCE

It is impossible in a short article to discuss all the conclusions of INFCE. There exists, after all, a summary volume containing over 250 pages—and the summary of this volume, issued to the press, runs to twenty-three typed pages. I have selected for discussion a mere handful of conclusions, chosen for their centrality to the non-proliferation question and to the political aims of INFCE.

The first such conclusion concerns the availability of uranium to meet expected demand. INFCE estimated that nuclear installed capacity in the world outside the centrally planned economies area would rise from the 125 GWe of today to between 850 and 1200 GWe in the year 2000, and to between 1800 and 3900 GWe in the year 2025. Uranium supply was considered adequate to the year 2000, but there could only be great uncertainty about the position thereafter. If, however, capacity approached the higher projection, after the year 2000, substantial deployment of fast breeder reactors would be needed.[18]

Precisely because of the connection between uranium supply and the need for fast reactors, the apparently technical question of uranium availability was in fact highly political. Estimates of uranium availability varied considerably between an optimistic United States and the conservative majority. This difference of view was underscored at the final plenary conference when the head of the United States delegation, Mr Gerard Smith, argued that the demand data were already out of date and needed continual updating if it was to be of value in policy-making.[19] In this he was echoed by the head of the Swedish delegation.[20] As for the related need for the fast reactor, even though the United States had failed in its attempt to, as it saw it, reduce proliferation risks by undermining the case for the fast reactor, nevertheless Mr Smith, echoed again by Sweden, noted that the INFCE reports had somewhat emphasised the positive features of the breeder; in contrast he wished to note

18. *INFCE Summary Volume, loc. cit.*, table 1, p. 4, and pp. 11 and 85. The current figure of 125 GWe is given in the summary issued to the press, para. 2.
19. INFCE Final Meeting, US statement.
20. *Ibid.*, Swedish statement.

that the breeder was not without its 'costs, risks and uncertainties'. This was, however, a muted demurral in the context of the United States policy since 1976.

The separation of plutonium for recycling in fast reactors is, for most countries with nuclear programmes, decades away. Of more immediate concern from a proliferation viewpoint is the prospect of reprocessing plants being established to separate plutonium for recycling in thermal (mainly light water) reactors. A second area of dissensus, or at least of varied emphasis, among the participants in INFCE surrounds the question of the value of recycling plutonium in thermal reactors.

The chairman of the Technical Co-ordinating Committee, Professor Abram Chayes (of the United States) singled out as one of the major conclusions of INFCE 'the unanimity of view that recycling plutonium through present-day reactors—as many countries were planning to do when the study started—has been shown clearly as making no economic sense.'[21] Similarly, Mr Smith commented that 'all agreed that the economic advantage of plutonium recycle in light water reactors will at best be small.'[22] But, on the other hand, the head of the Brazilian delegation noted the finding that 'plutonium recycle in thermal reactors can achieve savings of up to 40% in uranium requirements over the once-through fuel cycle, which makes reprocessing an indispensable operation in most nuclear fuel cycles.' The head of the Italian delegation spoke approvingly of the way in which, 'through INFCE, the role of plutonium in thermal reactors . . . in meeting our growing energy needs was singled out.' Finally, the head of the Swiss delegation noted that INFCE had shown that plutonium recycle in light water reactors raised no additional problems for non-proliferation compared with the once-through cycle (more on this theme below), and that Switzerland hoped to save 30 per cent of uranium requirements by this means.[23]

The key to this second area of disputed interpretation lies, of course, in the difference between narrow cost considerations and security of supply considerations. The INFCE reports are, in fact, quite explicit on this matter. At one point it is noted that plutonium recycle in light water reactors could save 35–40 per cent in uranium requirements over the once-through 'cycle' using existing technology, and 20–30 per cent if both the thermal reactor cycle and the once-through 'cycle' were improved to the optimum extent.[24] Later, it is stated that if plutonium is recycled in light water reactors:

> then the economic advantage is not likely to be large. However, some countries nevertheless see it as a positive contribution to energy independence and assurance of supply. . . . From the narrow micro-economic viewpoint, recycle in LWRs may be regarded as a relatively

21. *Financial Times*, March 1, 1980.
22. INFCE Final Meeting, US statement.
23. *Ibid.*, Brazilian, Italian and Swiss statements.
24. *INFCE Summary Volume, loc. cit.*, p. 12.

> marginal matter that might be valuable for an interim period until fast reactors are introduced; on the other hand, the importance of thermal reactor recycle to some countries may not be wholly reflected in micro-economic terms.[25]

Later still it is argued:

> Many developing countries, particularly those with small nuclear programmes, are unlikely to find the recycle of uranium/plutonium in thermal reactors economically attractive, at least in the early stages of its introduction, although some countries will see it as a positive contribution to energy independence and assurance of supply. For these or other reasons, some developing countries may decide to reprocess their spent fuel, and they have the same rights and incentives as other nations to make the most effective use of the uranium fuel at their disposal.[26]

In the light of these very clear and even-handed statements, the remarks quoted earlier from the two leading United States participants are significant for the way that they focus, as with the earlier subject of uranium availability, on the case against plutonium recycle and hence against reprocessing (in this case using economic arguments) and overlook the energy security arguments. Whether those remarks are the parting shots of the retreating campaign to rid the world of civil reprocessing, or whether their implied reluctance towards reprocessing will continue to feature in American non-proliferation policy remains to be seen, although the early signs are that the Reagan administration is inclining towards the former position.

The need or not, on uranium availability grounds, for fast breeder reactors, and the desirability of plutonium recycle in thermal reactors turn very largely on the desire for energy security. This in turn is bound up with the third area of INFCE findings to be discussed here, namely, assurance of supply of nuclear fuel and technology. INFCE stressed the need to work towards a political, economic, technical and commercial climate conducive to the establishment of long-term assurance of supply. It was argued as a general principle that:

> assurance of supply and assurance of non-proliferation are complementary. Not only do effective non-proliferation assurances facilitate supply assurance but the non-proliferation commitments of any country may be considered stronger to the extent that such a country relies on international markets for a part of its nuclear supplies. Moreover, greater assurance of supply can also contribute to non-proliferation objectives by reducing the pressures for a world-wide spread of enrichment and reprocessing facilities.[27]

In practical terms, it was argued that the way to try to guarantee assurance of

25. *Ibid.*, pp. 18-19.
26. *Ibid.*, p. 51.
27. *Ibid.*, p. 44.

supply lay partly through the introduction of supply contracts which provided for the negotiated updating of non-proliferation measures *without* unilateral interruption of supply, partly through a strong competitive market, and partly through the establishment of multinational ventures such as a uranium emergency safety network, an international nuclear fuel bank and financial participation by customers in uranium, enrichment and reprocessing ventures.[28]

No dissent was expressed at the final plenary conference on the principle of complementarity of assurances of supply and of non-proliferation. It is noteworthy, however, that many delegates[29] took the opportunity to make more or less explicit criticisms of United States actions since 1976, a point which the head of the United States delegation himself acknowledged in his speech. In this context, the head of the Argentine delegation, in one of the more forceful speeches, observed:

> We cannot go on thinking in terms of continuing to apply control after control: safeguards, Club of London, previous consent [to reprocess], IPS [International Plutonium Storage] and so on. We cannot go on retroactively modifying, by unilateral decision, the terms of agreed contracts. We cannot go on requiring submission without realising that we are inexorably impelling the submitter to develop his capacity for freeing himself.[30]

But although there was no dissent on the principle at issue here, the related question of the desirability of seeking to apply that principle, in part through the establishment of multinational ventures, was more controversial. This seems to have been because, in the appreciation of some countries, the proposal for multilateral ventures was conflated with the point made at various places in the reports that, on economic and non-proliferation grounds, there were advantages in restricting reprocessing and enrichment to a relatively few, large plants, located in countries with major nuclear programmes.[31] In response to this argument, the head of the Pakistan delegation stated:

> We do not accept the thesis that for economic reasons reprocessing, enrichment and fast breeder reactors should be confined to a few countries which either have large nuclear programmes or extensive uranium resources.[32]

Similar comments came from the Brazilian and (less explicitly) Argentine delegations, while the head of the Indian delegation argued:

> In the name of non-proliferation, there are now moves towards institutional arrangements aimed at limiting certain nuclear fuel cycle

28. *Ibid.*, pp. 44-45, 127-32.
29. Those, for instance, from the Netherlands, Belgium, Argentina, Pakistan and Yugoslavia.
30. INFCE Final Meeting, Argentine statement.
31. *INFCE Summary Volume, loc. cit.*, pp. 19, 44-5, 51.
32. INFCE Final Meeting, Pakistani statement.

> activities to a few so-called safe and secure locations. Though these locations have not been specifically defined the object seems to be to confine certain nuclear fuel cycle activities either to the territories of Nuclear Weapon States or to areas under their effective control and supervision . . . such arrangements would not only legitimise the possession of nuclear weapons by certain countries, but also give them a permanent technological and economic advantage over the rest of the countries. Institutional measures of this nature would, therefore, [be] tantamount to surrender of national sovereignty by the vast majority of countries, while enabling a chosen few to effectively dictate the programme which they deem to be appropriate for the peaceful utilisation of atomic energy in other countries.[33]

Thus, while there may be emerging a new conventional wisdom in favour of establishing relatively few large, and hence economical, reprocessing and enrichment plants, possibly under multinational control, at least four of the countries about whose nuclear intentions concern is often expressed clearly place a different interpretation on such a prospect.

The final area of the INFCE findings to be discussed here concerns the relative proliferation-resistance of fuel cycles. INFCE's fundamental conclusion on this point was that: 'no single judgement about the risk of diversion from the different fuel cycles can be made that is valid both now and for the future.'[34] Thus, the proliferation risks of the fast-breeder reactor cycle were held to be no worse than those attached to recycling plutonium in light water reactors, or even than those of the once-through 'cycle', in the long term, a conclusion markedly at odds with the view of the United States government at the inception of INFCE.

No dissent was expressed at the final plenary meeting over the conclusion that it is impossible to rank the various fuel cycles in order of proliferation resistance. On the contrary, the conclusion was taken as endorsing whatever national nuclear power plans already existed. One may perhaps expect some dissent in due course from supporters of the thorium-uranium 233 cycle who were not strongly represented at INFCE (because few governments have shown much interest in this cycle), and whose 'solution' to the problem of non-proliferation was dismissed partly because the effort to develop thorium breeders was seen as offering no non-proliferation advantages, and partly because it is not available as a commercial option in the immediate future.[35] So far, however, any such dissent has failed to achieve prominence.

Given the impossibility of ranking fuel cycles in terms of their proliferation risks, it seemed to INFCE 'more important and constructive to identify those points in the nuclear fuel cycles that are sensitive from the point of view of proliferation', and to consider what could be done about them.[36] Enrichment

33. *Ibid.*, Indian statement.
34. *INFCE Summary Volume*, *loc. cit.*, p. 24.
35. *Ibid.*, pp. 17 and 253-54.
36. *Ibid.*, p. 24.

and reprocessing were, of course, seen as the most sensitive parts of any fuel cycle which depends on them, and measures to reduce their proliferation potential were classified under the headings, technical, safeguards and institutional.

Technical measures[37] were seen as having a 'powerful influence on reducing the risk of proliferation'. 'Spiking', and other methods of protecting fissile materials with a radiation barrier, were said to involve 'considerable environmental, radiological, economic and resource utilization penalties and tend, in some cases, to diminish the effectiveness of safeguards'—a conclusion, incidentally, which contrasts with Mr Justice Parker's sanguinity about the use of such methods to protect plutonium shipments, in his report on the Windscale inquiry of 1977.[38] One technical measure which was thought worthy of further examination was the use of lower enrichment for research reactor fuels. Instead of the present general use of highly enriched (weapons grade) uranium, INFCE thought that enrichment to either below 20 per cent or to around 45 per cent would seem feasible for most research reactors, and in the longer term most could use less than 20 per cent enriched fuel. There was, however, some uncertainty about the cost penalty involved in the change to lower enrichment, so that while the proposal was generally endorsed at the final plenary session, the Turkish delegation for one urged that its implementation should not be at the cost of the developing countries.[39] Further action by states, individually or co-operatively, to implement this proposal may be awaited with interest. The only recent test case—the attempt by France to persuade Iraq to accept a new reactor using less highly enriched uranium, following the sabotage in April 1979 at La Seyne-sur-Mer of the core of the *Osirak* reactor—failed, with consequences which endorse the wisdom of the INFCE recommendation.

Safeguards measures[40] were deemed more important than technical measures. INFCE did not identify significant problems with the capability of methods and techniques as applied to existing operating plants, but further development and improvement of existing methods and techniques were foreseen as necessary for safeguarding enrichment plant, industrial scale reprocessing, and mixed oxide fuel fabrication, all of which involve access to weapons-usable material. The greatest difficulties appear to lie in the safeguarding of large reprocessing plant, because of the inherent uncertainties about the amount of plutonium in a consignment of spent fuel coupled with the complexity of the plant and the inaccessibility of most of the equipment during operation. (Elsewhere, the IAEA have stated: 'It is actually impossible to assure that there is no by-pass line out of the process material balance area for

37. *Ibid.*, pp. 38-40.
38. *The Windscale Inquiry, Report by the Hon. Mr. Justice Parker* (London: HMSO, 1978), Vol. 1, para. 7.7.
39. INFCE Final Meeting, Turkish statement.
40. *INFCE Summary Volume*, pp. 38 and 41-44.

any reprocessing plant . . . safeguards must be based on a continuous material balance check across the processing area.')[41]

Institutional measures,[42] finally, were judged potentially more important than technical measures in minimising the danger of proliferation, and led INFCE, as seen in the discussion of assurance of supply (above), to consider those multinational ventures already mentioned, together with such others as regional fuel cycle centres and international plutonium storage. But simply to raise the prospect of multinational ventures, with all the associated questions such as membership, financing, voting arrangements, conditions of access, dispute settlement and status of the host government is to emphasise, were emphasis needed, the centrality of politics rather than technology to the management of the problem of non-proliferation.

INFCE was, indeed, explicit on this point: as Working Group 4 observed, 'Proliferation is primarily a political and not a technical matter'.[43] Furthermore, it had been recognised at the organising conference that a governmental decision to construct nuclear weapons is: 'essentially a political decision motivated by political and national security considerations, among which is the relationship between vertical and horizontal proliferation and the existing and undiminished arms race.' However, it was also agreed at the organising conference that 'it was not the task of INFCE to discuss these political matters'.

To judge from the speeches of their delegates at the final plenary conference, the United States and most other developed countries found little difficulty in abiding strictly by this injunction. The primacy of politics over technical matters could be said to have been taken to mean that there are strict limits to what can be done with technical measures and safeguards; that institutional—especially multinational—ventures should be explored; and that the main political problem in these respects was to generate the necessary political will to enable these measures to have a chance of success.

Markedly different, however, was the note struck by, again, Argentina, Brazil, India, Pakistan, and two neutral European states, Austria and Sweden, all of which broke away from the technical to the explicitly political on this point. Austria and Sweden, unusually among the developed countries, called for completion of the Comprehensive Test Ban Treaty in addition to measures for controlling nuclear power.[45] The other four countries named above went much further and insisted on emphasising the connection between vertical and horizontal proliferation. Thus, the Pakistan delegate argued that there was no point in a policy of denial. Nor, for all their undoubted value, could safeguards ensure non-proliferation because:

41. IAEA, 'The Present Status of IAEA Safeguards on Nuclear Fuel Cycle Facilities', *IAEA Bulletin*, 22: 3/4, 1980, p. 31.
42. *INFCE Summary Volume*, pp. 38 and 44–48.
43. *Ibid.*, p. 147.
44. *Ibid.*, p. 1.
45. INFCE Final Meeting, Austrian and Swedish statements.

> the incentives towards proliferation spring from insecurity and the political climate in which we live . . . we must go to the heart of the matter which is security perception of nations (sic). In order to strengthen [the] non-proliferation regime we must not forget that there is an urgent need for controlling the unrestricted vertical proliferation which poses an everpresent awesome threat to human survival.[46]

The Indian, Brazilian and Argentine delegates spoke equally bluntly, the last of these adding that the exclusion of discussion of vertical proliferation from INFCE was yet another example of double standards being applied by the major powers.[47] This, of course, is exactly the sort of argument which these same countries had advanced during the NPT negotiations, which takes us, amongst some other conclusions, back to the question of how far thinking about non-proliferation had moved between the NPT and INFCE.

Conclusions

INFCE has undoubtedly cleared much technical brushwood, heightened sensitivity in a number of countries to non-proliferation, considerably improved the climate of nuclear diplomacy (buying in the process valuable time for the United States government), and identified where, on the relatively technical (as opposed to political) end of the non-proliferation spectrum, it is worth expending effort and where not. It was a remarkable diplomatic and technical exercise. In the words of Joseph Nye, one of the principal architect's of President Carter's non-proliferation policy:

> While officially INFCE was given a predominantly technical rationale, this was a means of attracting broad participation into what was really part of a political process of stabilizing the basis for the international regime. . . . As a diplomatic device, INFCE helped to re-establish a basis for consensus on a refurbished regime for the international nuclear fuel cycle.[48]

It is also clear that different countries will emphasise different parts of the INFCE reports as they resume negotiations with the United States over supply agreements, and as they seek to justify, nationally and internationally, their nuclear power programmes. Sweden is already seeking 'umbrella' approval from the United States for the reprocessing in Britain and France of spent fuel of United States origin, and says that it is 'backing its position with INFCE'.[49] One may expect similar attitudes from Japan and from Euratom with respect to the renegotiation of the 'prior consent' (to reprocess) clauses in their fuel supply contracts with the United States.[50] And Britain and France may be

46. *Ibid.*, Pakistani statement.
47. *Ibid.*, Argentine, Brazilian and Indian statements.
48. Joseph S. Nye, 'Sustaining Non-proliferation in the 1980s', *Survival*, 23: 3, May/June 1981, pp. 98–107 at p. 101.
49. *Nucleonics Week*, 21: 18, 1980, p. 1.
50. Pierre Lellouche, 'International Nuclear Politics', *Foreign Affairs*, 58: 2, 1980, pp. 336–50, at p. 341.

expected to point to uncertainties over uranium availability, and to the fast breeder reactor's relatively clean bill of health as regards proliferation risks, to justify their fast reactor programmes. Indeed, Sir Hermann Bondi referred at the final plenary conference to the British delegation's belief that the industrialised countries have 'a duty—to themselves and to developing countries—to ensure that, as uranium becomes scarcer and hence more expensive, fast reactors will be available to take the pressure off uranium supplies'.[51]

It is clear too that some developing countries carried forward from the NPT to INFCE a strong sense of being denied sufficiently free and unrestricted access to nuclear technology, and hence they continued to feel discriminated against, distrusted, and kept permanently in an underdeveloped state. Whatever may be thought of those arguments, and making also due allowance for diplomatic rhetoric, the expression of them persists. Neither has INFCE (nor could it have) reduced the resentment of the near-nuclear states (and others) about what they regard as double standards over vertical proliferation: the super-power attitude, in other words, of 'you must trust us with our huge arsenals, but we won't trust you with small ones', which, in terms of the inherently inequitable nature of power politics, it is hard to see how to escape. Both grievances carried over into the NPT review conference in August-September 1980 and resulted in a discordant meeting which broke up without agreement on a final declaration.[52]

Also carried over from the earlier NPT negotiations is a strong belief in the value of universal measures to curb non-proliferation. Thus, the United States, and some other governments, still seek 'full-scope' safeguards on all nuclear transactions, while the British government has been engaged in diplomatic discussions about the possibility of arranging a universal declaration of intent over supply and safeguards which could bring in the non-NPT powers. As Nye has observed, the charge that America's non-proliferation policy from the late 1970s 'focused on fuel cycle questions is largely correct'.[53]

Alongside this tendency, however, there seems to be a growing realisation of how very difficult it is to apply universal measures, either because of a lack of power to enforce the measures, or because other values are deemed more important than non-proliferation, or both. Recent controversies in the United States over whether, in the aftermath of Afghanistan, to provide nuclear fuel for an Indian reactor in the absence of full-scope safeguards, and whether to lift the aid embargo on Pakistan despite that country's reported attempt to build an unsafeguarded enrichment plant, suggest that the second of these reasons has been appreciated by the White House and the State Department, if not by all the relevant committees of Congress or the Nuclear Regulatory

51. INFCE Final Meeting, UK statement.

52. See Peter Whittle, 'What Did and Didn't Happen in Geneva', *ADIU Report*, 2:4, Oct/Nov. 1980), Science Policy. Research Unit, University of Sussex; *Nature*, 287, Sept. 11 and 18, 1980, pp. 98-99, 177-78; and *Strategic Survey 1980-1981* (London: International Institute for Strategic Studies, 1981), pp. 113-15.

53. Nye, *op. cit.*, p. 103.

Commission.[54] As for the first reason, a number of key countries are deeply suspicious of the potential inroads into national sovereignty which universal measures imply, and unlike in the NPT negotiations these countries tend to be developing ones South Africa, India, Pakistan) and not developed countries which are also allies of the super-powers. In these circumstances, and given also the increasing number of suppliers now compared with the 1960s, the writ of the super-powers runs much less far and they can do less unilaterally about nuclear proliferation. Indeed, the very establishment of INFCE in itself testifies to the inability of the United States government to impose its own non-proliferation approach upon the world.

The difficulty of maintaining a universal non-proliferation regime was underscored by the Israeli attack on Iraq's *Osirak* and *Isis* reactors at the Tanmuz Research Centre near Baghdad on June 7, 1981. The attack was described by the Israeli government as a defensive step to prevent the development by Iraq of atomic bombs. Its timing was said to be influenced by the need to destroy the larger, *Osirak*, reactor before it became operational, possibly in early July, since a later attack would release a huge wave of radioactivity over Baghdad. Commentators also drew connections between the timing of the attack and the recent French election (with the return of a somewhat more pro-Israeli president) and the impending Israeli elections.[55]

With respect to the maintenance of the non-proliferation regime several features of this incident are noteworthy. First, this was an attack by a non-signatory state upon a signatory state of the NPT: the relative impotence of the depository states in response may underscore concerns about the value of even such limited security guarantees as are implicit in the treaty. Secondly, the attack has restored the public appreciation of the technical impossibility of cleanly separating the peaceful from the military uses of nuclear energy. Thirdly, and connected with the last point, it lends support to those who doubt the value of the existing safeguards system: Iraq's temporary refusal of IAEA inspection after the unsuccessful Iranian attack on *Osirak* in the autumn of 1980 was a damaging precedent. Fourthly, another damaging precedent was, of course, created by the launching of a deliberate pre-emptive attack against the nuclear capacity of another nation. Fifthly, this example shows the predominance of specific regional and cross-frontier factors in the politics of nuclear proliferation. It is hard to imagine that the course of events in the Middle East would be much affected by, for instance, reduction in vertical proliferation as sought under Article VI of the NPT. Finally, and whether or not one accepts his conclusion that 'nuclear proliferation is likely to have a stabilizing effect on interstate relations in the Middle East', the Israeli attack surely reinforces feldman's recent argument that the transition to mature nuclear postures will be long and fraught with dangers.[56]

54. See *Nature*, 285 June 19, 1980, p. 524; *New Scientist*, July 3, 1980, p. 6; *Nature*, 286 July 31, 1980), p. 433; and *The Guardian*, Sept. 11, 1980 and June 16, 1981.

55. Press coverage of this affair was extensive. See, for instance, *The Times*, June 9-10, 1981.

56. Shai Feldman, 'A Nuclear Middle East', *Survival*, 23:3, May/June 1981, pp. 107-115.

In the relatively ordered bipolar world of the 1960s it was perhaps possible to think in somewhat universalistic terms, and to worry in the abstract about the 'Nth country' problem although even then, as we have recalled, the particular prospect of a nuclear-armed West Germany was a major concern of the Soviet Union. Nowadays there is perhaps more widespread appreciation of the uniqueness of each concrete case of potential proliferation,[57] a change in emphasis to which the INFCE process has almost certainly contributed. To this conclusion may be coupled the points made above that, in today's interdependent world, the major powers cannot always afford to make non-proliferation their highest priority, and that even if they could, they can less easily enforce their will (*inter alia*, because a policy of denial of technology looks weaker every year). If this assessment is correct, nuclear diplomacy may be expected to be rather more country-specific in the next few years than it has been since 1976, and to take as its motto the current saying that there are no sensitive technologies, only sensitive countries.

57. On this point, see Lewis A. Dunn and William H. Overholt, 'The Next Phase in Nuclear Proliferation Research', *Orbis*, 20, Summer 1976, pp. 497–524; Richard K. Betts, *Paranoids, Pygmies, Pariahs and Non-Proliferation* (Washington: Brookings Institution, General Series, Reprints 327, 1977); Imai and Press, *op. cit.*; and Ashok Kapur, *International Nuclear Proliferation—Multilateral Diplomacy and Regional Aspects* (New York, London: Praeger, 1979).