International Co-operation in the Nuclear Field – Past, Present and Prospects

by Bertrand Goldschmidt

On the occasion of the 20th anniversary of its creation, the Nuclear Energy Agency of the Organization for Economic Co-operation and Development (NEA/OECD) held a symposium in Paris on 1 and 2 February 1978. Some 200 participants from the 23 Member countries of the NEA as well as representatives of the Commission of European Communities, FORATOM and the IAEA attended the symposium.

At a panel discussion at the symposium, led by Dr. Sigvard Eklund, Director General of the IAEA, the future of international co-operation between advanced nations in the nuclear field was discussed. While recognizing that nuclear energy is at present going through a period of uncertainty pending resolution of the intertwined problems of gaining public confidence and of non-proliferation, the panel expressed its strong confidence in the future of nuclear power, and the vital contribution it would make, particularly between now and the end of the century.

During the meeting, a critical review was made of the way in which international co-operation has evolved since the early stages of peaceful nuclear development, and of the influence on this co-operation of the changing relationship between government and industry. The contribution of international co-operation – and its limitations – was carefully scrutinized, notably in the crucial area of the nuclear fuel cycle.

Dr. Bertrand Goldschmidt, formerly Director of International Relations of France's Commissariat à l'Energie Atomique, presented the following paper at the symposium. Dr. Goldschmidt is the Governor from France on the IAEA Board of Governors.

The First European Co-operation

Early in the year 1950, the Norwegian physicist, Gunnar Randers, found himself in a predicament: he was in charge of the construction, already at an advanced stage, of one of the first nuclear reactors to be made outside the Anglo-Saxon world, but he had not managed to find the requisite uranium. Indeed, it had been on his instigation that the Norwegian Government, encouraged by its national production of heavy water (the first such industrial production in the world), had granted just after the war the appropriations required for the contruction of a heavy-water research reactor of low power, quite reasonably assuming that the uranium needed for its operation would be found on Norwegian territory in the course of the few years required to build the reactor.

This was still at the height of the period of secrecy, for the Anglo-Saxon war-time Allies – the United States, the United Kingdom and Canada – has decided in November 1945 to abide by the agreement reached at the Quebec Summit Conference in August 1943, which was, first, to keep secret the technology developed jointly by them during the conflict and, second, to buy up between them all the uranium available in the Western world.

This policy, which blocked access to the two ingredients essential for any nuclear development, i e uranium and technical know-how, was designed to mitigate the consequences of the overlap between the military and scientific aspects of atomic energy

In principle, it was a temporary measure pending, as they said at the time, implementation by the United Nations of international control of the new source of energy, or as we would say today, pending establishment of an effective world policy of non-proliferation.

France was at the time the principal Western power not bound by the policy of secrecy A number of French scientists had played a prominent part during the war, first in the British team and later, after 1943, in the Anglo-Canadian team, in particular by contributing 180 kilograms of heavy water purchased from Norway at the beginning of 1940, which represented at that time the whole of the world's stock It was, moreover, precisely this transfer of heavy water from France to England in June 1940, and then to Canada, that led the Canadians to specialize in that particular branch of reactor technology and to champion today the cause of heavy-water power plants

It was further purchases of heavy water from Norway after the war, once again, that made possible the construction of the first two French research reactors Because of this close relationship, the French did not withhold from Randers the main results obtained with their first research reactor, completed at the end of 1948 By 1950 the construction of the Norwegian reactor was fairly far advanced, but uranium exploration had proved most disappointing. Randers went to Paris to ask Frédéric Joliot, the leading French nuclear scientist, to give him the necessary uranium, since France had done better than Norway in her first attempts at prospecting

Convinced that he was the only one who could help his Norwegian colleague out of the difficulty, as the rules of the Anglo-Saxon "condominium" were opposed to virtually all exports of uranium, Joliot decided to drive a hard bargain: he agreed to provide the uranium, but without the technical information relating to the essential processes of purification and transformation into the metallic form, insisting, furthermore, that the reactor should be considered a Franco-Norwegian project Randers rejected these terms, which he considered too harsh Although he had warned Joliot that he could overcome his difficulty in another way, Randers was thought to be bluffing Such was not the case, however, for shortly afterwards an agreement was concluded between Norway and the Netherlands, which had in its possession ten or so tonnes of uranium bought in 1939 on the advice of a university professor and hidden away during the war, the existence of this material had been kept secret up until then

Realizing their mistake, the French approached the newly-created Netherlands-Norwegian group with an offer to come in as a third partner, this time on rather generous terms as far as the exchange of information was concerned, and with an offer to purify and transform the uranium required for the reactor But it was too late, the Anglo-American allies were now alerted to the proposed arrangement and were opposed to Franco-Dutch-Norwegian collaboration in which France would inevitably play the dominant role, Washington advised against it, and the United Kingdom contributed part of what Randers had asked for from Joliot by taking over the task of purifying the impure Dutch oxide and converting it into metal. This is how the first international co-operation in the civil nuclear field came about The Dutch-Norwegian reactor was completed in 1951 at the Kjeller Centre, the first nuclear establishment to open its doors to technicians from other countries.

The Policy of Isolationism

A much more important agreement might have seen the light of day, however, at an earlier stage, following an undertaking given to Churchill by Roosevelt at the end of 1944 in a memorandum stating that close atomic co-operation between the American and British Governments would continue after the war in the military and commercial fields unless the two parties put an end to it by mutual agreement. But having accepted, at the end of 1945, the principle of effective and complete collaboration in the civil field, and then having evaded the issue for a period of serveral months, Truman finally told Attlee that the United States could not possibly conclude an agreement with the United Kingdom enabling it to start up a complex of industries which might be exploitable for military purposes just at a time when the three Anglo-Saxon allies were embarking, at the United Nations, upon the search for world agreement on control. Non-proliferation was thus used for the first time as an argument for reappraising a previous commitment.

Indeed, over the period between mid-1946 and mid-1948 almost 200 meetings at the United Nations were devoted to what might be called today the first "International evaluation" of the technical stages of the industrial development of atomic energy from the standpoint of controlling it The point of them was to study what was intended to be the practical application of the first non-proliferation plan, namely, the American Lilienthal-Baruch Plan. This plan was based on safeguards devolving from multinational administration, a supra-national body was to be the proprietary possessor of the world nuclear industry and to exploit and develop it in the name, and in the interest, of all nations. In short, as an example of world government in a matter of worldwide concern, it was undoubtedly the last chance for mankind to live in a world free of nuclear weapons.

The political constellation at the height of the cold war was hardly compatible with a project as revolutionary as this, and in the spring of 1948 the United Nations Atomic Energy Commission announced it had reached a deadlock and broken off its deliberations. The first attempt at non-proliferation had failed, and the policy of secrecy and isolationism could only be intensified as a result, lasting in fact until the first break: the joint Dutch-Norwegian undertaking described above, which was launched in 1950 and continued until 1960, bringing together the nuclear research teams and activities of the two associated countries. But the irony of fate is that on account of the Norwegian hydroelectric resources and the discoveries of natural gas in the Netherlands, and more recently of the North Sea oil, these two countries have in the end found themselves under less pressure to generate nuclear power, and the long-term importance of their early collaboration has thereby been reduced.

If I have dwelled at some length on these now only dimly remembered episodes in the pre-history of the Nuclear Energy Agency of the OECD, which celebrates its 20th anniversary this year, it is because we can already see in them the seeds of the problems that face us today; we can see the advantages of the concept of international administration of nuclear facilities, and a demonstration at once of the benefits a country can reap from the possession of basic materials and advanced technologies and of the limitations of a policy of withholding such materials or technologies.

The Policy of Openness

The first phase in the history of nuclear international relations, i.e. the period of isolationism, came to a close in the mid-1950s following the famous "Atoms for Peace" speech by

Eisenhower at the end of 1953, the relaxation of Anglo-Saxon policy and the lifting of secrecy during the United Nations Conference on the Peaceful Uses of Atomic Energy, held at Geneva, in 1955.

The second phase lasted until the beginning of the 1970s and was marked by the disappearance of the uranium monopoly, the availability of enriched uranium from America on the world market, and growing international trade first in research reactors and then in nuclear power plants, with scientific and technological secrecy vanishing from the scene (except as regards enrichment) and giving way to conventional industrial secrecy. This phase was also marked by the institution and broad-scale acceptance for the first time in world history of genuine international control, namely control of the peaceful uses of atomic energy, the safeguarding of which had now become one of the essential features of any nuclear collaboration between nations.

It was a period of openness marked by a more liberal attitude that was not, of course, entirely free from the political constraints inevitable in connection with the applications of uranium fission, but one characterized by a certain stability in those political constraints and by complete freedom with regard to technological and industrial options, in short, a relatively happy period favouring the growth of the nuclear industry. The resulting climate, at the end of the 1960s, enabled a large number of countries to accept the renunciation and discrimination inherent in the Non-Proliferation Treaty, made palatable as it was by a guarantee of free development for all techniques, and to place their entire nuclear activity under international control.

This period began with the golden years 1955–58, followed by the years of readjustment, which lasted until the middle of the 1960s (industrial development having got off to a false start, or at least having moved forward too rapidly), and finally, from the mid-1960s onwards, was witness to the development of nuclear power on a grand scale in more and more countries. Since the beginning of the 1970s, more specifically since 1974, we have entered a third phase in world nuclear development – a time of reappraisal. It is a period of instability marked by constant shifting of the administrative and political constraints, even during the implementation of contracts, and for some countries fraught with uncertainty as to the future of a nuclear industry caught by such changes in the midst of expansion

From the political standpoint this change can be explained both by the emphasis placed on things nuclear by those opposed to our technological way of life and by the importance given to the problem of non-proliferation at a time when there is need for added recourse to nuclear power in order to satisfy the energy requirements of a world shaken by the oil crisis Within the industrial context, the change stems from reactions to the emergence of competition in the area of enrichment and power plant construction, and more recently from the expression of doubts as to the political and economic wisdom of reprocessing and breeder-reactor operations.

This period has seen the return, as in the years of isolationism, of restrictions on the transfer of materials, equipment and technology as the result of a lack of confidence in international commitments and in the degree of protection afforded by international control It is too early for us to predict when and how we shall recover the much-needed stability in national and international regulations and restrictions pertaining to the new technology, or for us to know whether, having suddenly gone from the "Dark Ages" of secrecy and isolationism to a period of "Renaissance", with all its openness and stability, we are witness today to a lasting change, or whether, on the contrary, we are living in a cloud destined soon to pass and enable us to develop international nuclear collaboration once again in a climate as favourable as the one we knew in the past, by which I mean the climate essential for an effective policy of non-proliferation so adversely influenced by the present mood of increasing distrust created, paradoxically enough, by the very measures adopted for the sake of non-proliferation.

Scientific Co-operation

Since 1955 a veritable plexus of international relations, both bilateral (with the most advanced countries, especially the United States) and multilateral, has grown up in Europe and the world as a whole through the Nuclear Energy Agency (NEA), with 23, originally 17, Member States, EURATOM, with nine, originally 6, Member States, and the International Atomic Energy Agency, today with more than a hundred Member States.

Within this framework of collaboration we can clearly single out two categories (which we shall discuss in turn) according to whether the collaboration is or is not predominantly of the industrial and commercial type. Within the vast field of international relations free from direct commercial implications mention should first be made of theoretical research, which moreover, often lies on the fringes of nuclear energy properly speaking We could refer here to high-energy physics and the success of CERN at Geneva; the joint Franco-Soviet project for the bubble chamber in the Serpukhov accelerator; German-Anglo-French work on the high-flux reactor at Grenoble, joint European activities in the field of controlled fusion, sponsored by EURATOM, and the recent decision to build the JET device in Great Britain.

The training of engineers specializing in the nuclear field has been a broad-scale international activity; the Argonne and Harwell schools, like those at Karlsruhe and Saclay, have played a major part in the specialized training of engineers and technicians from, first, industrially-advanced countries and, more recently, less developed countries. Technical assistance, especially in the application of artificial radioisotopes, radiological protection and efficient utilization of research reactors, has assumed growing international proportions, first with the support of the advanced countries and now mainly under the aegis of the IAEA. These efforts have made it possible to instil in many countries not yet ready to embark upon nuclear power the confidence that they have not been completely left out of the nuclear venture An example we might mention here is the international food irradiation project under joint IAEA/NEA sponsorship.

To establish connections between experts in all countries is also essential The four United Nations Conferences on the Peaceful Uses of Atomic Energy held at Geneva, the recent IAEA Conference on Nuclear Power and Its Fuel Cycle, held at Salzburg, the meetings and symposia organized by the European Atomic Energy Society (a "club" made up of the national commissions of 14 European countries and set up in 1954), the American and European nuclear societies, FORATOM and the various national industrial forums — all have helped in their respective spheres to popularize nuclear energy by removing the final traces of the era of isolationism

The part played by NEA in connection with basic constants and nuclear data, like that of EURATOM and the IAEA in the realm of safety standards, deserves mention here, as does the establishment of safeguards systems, for which we are indebted to the IAEA, and also to EURATOM, though on a geographically smaller scale.

Multinational Undertakings

Finally, four European multinational projects going back 20 years, one set up by EURATOM and the other three by NEA, have contributed to the acquisition and sharing of information, each in its own distinctive way The EURATOM Joint Research Centre, composed of four establishments — Ispra, the largest, Geel, Karlsruhe and Petten — suffered initially from the fact that under the Treaty it was assigned too broad an area of competence, although the Member States with modest national nuclear programmes favoured this multidisciplinary approach, countries like France wanted it to be geared to activities with a technical risk or cost justifying joint action

These difficulties were smoothed out when the Members States reached an agreement, at the beginning of the 1970s, on a certain number of activities, mainly of public interest (reactor safety, waste management, etc.), requiring a staff of 2500 and an annual budget of 100 000 000 European Monetary Agreement units of account NEA was spared difficulties of this kind by virtue of the optional participation of Members States in its three joint projects Two of these were concerned with reactors·

— the boiling-water reactor plant at Halden in Norway, first built to provide steam for a pulp factory, only the current running costs of this reactor are charged to participating countries interested in fuel element behaviour and power plant safety studies,

— the Dragon high-temperature reactor, built and operated jointly at Winfrith in England, this plant was shut down in 1976, having been for a long time a highly advanced reactor of its kind and having furnished valuable information on a reactor type that, in spite of the difficulties encountered, even today still has numerous supporters and has not lost its chance of competing on the world market, especially where possible use in the chemical or metallurgical industry, is concerned

The third joint NEA undertaking — Eurochemic — was intended for the acquisition of industrial know-how and experience in irradiated fuel reprocessing, France being the only one of the thirteen participating countries to have had such experience at the time. The pooling of plutonium extraction technology, considered today one of the most sensitive operations from the standpoint of proliferation, seemed at the time to be highly desirable within the context of European co-operation and did not give rise to any political difficulties Built at Mol in Belgium, thanks to a good understanding between the principal European chemical industries concerned, the plant continued operating until it closed down in 1974, i e for nearly ten years, under satisfactory conditions Now it is soon to be bought up by the Belgian Government, an action that runs counter, paradoxically, to the present political trend in favour of internationalizing the administration of such plants

Though a technical success, this undertaking was a serious failure economically, for three main reasons

— the inadequate capacity of the plant (100 t/y), which represented a poor compromise between a pilot facility and an industrial-scale plant,

— a depression on the world reprocessing market during a large part of the life of the undertaking,

— the company's articles, under which it was not obligatory for shareholders to contribute to the increased capital outlays necessitated by a too low initial estimate of the cost of the plant, or to the repayment of growing annual deficits, but which allowed defaulting shareholders to reap the benefits alone, viz•the acquisition of technical information

The fact that there was a surplus of reprocessing capacity at the end of the 1960s which was responsible for Eurochemic's difficulties even led the United Kingdom and France, already in possession of large plants, and Germany, which was about to build one, to join forces in 1971 under an agreement (at first commercial and later on technological) giving rise to United Reprocessors — UNIREP — with a view to avoiding the risks entailed in an uncontrolled development of reprocessing capacity prior to saturation of existing plants A sudden reversal of the situation, so typical of the development of nuclear energy, which has now shown up in an alarming shortage of available capacity, has led the three UNIREP partners to reconsider the role of this industrial undertaking

And so, passing from Eurochemic to UNIREP, we have arrived at international relations that are predominantly industrial and commercial but which are still subject, to a lesser or greater degree, to political constraints

Commercial Relations

The activities we have just reviewed fully deserve the description of international collaboration, involving as they do in each case a joining of the forces of several countries in pursuit of a common aim But the terms 'collaboration' or 'co-operation' have also been used often enough, no doubt in contrast to the paralysis in relations during the period of isolationism, to describe bilateral commercial arrangements in which the forces are not truly pooled, but in which, on the contrary, the position of strength of the country selling, i.e. the possessor of the nuclear materials or technology or both, is used to impose political conditions on the purchasing country.

This has often been the case with the supply first of research reactors and then nuclear power plants, which has become a conventional transaction in international relationships in the field, here the more advanced supplier decides on the political constraints and provides at least the most important components, fuel elements and training facilities for the teams of operators, while the purchaser, on whose territory the facility is to be set up, contributes as much as he can afford to the project Between 1956 and 1958 it was the British, Canadian and French advocates of the natural-uranium fuelled and graphite or heavy-water moderated reactor type who captured the first markets But American industry, financially and politically backed by the United States Government, reacted promptly, profiting from its work with research reactors and submarine engines based on enriched uranium, it managed to gain the upper hand on the market, having first tried out in Europe — through the USA-EURATOM Agreement of 1959 which included joint financing of industrial research — what were called proven power plants although they were not yet proven in actual fact.

The joint construction and administration of nuclear power plants are obviously an ideal area for collaboration, through such collaboration it has become possible, in one case after another, to bring together the engineers and technicians, nuclear industries and electricity companies of a number of countries This is true of the Franco-Belgian power plants at Chooz and Tihange, the Hispano-French power plant at Vandellos, completed in the 1960s, the German-Belgian-Dutch SNR breeder reactor under construction, and the Franco-Italian-German prototype plant Super Phénix — evidence of the broad collaboration existing between European countries in this technology so important for the future of nuclear energy.

The Uranium Market

The provision of natural uranium and enrichment services is likewise an important aspect of international nuclear relations Their availability under stable as well as economically and politically acceptable conditions is essential for the regular implementation of nuclear power programmes Where natural uranium is concerned, the relations which involve international co-operation more than any other are those binding one country with another on whose territory the former carries out, or takes part in, exploration, prospecting and possibly mining operation, usually in exchange for the right to take away some part of the uranium produced If the mining zone is an important one, we may find a number of mixed and multinational groups, each responsible for a deposit This is the case, for example, with the Niger deposits discovered by France in the middle of the 1960s, in the mining of which, besides the organizations from those two countries, there are now participating German, American, British, Spanish, Iranian, Italian and Japanese companies

Nevertheless, in the Western world the uranium market has been subject, on many occasions in the past, to sharp fluctuations reflecting a complete lack of any spirit of international collaboration in this field The de facto monopoly of the Anglo-Saxons on uranium purchases meant a dearth of uranium for the other Western countries during the 1950s Then, starting from the early 1960s, a slow-down in American purchases and the discovery of large deposits in the United States resulted not only in non-renewal by the United States of some important contracts still running in Canada and in Africa, but also in protectionist action involving an embargo on American uranium imports

The outcome of this was swamping of the market and a slump in prices at a time when an increased prospecting effort, such as France alone of the European countries was then making in Africa, would have been necessary to cope with a demand in keeping with the veritable blossoming of ambitious power plant programmes, i e at the end of the 1970s and beginning of the 80s Furthermore, the chief manufacturer and exporter of power plants helped, at the beginning of the 1970s, to perpetuate the stagnation by capturing and neutralizing part of the domestic and foreign market in the United States Indeed, the manufacturer offered along with the sale of power plants all the uranium needed to fuel them for their 30 years of operation, without covering itself by buying the requisite stocks, and thereby artificially reduced demand The concerted efforts of producer countries other than the United States aimed at remedying the situation were slowly beginning to produce results when suddenly, in 1974, the situation was reversed and the shortage emerged again accompanied by its inevitable counterpart – a considerable increase in the price of uranium

A more or less simultaneous occurrence of several factors was responsible for this reversal. the oil crisis, the decision taken by some electricity companies to cover themselves on a long-term basis and even to stock up with uranium – which they had never done before, the persistent failure of the Australian producers to come on the market, owing to the influence of trade unions hostile to nuclear energy, at a time when large desposits had just been discovered there, the slow-down, and later discontinuation, of Canadian exports as a result of constant doubt as to the political terms of sale, the emergence of the United States as a buyer on the foreign market as a consequence of the import embargo gradually being lifted, and finally the revelation that many sales thought to be firm were without security.

It is to be hoped that Canada* and Australia, two of the biggest Western producers, will soon get their exports going again and that the doubts regarding constaints associated with non-proliferation will be satisfactorily dispelled at the same time Although it is normal and desirable that natural uranium or slightly-enriched uranium sales for civil projects should be subject to conditions associated with peaceful utilization and to the international safeguards required for that purpose, it is in an equal degree unacceptable, for the vast majority of importing countries, that such conditions should also be accompanied by demands constituting direct interference in their national fuel cycle strategy.

Uranium Enrichment

Similarly, the fact that the United States Government had until recently a virtual monopoly on the supply of enriched uranium required for fuelling light-water reactors and power plants – by far the most common type – gave it an invaluable political and commercial advantage. It was then inevitable that the more advanced countries should aspire first to building the power plants themselves – as was done by Germany, Sweden and France – and then to acquiring a certain degree of independence as regards enrichment

A brief account of international relations in connection with the isotopic separation of uranium, an amazing example of collaboration and competition, will be a good way to finish this review. In 1941 the British leaders were convinced of the importance, and the difficulty, of constructing a national plant for the production of uranium-235, for which the gaseous diffusion technique had already been selected. Potential siting of the plant soon became a bone of contention, first between the supporters and opponents of independence vis-à-vis the Americans, and later between Churchill and Roosevelt The war finally came to an end without the British plant seeing the light of day – it was not built until ten years later at Capenhurst – and without the British being associated with the technology used for the American gaseous diffusion plant at Oak Ridge.

In 1954, negotiations got under way for the construction in France, with the assistance of British industry, of a plant similar to the one at Capenhurst, which had just started operating. The French proposal was at first well received by the British officials concerned, who were in favour of exporting their most advanced techniques, but the affair was dropped in face of official opposition by the United States, consulted under the Anglo-American Agreements of 1943 on secrecy in atomic matters. At the end or 1955, during the initial negotiations for EURATOM, the French delegation described the isotope separation plant as a priority project to be carried out jointly, without waiting for the Treaty to come into force, and this viewpoint was adopted by the Committee of the six heads of delegation.

Since the Organization for European Economic Co-operation (OEEC) had already included a plant of this kind in its list of possible joint undertakings, a study group was set up with the participation, besides the Six, of Denmark, Sweden and Switzerland. The French members were advocates of gaseous diffusion, a process for which the research had already reached an advanced stage, while the Germans, at first advocating a jet process that they had discovered, then joined forces with the Dutch and supported the ultra centrifuge technique, whose economic advantages and imminent development they vouched for.

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* Ed note the matter has already been favourably decided

In 1957, following the Suez crisis, the study by Armand, Etzel and Giordani, the three "Wise Men" of Europe, on Europe's nuclear energy requirements helped to bring about the downfall of the initial project for a European enrichment plant Their report, prematurely prophetic since it envisaged immediate and broad-scale recourse to nuclear energy to combat an imminent shortage of energy and oil, and the concomitant drain on foreign exchange, as a necessity, was based on an idea intended to unite the Six and gain more from the American achievements, especially from the highly favourable price of enrichment in the United States Thus at the beginning of 1958 the study group for the European isotope separation plant, of which I was chairman, ceased to exist, France not having been able to convince a single one of her eight potential partners of the urgency of the project

It was not in fact until 10 years later, after the start-up of the French plant at Pierrelatte, that the European experts first from FORATOM and then from EURATOM proclaimed the need in 1967 to free Europe from its complete dependence on the United States in the matter of fuelling power plants with enriched uranium. They were even willing to accept, if necessary, a higher price for a European product

It was against this background that there came, in 1968, the sudden and dramatic announcement by the German, British and Dutch Governments that they would be co-operating on the ultra-centrifuge technique in view of the progress the three countries had made independently in that process, which consumed far less energy than gaseous diffusion. Their aim was to build pilot facilities, at Almelo in the Netherlands and at Capenhurst in England, and construction was to start by the beginning of the 1970s

The negotiations ended on 5 March 1970, the very day of the entry into force of the Non-Proliferation Treaty, with the signing by the three Governments of the Almelo Treaty, stipulating the political conditions for industrial co-operation between them aimed at creating an improved model of the centrifuge It was not until last year that the two prototype facilities were officially started up at Capenhurst and Almelo, each one operating with different centrifuge models Through extension of these plants it is expected to attain two million separative work units (SWU) by 1982, as opposed to the hundred thousand SWU at present in operation

One might have thought that the American reaction to this European initiative would have been to ease up the commercial conditions governing enrichment services On the contrary, they were made at that time much stricter the terms now included payment in advance for part of each order, several years' notice of consignments, and a penalty in the event of cancellation of a consignment, the price for which in any event was to be fixed unilaterally by the United States authorities, and only at the time of delivery

At the beginning of 1971 the Soviet Union made its appearance on the market by concluding an enrichment contract with France. The reaction of the United States to this breach of their monopoly was an offer, made at the end of 1971, to make their gas diffusion technology available to multinational undertakings safeguarded by the IAEA and open to participation by the United States, but not in a position to compete commercially with American production This offer, the terms of which were dictated not just by a concern for non-proliferation, was not taken up by the advanced Western countries to whom it was made

Just the reverse, it helped to consolidate the European projects, more especially the interest in a French proposal for a joint venture based on gas diffusion, which led to the creation in 1972 of a study group composed of industrial organizations from Germany, Belgium, United Kingdom, Spain, France, Italy, the Netherlands and Sweden. The industries of URENCO Member States and Sweden withdrew from the association in 1973 and 1974 when it was being converted into an industrial company and was about to move on to the construction stage; Iran later joined. In this way, at the end of 1974, just at the moment when the Americans made it known that they could not accept any more enrichment orders, work was begun on the Tricastin plant, which is to have an output of approximately 11 million SWU and is to start operation next year. The possibility of extending this work by the construction of a second plant, COREDIF, with the same partners, is also being considered.

EURODIF and URENCO should constitute by 1985 one-third of the Western enrichment capability. Unlike URENCO, the industrial operation of which was preceded by an inter-governmental treaty, EURODIF is an industrial company based on French law, with a French majority interest, but with multinational participation. It was, so to speak, in at the start of this dual nuclear operation — doubly nuclear in as much as the plant is to be supplied with electricity from four pressurized-water reactors each with an output of 900 MW(e).

International Nuclear Fuel Cycle Evaluation

Finally, to end this survey of multinational activity in the area of fuel enrichment, mention should be made, within the context of non-proliferation policy, of a programme that received its impetus from President Carter — the expert studies to be conducted in connection with the International Nuclear Fuel Cycle Evaluation (INFCE), designed to find ways of providing supply guarantees to importing countries (re-insurance, banking, etc.) and thereby encouraging them to abandon any plans they might have had to develop their own enrichment capability. INFCE will also be tackling the important problem of supplying the numerous research reactors in the world fuelled with highly enriched uranium, the one and only supplier of which so far — the United States — is becoming more and more reluctant on grounds of non-proliferation. One solution at present being considered would be to use uranium with less than 20% enrichment in a fuel specially designed for the purpose.

The proposal for multinational development of a "non-proliferation" enrichment process announced by France in the spring of 1977 could also be a means of solving this problem in a politically satisfactory manner.

INFCE is in fact like a very broad, continuing international symposium on all aspects of the fuel cycle, seen mainly from the standpoint of non-proliferation. As a most unusual exercise in the friendly exchange of information, it has two years in which to study, as its main function, the best ways of promoting the development of nuclear energy while curbing proliferation as much as possible. It will be called upon, among other things, to reply to the objections levelled against fuel reprocessing and breeder reactors considered by some to be both too hazardous from the standpoint of proliferation and not really justified in the economic sense. It will act as an honorary board of judges that could eventually, or so many of us think, rehabilitate these parts of the cycle by demonstrating that they are capable of being protected against the risks of proliferation and are also indispensable for the full-scale development of nuclear energy.

Although now, in 1978, 20 years have passed since the establishment of the international organizations NEA, EURATOM and IAEA, it is only 40 years since the discovery in Europe

— in laboratories at Rome, Berlin, Paris and Copenhagen — of the fission of the uranium nucleus

The distance covered since then is staggering: the dream of the alchemist realized, with the production of tons of a new element, radioisotopes in almost unlimited species and quantities now at the disposal of research, medicine, agriculture and industry, the weapon which enabled us to end the Second World War and the arms on which depends the balance of peace that has followed it; the modest but remarkable success in propulsion of ships, including the nuclear submarine, and finally, at a time when our civilization is confronted with the oil crisis, a new form of energy that already accounts for almost 10% of the electricity generated in the industrialized countries (even close to 20% in some of them) and which by the turn of the century will be absolutely essential in overcoming underdevelopment

After meeting and surmounting the many difficulties built into this technology, in most cases through co-operation between countries, let us hope that man, who so often destroys what he creates, will not set up any more formidable obstacles in this, his triumphant path.