Radioactive waste management policies

Eight senior government representatives outlined the views and policies of their countries in the field of radioactive waste management at a "scientific afternoon" during the 27th Regular Session of the General Conference of the IAEA in Vienna in October. The countries represented were Argentina, France, the Federal Republic of Germany, India, Japan, Sweden, the United Kingdom, and the USA; statements made by the participants are reproduced here.

Summing up the afternoon's discussions Dr Hans Blix, Director General of the IAEA, noted points of consensus which had emerged. He recalled that it had been recognized as early as 1957 that various options for the safe management and disposal of radioactive waste must be identified. Extensive research and development programmes have been carried out. To date, the record of the nuclear industry in radioactive waste management has been quite satisfactory. Wastes have been stored and managed with a minimal impact on man and his environment: no major environmental pollution such as that which has been caused by oil spills has occurred in the nuclear field.

Care is being taken by all countries, industrialized and developing ones alike, to ensure that the problems of waste management will not become a burden for future generations. In some countries the financing of all such operations including decommissioning is charged to the utilities already.

"I note another consensus, namely, that there is no technical urgency to dispose of highly radioactive wastes, because they can be safely stored and managed for many decades — long enough to permit selection of the most appropriate disposal option. Indeed, there seems to be a consensus that there is great advantage in waiting for final disposal, in order to allow the waste to lose radioactivity and heat".

Dr Blix noted that the safe and permanent disposal of radioactive waste is a global concern, and Member States recognize the need for international co-operation. "Internationally accepted generic criteria for the safe disposal of wastes would be most useful", he said. "I may add that the IAEA Secretariat has held consultations with experts and regulatory organizations in a number of countries with advanced programmes for nuclear waste management and has found broad support for work on such criteria".

Design work and investigations into the development of repositories for high-level waste have been or will soon be undertaken in many countries. In the area of low-level waste disposal there are two trends: one of them sea-dumping, the other land disposal. International organizations are actively involved in evaluating the safety of the options. The management of low- and intermediate-level wastes will need to receive continuing attention; but the technology which is available to control liquid and gaseous effluents from the operations of the nuclear industry is effective enough to make nuclear power an environmentally very clean source of energy.

"In our age of environmental awareness, when the effects of pollution and conventional toxic wastes are of major concern to man and his environment, I think we must conclude that the record of the nuclear industry in waste management is remarkable compared to that of other industries", said Dr Blix. "I think we have heard enough this afternoon to appreciate that all countries — not just those from whom we have heard — are aware of the absolute need to ensure that environmental acceptability is not jeopardized".

Admiral Carlos CASTRO MADERO
Chairman,
National Atomic Energy Commission,
Argentina,
Governor from Argentina on the IAEA's Board of Governors

The production of high-level radioactive wastes is a consequence of the nuclear generation of electricity. The nature of these wastes is the same whether a decisions is taken to reprocess or not to reprocess the spent fuel.

The option of direct disposal of irradiated fuel elements has been abandoned in Argentina not only because of the importance for power production of the plutonium contained in them, but also for ecological reasons. Indeed, fuel elements are not designed to retain radionuclides on a long-term basis after disposal and, furthermore, the presence of the total actinide inventory in non-reprocessed fuel would have a greater radiological impact than if the plutonium were recycled.

The problems involved in the storage of high-level radioactive wastes will be significant in the case of

Delegates to the General Conference of the IAEA discuss part of an exhibition of Member States' practice in radioactive waste management.

Argentina in the second half of the 1990s. Notwithstanding, the decision to overcome the technological problems of disposing of the wastes has been made well in advance.

The fundamental objective in managing radioactive wastes is to keep them isolated from the biosphere over the time required for them to decay to an adequate extent.

At the present time the opinion is internationally held that the disposal of high-level wastes conditioned in solid form in deep-lying geological formations with the appropriate characteristics is a way of dealing with them that would impose upon present and future generations risks no greater than the normally accepted hazards of everyday living.

Argentina is currently making a study of the feasibility and the conceptual design of a deep-lying engineered depository in non-fractured granite formations in order to dispose of the wastes stemming from the Argentine Nuclear Plan. In the wake of extensive investigations into potential sites a granitic intrusive formation has been selected in the Sierra del Medio, near the locality of Gastre (Chubut Province), and it is there that detailed studies are now under way with drilling to depths greater than 600 metres.

The basic design assumption for a possible repository in the granite formation is that it must inevitably contain a certain amount of water through which, in the very long term, there will be corrosion of the container, inflow of groundwater into the matrix containing the wastes, leaching of the matrix, and consequent migration of the radionuclides. In taking this as the basic supposition, the important point is to make sure that there is a long enough "delay" in the occurrence of these processes.

A delay of this kind depends on a suitable combination of geological and engineering barriers. The engineering barriers are being studied by a number of Argentine institutions specializing in the science of material and corrosion processes, supplemented by radioecological, thermal, and geological research work under the supervision of the Argentine National Atomic Energy Commission (CNEA) and the National University of San Juan.

In addition to the "normal" mechanism by which radionuclides are reintroduced into the biosphere, the design requirements take into account the possible occurrence of disruptive events of a random nature. For both types of situation, the safety goal is an adequate reduction in individual risk and limitation of the collective impact to values not exceeding those resulting from other stages of the nuclear fuel cycle.

The repository will have to meet the needs of the Argentine nuclear programme. The six nuclear power plants foreseen by the end of the present century will, by operating for 30 years, generate approximately 80 GWy of electrical energy. The wastes stemming from the reprocessing of the fuel elements used to produce this energy will require about 3000 containers approximately 0.6 m in diameter and 1.6 m high. Similarly, provision will have to be made for future enlargements of the repository as the needs of the nuclear programme gradually increase.

The radioactive wastes will be incorporated into a vitreous matrix of the borosilicate type inside a stainless steel receptacle. The receptacle will be coated with lead about 10 cm thick (which makes it resistant to corrosion for a period estimated at 1000 years), and protected on the outside by a metal sheath. The design of the containers will comply with the IAEA regulations for safe transport.

The content of fission product and transuranic oxides has been fixed at 10% by weight. Furthermore, the minimum decay time for the wastes prior to their storage in the repository has been limited to 20 years from the moment they are taken out of the reactor. The thermal power of each container will be 500 W.

An additional engineering barrier is the final sealing of the repository caverns with a filling material exhibiting high resistance to the inflow of water and the migration of the radionuclides. This can be done with a mixture of sand and bentonite with a high retentive capacity, which will be used to fill up each of the caverns made in the repository.

It has been decided that the permeability of the rock in the zone where the repository is to be constructed should not be greater than 10^{-9} m/s, and the maximum design temperature of the rock has been fixed at 60°C.

Study of the way in which the temperature of a granite formation changes with time shows that a limit of 60°C as the maximum design temperature for the rock necessitates a distance of approximately 5 m between the containers and a thermal power density of 5 W/m^2 on the horizontal plane of the repository.

The containers will be placed upright in shafts dug into the floor of the galleries, the latter being separated by a distance of 20 m. The shafts will be 1 m in diameter and approximately 4.5 m deep.

Site selection studies were begun in 1980. At the initial stage it was possible to identify 200 granite intrusives distributed throughout the country. Next, there was a pre-selection operation to identify those formations which lay outside the seismic zones and beyond areas where there were mining operations or oil production either now or in the future, which did not show major petrographic alterations, and which did not lie in areas known to have unfavourable hydrogeological characteristics.

Furthermore, as an additional selection criteria, account was taken of certain characteristics regarded as unfavourable from the standpoint of the construction and operation of the repository. Among such undesirable features were populated zones, tourist areas or regions with difficult access.

In this way it was possible to identify seven bodies located in the south of Argentina as the ones best meeting the established pre-selection criteria.

At a later stage, on the basis of a survey of the pre-selected granite bodies, four of these were singled out as the most suitable formations for continuing detailed studies.

It was decided to carry out the studies in the Sierra del Medio (one of the four masses identified) in accordance with the following scheme of operations:

(a) Photo-interpretation;
(b) Statistical analysis of alignments;
(c) Geological and geophysical reconnaissance of the rock mass;
(d) Drilling down to 200 m;
(e) Geomorphological and hydrogeological analysis on a regional scale; and
(f) Deep wells to a depth of more than 600 m.

On the basis of an analysis of the alignments and the geological and geophysical survey of the rock mass, ten wells were dug for purposes of petrographic and structural investigation. These wells, which varied from 200 to 280 m in depth, were made in order to study in detail the edges of the area selected as well as the fractures, dikes and other anomalies observed at the surface. The results obtained were analysed by geostatistical techniques.

At the present time an analysis is being made of samples obtained from four wells 600 m deep which are located at the top of an area of 4 km^2, identified as one showing least alteration. This analysis will provide the data needed for completing the initial phase of the detailed study of the Sierra del Medio.

The results obtained so far are promising enough to justify continuation of the detailed investigations, which have tended to favour the Sierra del Medio as the choice of site. These studies are expected to be complete by the middle of 1984.

The decision to build the repository will have to be taken in the near future. Although the problem of high-level waste in Argentina is not really an urgent one, the CNEA feels that it should tackle the problem of the management and disposal of wastes stemming from its nuclear power programme in order that future generations will not be faced with the challenge of an "inherited" problem, when it is already too late.

Mr Jean AUROUX

Secretary of State,
Ministry of Industry and Research,
with responsibility for energy,
France

This Round Table organized by the International Atomic Energy Agency is devoted to radioactive waste management. I am happy, it should be said at the outset, to have this first opportunity of making contact with a body which, by its activities throughout the world, is helping us to advance towards one of the objectives that has been most important to me since I took over the difficult task of shaping energy policy for the French Government. I am speaking of the objective which animates all your work, and which must be considered as the final goal of all the progress we hope to accomplish in energy matters: to put energy at the service of mankind, and not to make the nations slaves to energy. Today, after successive bouts of tension on the oil market, the abundance which has appeared for the time being, and which is very largely due to the recession the world economy has been going through for some years now, should not allow us to forget that this goal is a true challenge. In this context nuclear energy seems for many countries to be one possible way, if not the only way, of confronting the energy challenge of tomorrow while preserving national independence and acquiring immunity against future fluctuations in the prices of energy raw materials.

This is the analysis which decided the launching of the French nuclear programme. By 1990 more than 70 per cent of the electricity generated to meet France's needs will be of nuclear origin. At that time, power stations whose construction has already been inaugurated will have wholly replaced the fossil-fuel-fired stations for long-term utilization.

By 1990 we shall also have – and this is a particularly important point – an irradiated fuel reprocessing capacity of 1600 tonnes per year in service. This capacity will make it possible to meet French needs, and also the needs of many other countries which have launched nuclear power programmes and want to get the most out of the fuel cycle appropriate to their plants.

Whoever wishes to gain mastery over the fuel cycle as a whole cannot afford to neglect the final link in the cycle, namely waste management.

All the activities of the nuclear industry, like all other human activities in general, produce waste. Just to give you an example, France produces five tonnes of waste annually per inhabitant, only one kilogram of which is radioactive waste. This figure demonstrates that radioactive waste, while undoubtedly a serious question, certainly does not constitute an insoluble problem.

Waste management began to attract intensive research and show remarkable results only after the other stages of the fuel cycle. Nevertheless, the results are available now, and they make it possible for us to approach the waste problem from now on with the same confidence as the actual production of nuclear electricity.

But now I should like to dwell for a moment on the approach which the French Government plans to take towards waste management. Their policy can be summed up in four main principals: (i) integrated conception of the nuclear power generating system as a whole, including its technical aspects; (ii) structures which take into account the requirements of long-term waste management; (iii) carefully defined criteria for safety and security which are accepted by the highest scientific authorities of the country; and (iv) the broadest possible involvement of all interested sections of the population.

First, let us consider the integrated conception of the power generating system. It is this approach which led French engineers to adopt the reprocessing option. If we examine the evolution of prices in the energy field, we are bound to exclude straight away the possibility of utilizing a resource to the extent of only 1 or 2 per cent of its energy potential. This is something we cannot afford today, and our descendants -- who tomorrow will have to suffer the consequences of the wastage we allow ourselves today – will be able to afford it even less. In these circumstances any solution which enables us to make better use of a resource as scarce as uranium should not be neglected. Thus the reprocessing of fuel has become an imperative, an essential element in any energy programme which relies on uranium. This being so, it was important to consider the whole of the power generating system, including the fuel fabrication stage, as a function of reprocessing.

As far as wastes are concerned, our attitude consists in carrying the reasoning process a step further and considering from the very beginning of the fuel cycle the question of their long-term treatment, conditioning and management.

Thus the producers, knowing the criteria which have been accepted by all, will be at pains to design their facilities so as to allow the waste produced in them to be conditioned in a form such that they can be taken over by the body responsible for long-term management. This body is thus involved at a very early stage in preparing specifications for the waste to be produced.

This hierarchy of responsibility is the only way of giving waste management its proper place in the overall energy production process and of ensuring that the measures which have become indispensable through selection of the nuclear power option are taken into account at their true cost, so that we do not mortgage the future.

On the technical side, while the final solutions are still a subject of research, we can already discern the general lines they are going to follow. We can make a rough classification of wastes in two categories: those which after appropriate conditioning can be stored on the surface of the ground and those which have to be buried at great depth.

At the Centre de la Manche, France has already gained considerable experience of surface storage.

Storage in deep formations, on the other hand, is to be tested first as a pilot operation. This operation, which goes under the name of "underground laboratory", will not involve the storage of real waste but will be designed to verify the correctness of the concept. It is to be started soon in France, and the countries of the European Communities which wish to join in the operation are free to do so.

Conditioning methods are also to be a subject of thorough research. French industry has already demonstrated its know-how in developing a vitrification process for very high-level waste. The system in question has in fact already been adopted by a number of countries and is attracting great interest in the international community. France is also conducting a sizeable research programme on the conditioning of low-level waste. Thus, mobile waste incorporation units and methods of reducing the volumes to be stored have already been developed.

The third main point that I want to talk about is structural relationships. France has in fact developed relationships aimed at ensuring the best possible co-ordination between research workers and those who use the fruits of their research. Thus, one mission of the Commissariat à l'Energie Atomique is to carry out a programme of scientific and technological research which will guarantee France the essential know-how in matters of waste management. The National Agency for the Management of Radioactive Waste is responsible for practical implementation of the waste storage programme. It is at present in charge of operations at the Centre de la Manche, but very soon two new centres are to be installed under the Agency's responsibility, as was recommended by our Senior Nuclear Safety Council on 19 April 1983.

The fourth component of our waste management policy is particularly important to me because it represents an innovation which I shall venture to describe as historic. I am referring to the introduction of democratic procedures in the selection of waste management technology. The first element in this democratization consists in enhanced participation of the regions in the decision-making process. France has undertaken sweeping reforms of local consultation procedures which greatly improve the ability of the public to express an opinion.

It is essential that local public interest groups should be associated with decisions, but that is not sufficient in itself; they must also share the benefits which accrue to the national community from the facilities which they accept on their territory.

In the first place, a centre is bound to create in the community a certain number of jobs (200 during regular operation and a larger number during the construction phase) and the activity so generated will naturally benefit the community. Secondly, the construction of a storage centre is a very substantial enterprise, so it is reasonable to expect that the community accepting the centre will benefit from newly introduced equipment and infrastructures, and that an aid programme will be set up in parallel to the construction site.

In the third place, finally, the operation of a waste storage centre should bring financial advantages for the community involved, and we are at present considering what possibilities exist in this sphere.

Another requirement for introducing democracy in the selection of waste management technology is to have well-defined criteria which are known to the public. In this connection, the forthcoming publication of our *Fundamental Safety Regulation* for waste management seems to me to mark a very important stage in France's approach to the waste management question.

This Regulation will make it possible in future to consider the selection of storage sites on the basis of scientifically established criteria. In particular, it establishes standards for the successive containment systems designed to prevent any escape of radioactive materials into the biosphere.

The approach taken to determining the acceptability of storage sites seems very far-sighted to me: it consists in choosing sites where contacts with the biosphere (particularly through water flow) can be easily modelled so that it is possible to estimate the long-term evolution of the site by projecting into the future the human activities with which we are already familiar.

The Regulation also provides for an acceptability threshold for packages stored on the surface of the ground: their activity must not exceed 0.01 Ci/tonne on average after a period of surveillance at the end of which the centre can be released.

Finally, the Fundamental Safety Regulation gives an explicit definition of the site release concept: after a period of surveillance which in no case may exceed 300 years the centre must be usable for normal, traditional human activities without the need for any special precautions.

This Regulation imposes new conditions, more rigorous than those adopted previously, which represent the greatest possible measure of protection for both human beings and the environment.

If I may, to conclude, sum up France's position on the nuclear waste issue, I should like to repeat a quotation printed at the head of a report on radioactive waste management by two young engineers who had chosen the subject for their thesis. The quotation is from Jean Cocteau, well known for having raised paradox to the rank of a philosophical system: "By dint of getting to the bottom of a problem, one gets stuck with it". Well, as far as waste management is concerned we do intend to get to the bottom of the problem, and we do not intend to get stuck with it. This is the goal we have set for ourselves, and if my country is opening up new technological prospects in the waste management field, I am happy and proud to have been able to suggest the tenor of these developments to you.

Mr Manfred POPP
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Federal Republic of Germany

Waste management continues to be of central importance for nuclear energy utilization in the Federal Republic of Germany.

Politically, it is widely accepted that timely progress of the establishment of the back-end of the fuel cycle in all areas of spent fuel storage, reprocessing, waste management, and disposal, as well as recycling, is an important element of the credibility of nuclear energy policy. Legislation and jurisdiction, therefore, have led to the definition of conditions which have to be met by reactor operators. For the individual plant, licensing authorities require provisions for spent fuel management (storage and/or reprocessing) six years in advance. In general, a certain schedule for site investigations and the establishment of waste management facilities has to be met as a pre-condition to construction and operation of nuclear power plants.

Technically, the foundations for the establishment of the waste management concept have been laid during almost 20 years of comprehensive R&D.

Organizationally, the atomic energy law draws a line between the responsibilities of the nuclear industry and the Government. Industry is responsible for spent fuel storage, reprocessing, and waste conditioning. For these purposes, the Deutsche Gesellschaft für Wiederaufarbeitung von Kernbrennstoffen (DWK) has been set up by all 12 utilities operating nuclear power plants. Final disposal of radioactive waste remains the responsibility of a governmental agency, the Physikalisch Technische Bundesanstalt (PTB) at Brunswick. According to a provision in the atomic energy law, the PTB uses the services of an industrial operator, the Deutsche Gesellschaft zum Bau und Betrieb von Endlagern (DBE), set up to fulfil this task by three state-owned companies.

Financially, with the exception of R&D projects like ASSE and PAMELA, the costs for the establishment of waste management facilities have to be borne by the waste producers. The operation of the utility-owned DWK is a normal cost factor of nuclear-generated electricity. The governmental costs for the establishment of waste disposal facilities are reimbursed through a special pre-payment ordinance from the waste producers.

The main political milestones for the waste management concept, as established in 1979, were as follows:

- Extension of the storage capacities for spent fuel elements at reactor sites and construction and operation of away-from-reactor (AFR) storage facilities as soon as possible.
- Site selection for a reprocessing facility until 1985; operation before 2000.
- Evaluation of the feasibility of the Gorleben salt dome for disposal of all types of radioactive wastes until 1990; operation of a repository until 2000.
- Assessment of the safety aspects of direct disposal of spent fuel until 1985.

At present, the establishment of the waste management concept proceeds according to schedule, in some areas well ahead of the political milestones.

- The *compact rack* at-reactor storage is already being licensed for most of the reactors in operation and planned for all new ones under construction.
- The Gorleben *AFR storage* will start operation very soon, construction is completed. The fuel is stored in dry-storage transport containers.
- Two alternative sites have been selected for a reprocessing plant of 2 t/day throughput in Bavaria and Lower Saxony. The safety analysis report has been submitted to the licensing authorities and made public in September this year. The first licensing permit is expected end of next year, operation should start in 1992.
- The PAMELA demonstration plant for the vitrification of high-level wastes at Mol is in an advanced stage of construction.
- The ASSE mine continues to be used as R&D test facility, including tests with high-level wastes.
- The former iron ore mine Konrad is being transformed into a repository for low-active wastes and wastes from decommissioning of nuclear facilities, operation should start in 1988.
- The evaluation of the Gorleben salt dome is well under way. The construction of the two shafts is starting this

month. Results from the exploratory mining are expected around 1990.

- The evaluation of direct disposal techniques proceeds according to schedule. Experimental disposal canisters have been constructed. A comparative assessment of the safety aspects will be conducted next year.

Waste management in the Federal Republic of Germany has left the status of conceptional work. In all areas planning, licensing, and construction proceed according to tight time schedule. We are confident that all elements of the concept will become fully operational before the turn of the century.

Mr Raja RAMANNA
Chairman,
Atomic Energy Commission,
Secretary to the Government of India

It was recognized quite early in India's nuclear programme that safe management of radioactive wastes is vital for its successful implementation. More than a decade before commissioning of the power reactors, emphasis was laid on studies relating to impact of radioactivity on the environment. The basic philosophy in the management of all radioactive wastes has been to concentrate and contain as much activity as possible and discharge to the environment only those streams that have activity concentrations far below the nationally and internationally accepted levels.

As a policy, management of radioactive wastes has been the responsibility of an independent unit which is answerable only to the health and safety authorities in meeting their requirements and not to the facility operator. This has led to the initiation of extensive research and development programmes with a view to ensure safety and self-reliance through maximum utilization of indigenous technological capabilities.

Over the years, the philosophy of radioactive waste discharge to environment has been continuously under review. This has resulted in adopting more and more stringent measures to minimize the release of radioactivity to the environment. These measures to minimize discharges from Indian nuclear facilities have been adopted not because of any adverse effects noticed in our environment, but in pursuance of our opinion that the ultimate goal of radioactive waste management should go beyond merely satisfying prevailing regulations.

Due to the vastness of the country, with widely varying environmental features at the different nuclear sites, it was required to evaluate the specific characteristics of each site and adopt norms for both discharge of radioactivity to the environment as also for containment of wastes that cannot be discharged. While the limits for discharge of effluents at coastal locations like Tarapur and Kalpakkam take into account the significant dilution capacity available in the environment, the levels prescribed for hinterland sites like Rajasthan and Narora are, per force, more restrictive.

In principle, the Indian programme envisages two distinct modes of final disposition in respect of radioactive wastes; near-surface engineered extended storage for low- and intermediate-active wastes and deep geological disposal for high-level and alpha-bearing wastes. While other options like sea-dumping for low-active wastes and emplacement at medium depths below ground for intermediate-level wastes are being studied as possible options, our present strategy does not include these modes of disposal.

Economic considerations would warrant a large-capacity fuel reprocessing plant, centrally located, along with the required radioactive waste management capability. But in a largely populated, developing country like India, the logistical constraints, in terms of adequate transportation, network of suitable standards, and other infrastructural requirements, need to be reckoned with. As a result, at the present stage of the national development and priorities, we have found it more appropriate to set up smaller plants at different locations, notwithstanding certain economic penalties and the increased surveillance commitments. For the same reasons, it is necessary also to set up a vitrification plant for high-level wastes along with an engineered interim storage facility for the solidified waste products, colocated at each fuel reprocessing facility site. Only the ultimate disposal site for high-level wastes is presently conceived to be a centralized location.

Therefore, our policy can broadly be stated as follows:

- Any discharge of radioactive liquid or gaseous wastes to the environment should be as low as reasonably achievable, consistent with economic and societal factors.
- Low- and intermediate-level solid wastes and solidified wastes resulting from conditioning of waste concentrates or liquid wastes generated due to operation of reactors and research laboratories, are to be emplaced in shallow land repositories, specifically constructed for the purpose.
- High-level and alpha-contaminated liquid wastes from fuel reprocessing facilities, which are initially stored in tanks, will be vitrified and the solidified products are to be stored on-site in near-surface engineered storage facilities, with appropriate cooling and surveillance provisions for a minimum period of twenty years.

• Disposal of high-level vitrified and cooled waste products, and alpha wastes, will be in deep geological formations, specifically chosen for the purpose.

In terms of the magnitude of the problem, the question of radioactive waste management does not warrant any concern at the present time in India. Though our current nuclear power generation is modest, considering the committed nuclear power programme by the turn of this century, it is necessary that our policy goals are framed from a long-term perspective. Our experience in managing low- and intermediate-level wastes has been good and it is expected that our present scheme for management of high-level wastes, which will be effective in the near future, will also be a step forward in fulfilment of our objectives.

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Science and Technology Agency,
Japan

During fiscal year 1982, 24 nuclear power units (17 GWe capacity) supplied 20% of all electric power in Japan, while the capacity shares 12.3% of the total power generating capacity. Now that the nuclear power achieved 67.6% in its average availability factor last year, which is close to theoretical maximum, it is by far regarded as the most reliable energy source.

And this fact is driving the public to pay more attention to waste management rather than to safety of plant in general. According to the nuclear development programme, 20 nuclear units (19 GWe) are either under construction or in the planning stage. Therefore, as Japan has more nuclear power capacity, the establishment of a waste management system becomes a growing concern as an integral part of the nuclear power development programme.

Radioactive waste management policy in Japan is prescribed in the *Long-Term Programme for Development and Utilization of Nuclear Energy,* revised in June 1982 and adopted by the Atomic Energy Commission, which is a supreme organ to set up nuclear energy policy.

Low-level radioactive wastes – Among the low-level radioactive wastes generated in significant quantity from the daily operation or maintenance work at various nuclear facilities such as power stations, nuclear fuel fabrication plants, and so on, gaseous effluent and part of liquid wastes which are released to the environment, in accordance with the relevant regulations and the principle to keep environmental release as low as reasonably achievable, have so far posed no considerable problem. Other liquid wastes and solid wastes must be suppressed at their generation stage, reduced in their volume and solidified through best utilization of treatment technologies such as incineration, compression, mixing with cement, and then finally disposed of, either into the sea or into the land, depending on their characteristics.

The private sector which generates the wastes is to treat these wastes and is also responsible in principal for their disposal, after the stage when the technical prospect of disposal would have been determined through experimental disposal, and so on.

Because of its small land area and large population density Japan has strong needs for sea disposal and had already ratified the London Dumping Convention, in 1980, and taken part in the OECD/NEA Multilateral Consultation and Surveillance Mechanism for Sea Dumping of Radioactive Wastes, in 1981, with an intention of disposing of low-level wastes under the same international framework as followed by some European countries.

The sea disposal programme in Japan is to carry out experimental sea disposal of limited amount of radioactive wastes at the proposed area in the Pacific Ocean in advance of full-scale operation. The Government has carried out comprehensive environmental safety assessment as regards the sea disposal programme. In addition, since 1977 the second oceanographic survey at the proposed area, and the various demonstration tests on the packages concerning the integrity during descending to the sea bottom and the long-term anti-corrosion performance, have been carried out to make the safety of the sea disposal all the more confirmed.

Therefore, the scientific consideration on sea-dumping by the expert group to be set up at the coming Consultative Meeting of the Contracting Parties to the London Dumping Convention is one of the most important milestones which Japan should clear successfully so as to gain more common understanding on the safety of sea disposal at international level.

As for land disposal, the Japan Atomic Energy Research Institute (JAERI) and the Radioactive Waste Management Center are taking the lead in the experiments and research activities necessary for the establishment of a safety evaluation method. In parallel, various surveys for candidate sites are also being carried out throughout the country. Meanwhile, at the sites of nuclear plants the accumulated low-level wastes are stored in the warehouses and kept under control. And the Government is subsidizing the further development of waste treatment technologies for volume reduction and stabilization in private industries, although the rate of waste accumulation is considerably decreasing since almost every site has been equipped with incineration and/or compression facilities.

In this situation, the nuclear business is required furthermore to make the total prospect of the back-end clear as far as possible. In this regard, according to the Long-Term-Programme, the conceptual design of away-from-reactor (AFR) storage is developed for its early operation as an option to step toward disposal. Such an AFR storage must be effective as a measure to improve the economy and efficiency of management by means of aggregating the wastes in many sites to a central facility, and also to appeal to the public by demonstrating the safety and effectiveness of waste management at specific site conditions, which is necessary for the ultimate disposal. In this context, the Science and Technology Agency has formalized and published the basic idea of the AFR storage last July, with a view to stimulating both the public and local interest necessary to promote the siting.

Decommissioning of reactors – Radioactive waste management is deeply interrelated with the decommissioning of reactor facilities. Although Japan has more than 10 years until its oldest power plant comes to be decommissioned and be scrapped down for renewal, it is three years since the R&D project has started in JAERI to demonstrate the technology which is safe and effective in terms of control of radiation exposure and radioactive waste generation, making use of the JPDR, small-scale BWR plant.

In this connection, it is a matter of interest for Japan to establish the *de minimis* concept and the control system for the very low-level radioactive wastes as early as possible.

High-level radioactive wastes – Since the outset of nuclear energy development, Japan has made it a basic policy to promote reprocessing so as to recover and recycle the uranium and plutonium contained in the spent fuel. High-level radioactive wastes produced by reprocessing are now stored, in the form of solution, in tanks, at the reprocessing plant. These wastes are to be vitrified and stored to cool off for a certain period (30 to 50 years) at an engineered facility, where the Government is asked to demonstrate the respective technologies. Then the high-level wastes will be finally disposed of into repositories in geological formations under due control of the Government.

The pilot plant for vitrification is expected to start operation by around 1990, the extensive R&D efforts on the physical characteristics of potential geological structures have been made, and in 1984, a comprehensive review on the result is planned before the R&D embarks upon the next phase to investigate the promising sites.

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The waste policy issue has played an important part in the nuclear debate in Sweden during the last few years. A number of temporary legislative measures were introduced to solve critical political issues in connection with the completion and fuelling of new nuclear power stations. According to the Stipulation Act of 1977 permission to load a nuclear power reactor for the first time could only be given if the owner had shown that satisfactory arrangements were made for an entirely safe disposal of the spent fuel. The Stipulation Act deals only with the reactors which had not been loaded in October 1976 and is in effect a supplement to the Swedish Atomic Energy Act of 1956. A law concerning the financing of future expenditures for spent nuclear fuel and decommissioning of reactors, the Financing Act, was unanimously passed by Parliament in 1981.

An ad hoc commission was set up in 1979 with members from all political parties represented in Parliament, with the task to work out a new and comprehensive legislation. On the basis of the Commission's report the Swedish Government last month presented its proposal for a new law, which will come into force on January 1st, 1984. This legislation has been prepared in close consultation with the other political parties and it is hoped that the new proposal will find a broad support in Parliament. In particular, the new law regulates the waste management policy, and comprises the construction, operation, and final decommissioning of all reactors and all other nuclear facilities foreseen in the present programme. It will replace the Atomic Energy Act, the Stipulation Act, and parts of the Financing Act and will resolve a number of questions that were not covered consistently before.

The proposal now put before Parliament thus sums up the policy of the Swedish Government, in particular with regard to the high-level waste originating from the spent reactor fuel.

The fundamental philosophy of the new law is that everyone holding a permit to operate a nuclear reactor or to pursue any other nuclear activity carries the primary responsibility for the maintenance of safety. This means that it is not sufficient to fulfil the various conditions that the regulatory authorities have prescribed, the operator himself has to ensure that safety is upheld to the extent that is practically possible.

The implication when it comes to waste management is that the operator of a nuclear reactor is obliged not only to pursue the current activities of waste management, but also to provide for a comprehensive R&D programme so that the best available methods can be deployed at all stages of the handling and storage of radioactive waste. The new law does not prescribe any particular method for the ultimate waste storage. The reason for this is that the Swedish Government is not prepared to decide today which method is to be preferred. Much can be said in favour of direct disposal of spent reactor fuel in preference to reprocessing, in particular in order to prevent the development of activities that could contribute to the proliferation of nuclear weapons. But the methods in existence today for both reprocessing and direct disposal of spent fuel are still under rapid technical development. It is only in the last few years that major R&D efforts have been devoted to methods of treatment and final storage of high-active wastes. It is very likely that we will have much better and safer methods some 20 years from now.

Consequently, the Government finds it unwise to prejudge the issue and prefers to wait until a decision has to be made. A primary purpose of the new law is therefore to promote the waste management R&D.

Great emphasis has been given in the new law to the obligation to ensure full information on all aspects of safety. Local safety committees are already created at all the reactor sites. Such committees will also be formed in all communities where installations will be built for storage, treatment, and final disposal of waste. It is the Government's policy to maintain full transparency within the whole area of nuclear safety.

The fundamental principle for the financing of waste management and decommissioning is that the costs shall be borne by those who benefit from the activity which produces the waste. Consequently, the capital needed for the waste management activities must be raised during the operating life of the plants and be kept available for future requirements.

As mentioned earlier, the owner-operator is already now responsible for the financing of all waste management measures during the operation of the reactor and for the decommissioning of all nuclear installations in the nuclear power programme. A fee is thus charged for every nuclear kWh produced and deposited in an interest-carrying account with the Swedish National Bank. The fee is decided for every calendar year based on a plan submitted by the reactor operators. Depending on the previous history and the characteristics of the reactors different fees may be established, provided that the aggregate amount of fees paid during the operating life of a reactor covers all waste management costs. The accrued capital is used to reimburse the reactor owners for costs incurred for waste management and may be used to grant loans to the reactor owner against normal security.

Based on the plans described later, the utilities presented detailed cost calculations for the whole back-end of the Swedish nuclear fuel cycle for the first time in 1982. The total cost is estimated at near Skr 40 billion (equivalent to US $5 billion) in 1983 prices. This figure includes what has already been spent and all types of waste, including waste from research reactors and from outside of the nuclear power sector. However, it should be emphasized that future technological developments have not been taken into account in these calculations.

Based on the plan submitted the fee has been set at 1.7 Öre or some 2.2 mills* per kWh electric for 1982 and 1983.

High-level waste has been in the centre of controversy in the last few years. But the low- and medium-level wastes require increased attention. It should be observed that the cost of managing such wastes from nuclear power plants is regarded as a production cost and consequently is not covered by the Financing Act. The new law places a responsibility for these waste categories not only on the nuclear power industry but also on non-energy nuclear activities. The utilities will finance the management of waste originating from R&D carried out for the Swedish nuclear power programme. The Government will bear the cost of management of the waste originating from other sources than nuclear energy facilities, mainly from medical applications, scientific research, and technical-industrial use of isotopes.

The organization for carrying out this waste management policy is based on the afore-mentioned principles. The nuclear utilities are obliged to take the necessary measures to ensure safe management and disposal of the waste. The Government has recommended that this should be done jointly within one organization.

The Swedish Nuclear Fuel Supply Co. (SKBF) was founded in 1972 by the nuclear utilities for common services within the nuclear fuel cycle. The utilities have assigned SKBF the task of co-ordinating, planning, and executing on their behalf the investigations and measures required. The shares of the company are divided in proportion to the owners' licensed nuclear power generating capacity.

There are two regulatory authorities to supervise the safety of the nuclear power in Sweden: the Swedish Nuclear Power Inspectorate (SKI) and the National Institute of Radiation Protection (SSI). They are responsible for licensing and control according to the Atomic Energy Act (and the new law) and the Radiation Protection Act, respectively. They play an important rôle in waste management and decommissioning, since they have to study and appraise the nuclear safety and radiation protection of the proposed facilities and processes. They prescribe the conditions which the nuclear utilities have to meet to build and operate a facility, make sure that

* 1 mill. = US $\$10^{-3}$ = 0.1 ¢.

the conditions are adhered to and, if they deem it necessary, impose new or complementary conditions.

A new autority, the National Board for Spent Nuclear Fuel (NAK), was set up in 1981 to handle the new tasks according to the Financing Act. The responsibilities of the Board extend only to the spent nuclear fuel and radioactive waste originating from this fuel and to decommissioning. The Board does not assume or supersede the regulatory functions of the Nuclear Power Inspectorate and the National Institute of Radiation Protection. The question of responsibility under the new law, when it comes to the scrutiny and approval of the R&D plans, is still under study.

The safety authorities can also conduct R&D in order to strengthen their technical and scientific competence. All costs incurred by the regulatory authorities in the nuclear field are paid by the utilities through special fees.

The planning and implementation has been given a firm base by the resolution of the Parliament following the nuclear referendum.

The total cumulative net production of the 12 reactors, with a total installed nuclear generating capacity of 9500 MW, is estimated at 1500 TWh up to 2010. The residues from this production are estimated at around 7000 tonnes of spent fuel (calculated as uranium), 100 000 m^3 of reactor waste from nuclear power plant operations, and 150 000 m^3 of decommissioning waste.

In June 1982, SKBF presented its first radioactive waste management plan to the Board for Spent Nuclear Fuel. The plan comprises general premises, a comprehensive research and development programme and a detailed description of facilities, including calculated costs as quoted earlier.

According to the present timetable, the site for the high-level waste repositories should be chosen by the end of this century. Construction work for these and the encapsulation facilities should begin about 2010 and be completed about 2020. The designs of the repositories and facilities are given in some detail and present data on construction work, staff, and investments. This is necessary for reliable cost calculations but it must be emphasized that undoubtedly many changes will take place before any construction work is to begin.

The plan is based on the concept of multiple-barrier repository about 500 m down in crystalline rock. The deposition will be preceded by an intermediate storage period of about 40 years in order to limit the heat flux in the repositories. A technical concept based on reprocessing has been approved under the terms of the Stipulation Act and reprocessing contracts have been concluded for about 10% of the total amount of fuel foreseen in the plan.

However, a new analysis and description of another concept, which is based on a system for the disposal of under-processed spent fuel, was presented in May of this year and has been sent out for review to a great number of expert organizations in Sweden and abroad, among them the IAEA. It forms the bases for the application for permission to load the last two reactors in the Swedish 12-reactor nuclear programme.

Obviously, it would be much simpler and more economical if all the spent nuclear fuel could be handled according to a single concept.

A detailed description of the planned system for radioactive waste management was given at the Seattle Conference. Work in the 1980s is concentrated on the construction of facilities to ensure an uninterrupted production of nuclear-generated electricity and on continued development of a system for disposal of the nuclear waste. A Central Intermediate Storage Facility for Spent Fuel (CLAB) is under construction in a rock cavern at Oskarshamn and is scheduled to start operation at the beginning of 1985. A Central Final Storage Facility for Low- and Medium-Level Waste (SFR) from reactor operation is under construction at Forsmark. It is to be located underground and it is planned to be in operation in 1988.

Low- and medium-level waste from nuclear power R&D, mainly originating from work in Studsvik, will be treated and put in temporary storage there before being transferred for final disposal at the SFR at Forsmark, and so is waste originating from other sources than nuclear energy facilities.

As all the nuclear power plants, as well as the CLAB and the SFR, are situated by the sea, a sea transportation system, consisting of a ship designed specially for nuclear waste transport and special transport vehicles, was put into operation at the beginning of this year.

Like many other nations, Sweden is concerned about the present practice of dumping radioactive substances at sea. The five Nordic countries have consistently been of the opinion that sea disposal of radioactive wastes of any type should be avoided, and that land-based methods of disposal where the wastes can be isolated from ecosystems and more easily kept under surveillance, should be used.

The R&D programme covers a wide spectrum of disciplines, in which research is conducted both in Sweden and abroad. It includes a broad geological programme with extensive investigations including test drillings at 10 to 20 sites within this decade. The International Stripa Project is also connected with the programme. About 85 million Skr will be spent this year on nuclear waste management R&D. The new law foresees that alternative solutions are covered by the programme, it has to comprise at least a six-year period and it will be reviewed by the authorities every three years.

In summary, the Government has at its disposal all tools of regulation and organization required in order to secure that all practical implementations, be it construction and operation of facilities or R&D, will be carried out in a timely fashion and in accordance with a comprehensive plan. The new law now before Parliament will strengthen the safety by clarifying the division of responsibilities. It will also give Sweden improved possibilities to fulfil its international obligations, in particular when it comes to non-proliferation. It is hoped that the new legislation will achieve a broad consensus and thus form the basis for a stable long-term policy for nuclear waste management.

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The UK Government is satisfied that it is feasible to manage and dispose of all the radioactive waste currently envisaged in the United Kingdom in acceptable ways, although the technology required may have to be further refined and developed. The necessary work is in hand.

We have compiled a waste inventory and have prepared a long-term strategy for the management of all wastes identified, including those at present stored. We identify the most appropriate management method available for each waste type and then ensure that the chosen method is implemented according to an agreed programme and in a way that is consistent with the objectives for radiological protection. Where the disposal routes are not at present available, it is our objective to ensure that such wastes are safely stored, with treatment, if necessary, but taking due account of the suitability of the treated wastes for eventual disposal.

Our research programme includes studies designed to bring out relevant management options, and also studies which will assist in formulating the criteria to assess them. A systems engineering study makes it possible to take into account the interactions between different management approaches and to evaluate the costs, in radiological and financial terms, of alternative waste management systems.

The UK Radioactive Waste Management Organization has three elements: Government; the nuclear industry, including the electricity-generating utilities; and the private sector. At the Government level the regulatory bodies ensure, by general oversight and the use of their statutory powers, that high standards of radioactive waste management are maintained; that potential hazards are reduced to levels that are not only acceptable but are as low as reasonably achievable; and that the public are fully safeguarded both now and for future generations.

While the Government remains responsible for the overall waste management strategy, its implementation falls to the nuclear industry and generating boards, acting where appropriate through the Nuclear Industry Radioactive Waste Management Executive (NIREX). NIREX was set up in 1982 in order to provide a mechanism by which the nuclear industry can fulfil their own responsibilities within a comprehensive national plan for waste management. Regulatory Departments require the waste producers to develop detailed plans for dealing with the various waste types, within the scope and projected timescale of the national strategy. Following the approval of these plans, the Environment Departments will receive specific proposals from the industry for new facilities. The nuclear industry and the generating boards will retain their existing plant and facilities, but the creation of NIREX enables the bodies involved to arrive at a common view and take common action by the promotion of schemes which will benefit more than one body. All costs will be borne by the producers of the wastes through their contributions to NIREX. Following public consultation, the Government will give NIREX detailed guidance on the principles which will govern the assessment of their plans and proposals.

At present there is a variety of methods in the UK for disposing of radioactive wastes. Each disposal requires separate authorization on a case-by-case basis under our Radioactive Substances Act 1960. For very low-level wastes, conventional waste disposal methods are used such as discharge to sewers and disposal on local authority refuse tips. For low-level wastes not suitable for such methods, there exist shallow land burial facilities at Drigg in Cumbria and Dounreay in Scotland. NIREX is currently considering the identification of a successor site for Drigg. In addition some low-level wastes are drummed and disposed of in the Atlantic Ocean, subject to the London Dumping Convention and the consultation and surveillance mechanism of the NEA.

There is at present a lack of suitable disposal facilities for intermediate-level wastes and it is important that this be remedied as soon as possible. The types of waste that can be accepted at any given facility will depend upon the eventual design, and it is not therefore possible to say now what facilities will be required. NIREX is reviewing potential sites for investigation with the objective of bringing into operation by the end of the decade facilities which should be able to accept a high proportion of intermediate-level wastes.

Heat-generating wastes are the highly-active liquid residues arising from the first stage of the reprocessing of spent nuclear fuel, or the fuel itself if it should be designated as a waste. The liquid residues have been safely stored in cooled stainless steel tanks at Sellafield for up to 25 years. Work is going ahead on the construction of a vitrification plant at Sellafield which will convert the liquid wastes to glass. The blocks will then be stored at the surface for a period of at least 50 years to allow for thermal decay, which will simplify eventual disposal.

The options for disposal of heat-generating wastes are already clear in outline: burial deep underground or emplacement in the deep ocean. There has been extensive research into burial deep underground and we consider that its feasibility has been established in principle. Research is continuing into emplacement on or under the ocean bed in order to bring knowledge about those options to the same level by 1987. However, we still have plenty of time before we need to take decisions about the development of disposal facilities for heat-generating wastes.

The most significant discharge of radioactive liquid effluent in the UK is through the pipeline to the sea from reprocessing activities at Sellafield. Much smaller quantities of radioactivity are discharged to the sea from other nuclear sites. All discharges have been, and are, within authorized limits; and in all cases the resulting exposures are well within ICRP recommendations, but plans are well advanced to reduce them still further. Discharges to the atmosphere are of relatively minor importance under normal operating conditions. The conclusions of a recent NEA report and our own examination of the problem do not point to any present need for further national and international controls to limit the build-up in the atmosphere of long-lived radionuclides, but the subject will be kept under review.

Radioactive waste is of much public concern. The public sometimes see it as dangerous and intractable material which poses almost insuperable management problems. This view is, in the Government's considered judgement, an exaggerated one. Closer study of the question shows that, although problems and dangers are certainly present, the problems are being resolved, and the dangers can be eliminated by the systematic application of known technology and sound common sense. Policies to this end will not, however, be successful unless there is public support based on a full and accurate assessment of the situation.

The UK Government proposes to take the appropriate measures to provide the necessary basis for public support. It will continue to make available information about the amounts of waste stored at civil nuclear sites. It will continue to publish accounts of monitoring, research and discharges to the environment. It will make readily available information about its policies and the reasoning behind them. It will ensure that its strategy is publicly available.

For more than 30 years the UK has been engaged in the development of nuclear power for peaceful purposes and, over that time, has had an excellent record of ensuring the safe management of the wastes that arise from its use. The Government is convinced that we can continue to manage those wastes safely and successfully in the future and that solutions to the problems of radioactive waste management are available to us as and when they are required. What is needed is effective action to develop these solutions and put them into practice at the appropriate time in ways that will be publicly acceptable.

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Radioactive waste management is an important and critical concern to us all – individually, nationally, and internationally. In the international arena, the International Atomic Energy Agency (IAEA) had its first conference on this subject in the United States in May of this year. Unfortunately, I was unable to personally host Dr Blix and the Agency at the conference as I had hoped and expected. However, I understand it was a successful conference at which the following major conclusions were reached:

(1) In most countries which are engaged in nuclear activities, management of nuclear waste disposal is well under way.
(2) Solutions to institutional, regulatory, financial, and socio-political issues are prerequisites to successful deployment of the available technology.
(3) In general, nuclear power can be harnessed for mankind without creating an unmanageable waste disposal problem.
(4) There was a consensus that no technological breakthroughs are required for the safe management of radioactive waste.

All participants in that first conference should be commended for their contributions, and Dr Blix should be especially commended for his personal and knowledgeable involvement in the nuclear waste issue.

I wish to emphasize that we *all* have a great deal at stake in assuring that the IAEA maintains its basic technical capability for addressing critical issues, such as nuclear waste management.

Turning now specifically to waste management in the United States, for almost four decades high-level radioactive wastes have been generated in the United States. These wastes have been stored prior to disposal in both large tanks for reprocessing waste and water basins for spent fuel.

Many isolation concepts have been discussed over the years and the concept of isolating nuclear waste in mined repositories deep underground was first advanced in 1957 by a committee of the National Academy of Sciences. Their recommendation was that rock salt be studied as having favourable characteristics for underground disposal.

We spent a decade of research evaluating bedded salt as a host rock. Based on that research, we initiated an accelerated programme in 1970 to develop a repository in bedded salt at Lyons, Kansas. However, we weren't ready either technically or politically for such a major step at that time. Consequently, this programme was dropped and a broader national programme looking at additional rock types around the country was initiated.

The studies and exploration in these media – salt, basalt, tuff and crystalline rock – have continued over the years. However, while the responsibility for the permanent disposal of this waste has rested with our Federal Government since the Atomic Energy Act of 1954 was enacted, until recently, major obstacles have existed in the United States which have impeded the successful disposal of nuclear waste. These obstacles have included fluctuations in national policy; unwillingness of States to host a repository; and uncertainty in annual funding for nuclear waste activities.

Recognizing these problems and the need to remove the waste management issue as an impediment to the future use of nuclear power, late last year the United States Congress passed legislation to bring to an end years of indecision on how to solve the problem.

The Nuclear Waste Policy Act of 1982, signed into law by the President January 7, 1983, established a schedule and step-by-step process by which the President, the Congress, the States, affected Indian tribes, the US Department of Energy and other Federal agencies must work together in the siting, construction and operation of geologic repositories for disposal of high-level radioactive waste generated by civilian nuclear reactors. This law has provided a mandate and, more important, a set of rules for proceeding with the identification and selection of sites for a repository as well as for interim storage facilities in the event they are needed.

The Act also established a mechanism to ensure adequate funding for the programme to be paid for by the users of nuclear power. As of April 7, 1983, we began charging all US utilities with nuclear power reactors a fee of one mill – one-tenth of a cent – per kilowatt-hour of electricity generated by a civilian nuclear power reactor for disposal services. We believe the revenues from this fee, which will initially be about $400 million a year, will be adequate to cover all projected waste disposal costs.

The Department of Energy has the responsibility to provide for the permanent disposal of high-level radioactive waste such as spent nuclear fuel or reprocessed spent nuclear fuel. The Act strengthened this responsibility and confirmed the Nation's commitment to nuclear waste disposal and to the role of States and the public in the process leading to permanent disposal.

As a basis for the site selection process, the Department of Energy must issue Site Selection Guidelines. These Guidelines will be used for the recommendation of sites for repositories in geologic formations. To date, we have gone through an elaborate review process regarding these Guidelines. After receiving concurrence on these Guidelines from our Nuclear Regulatory Commission, we plan to issue them Guidelines late this year.

Nine potential repository sites have been identified in six States – one basalt site in Washington; one tuff site in Nevada; two bedded salt sites in both Utah and Texas; and three domed salt sites, two in Mississippi and one in Louisiana.

The Nuclear Waste Policy Act requires that by January 1985, the Department of Energy recommend to the President at least three sites for detailed characterization which includes construction of exploratory shafts and extensive testing and data collection. Based on the results of site characterization we will recommend to the President one of these sites for the first repository. Subsequently, the Nuclear Waste Policy Act calls for the President to recommend to Congress by March 1987 the site for the first repository.

When this recommendation is made, the Governor of the State in which the proposed site is located may veto the selection, in which case the veto stands unless overridden by both Houses of the United States Congress.

After a site is approved, the Department of Energy will submit a construction application to the Nuclear Regulatory Commission. The Commission has three to four years to approve the application; and once we receive the construction license, construction will begin with the mandated target to begin accepting waste by 1998.

The Act also provides for the siting and licensing of a second repository. The schedule for the second repository is for DOE to recommend to the President by July 1989 three sites for detailed site characterization.

As part of our efforts toward siting of a second repository, we are conducting detailed literature studies of crystalline rock formations in 17 States to determine if those States contain potentially acceptable sites for a second repository. These States are in the North Central, Northeastern and Southeastern parts of the United States.

As a back-up to the repository siting programme, we are studying the need for and feasibility of constructing monitored retrievable storage facilities. This could provide the capability to rapidly implement a long-term nuclear waste storage option should the repository be delayed.

The Act clearly states that utilities have the responsibility for interim storage of their spent fuel. However, the US Government may provide up to 1900 metric tons of Federal Interim Storage based on need and eligibility determined by the Nuclear Regulatory Commission.

As an alternative to geologic disposal, we are currently studying sub-seabed disposal. As many of you know, we are participating in international studies to determine the feasibility of sub-seabed disposal.

Our contribution to the international scene is a national programme aimed at constructing a geologic repository by the late 1990's. And based upon the Nuclear Waste Policy Act, we have made an offer to co-operate with and provide technical assistance to non-nuclear-weapons states in the field of spent fuel storage and disposal. In addition, we are prepared to engage in information exchange and other forms of co-operation in connection with the disposal of high-level waste.

We anticipate that there will be continued strong interest among nations in collaborating in the field of nuclear waste management. We are prepared to work hard and diligently to ensure that we all can benefit from our experiences in nuclear waste management technology.

Safe, permanent disposal of nuclear waste is a global concern. We need to have international co-operation so that all countries which have the need for disposal may share the results of the development and demonstration of the technology in planning and executing their programmes.

Based upon our experience in the United States, the following four conditions must exist in order to have a successful national waste management programme:

(1) You need a fixed, stable policy to conduct successful nuclear waste management; (2) You need broadly accepted standards for health, safety, and environmental protection; (3) You need the best technology and scientific data available and the most qualified manpower to assess compliance with these standards; and (4) You need the geologic and engineering capability to achieve safe and reliable disposal of high-level waste.

To the degree that any one of the four conditions is missing, problems will be encountered. For instance, prior to passage of the Nuclear Waste Policy Act, need number one – a fixed, stable policy – was missing in the United States. This was clearly a problem. However, through strong national programmes and international co-operation, eventually all countries dependent on nuclear power should have the resources for successful waste management programmes.

Among our Nations, we have the technologies needed to safely handle nuclear waste now and in the future. Many countries now look to nuclear power for such a large portion of their total electricity generation that life without nuclear power generation would be unthinkable. With the growing importance of nuclear power generation in the world, it is essential that we implement effective waste disposal technologies. With continued research and operation, more options will become available, especially if there is maximum international co-operation.