

COMMISSION OF THE EUROPEAN COMMUNITIES

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PROPOSAL FOR A SECOND FIVE YEAR PROGRAMME
(1980-84) ON RADIOACTIVE WASTE MANAGEMENT
AND STORAGE
(INDIRECT ACTION)

(Presented by the Commission to the Council)

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In 1975, the Council approved a five-year programme on the management and storage of radioactive waste, involving a budget of 19.16 million u.a. and a staff of four. It is due to expire on 31 December 1979. At the time, the Commission pointed out that in view of the type of question dealt with, it ought to be regarded as the first phase of a longer-term programme. Accordingly, the Commission is now proposing that the Council approve a second five-year programme (for 1980-84), which would be the logical continuation of the first one.

The proposed programme would require 53.5 million u.a. and a staff of fifteen.

Its objective would be the same as that of the first programme, namely to provide effective solutions to safeguard the public and protect the environment against potential hazards associated with nuclear activities. In view of the progress already achieved, however, the research would now be oriented more towards pilot projects and experiments under real-life conditions, and towards evaluation of the quality of the radioactive products obtained after treatment with a view to their storage.

The programme would be implemented under shared-expense contracts concluded with the competent public or private bodies in the Member States.

In carrying through this indirect action programme, the Commission would again have the assistance of an Advisory Committee on Programme Management which is also responsible for the direct action programme.

The close cooperation established with the Joint Research Centre in the field of radioactive waste would likewise be maintained.

B. PROPOSAL FROM THE COMMISSION TO THE COUNCIL

Second five-year programme on radioactive
waste management and storageI. INTRODUCTION

The programme on radioactive waste management and storage approved by the Council on 26 June 1975⁽¹⁾ is one of the measures by which the Community is seeking effective means to ensure the safety of the public and protection of the environment in view of the need to develop nuclear energy along with the conventional and new energy sources.

This programme is due to expire on 31 December 1979.

Having regard to :

- the maturity of the nuclear industry and the increasing numbers and variety of installations now being brought into service;
- the time needed to develop and try out solutions likely to give an answer to the problems involved in the management, and above all the disposal, of radioactive waste; and
- the promising results of the first programme. The Commission now proposes to the Council a second five-year programme to commence on 1 January 1980. The new programme will be the logical continuation of the current one.

This document begins by reviewing the first programme and the results achieved, goes on to explain the reasons that have prompted the Commission to propose a follow-up programme, and outlines what are to be its main features.

The detailed contents of the second programme, subdivided into four chapters, are given in the Annex.

(1) OJ L 178/28 of 9 July 1975.

II. The first programme on radioactive waste management and storage.

II.1. Contents

By its Decision of 26 June 1975, the Council approved a five-year programme to run from 1 January 1975 to 31 December 1979, covering the research listed below:

A. Research aimed at solving technological problems involved in the treatment, storage and disposal of radioactive waste.

Treatment

- medium-activity solid waste: study on immobilization with plastic resins;
- high-activity solid waste: decontamination and conditioning of irradiated fuel element claddings;
- high-activity solid waste: immobilization of calcined fission products in a metal matrix;
- plutonium-contaminated solid waste: incineration process;
- comparative study of the properties of various materials that might be suitable for the immobilization of high-activity waste.

Storage and disposal

- storage of solidified radioactive waste in engineered structures;
- disposal of radioactive waste in suitable geological formations, including the formations currently being studied;
- storage of gaseous waste.

Study of an advanced management model

- separation and recycling of long-lived waste (actinides).

B. Measures to help in defining general arrangements (legal, administrative and financial) for waste storage operations.

- review of the problems raised by radioactive waste management for which no solution can be found in existing international legal, administrative and financial provisions; proposal of solutions;
- study of the principles that ought to govern radioactive waste management.

II.2. Execution

This indirect action programme is being carried through on the Commission's responsibility by means of shared-expense contracts concluded with public and private bodies in the Member States (chiefly public, owing to the nature of the research involved). The contracts concluded in this connection number about a hundred (as at December 1978).

In implementing this programme, the Commission is assisted by the Advisory Committee on Programme Management (ACPM) set up by the Council Resolution of 19 November 1973 to deal with the direct-action programme on the processing and storage of radioactive waste; the powers of this Committee were extended to cover the indirect-action programme by the Council Resolution of 26 June 1975. The cooperation has proved very fruitful owing to the helpful spirit that has developed between members of the ACPM and senior officials of the Commission departments, resulting in common viewpoints on most of the problems.

The Commission has also set up eight standing working parties to deal with the various research topics listed in the programme, and to:

- provide specialized scientific support for the Commission and the ACPM in handling the technical aspects of the programme;

- ensure that at operational level there are frequent exchanges of views and information directly concerning the latest progress of research under the programme.

The standing working parties are composed of national experts appointed by the ACPM, the Commission's contractors and representatives of the Commission departments including the JRC. This membership ensures that everyone concerned is kept equally well informed, whether the research is being carried out in his own country under contract to the Commission or not.

These working parties have met several times a year, according to the needs of the programme and everyone concerned finds them to be extremely useful centres of information and discussion.

Having received a unanimously favourable opinion from the ACPM, the Commission notified the Council on 1 August 1977 that the revision of the programme, for which provision was made in the 1975 Council Resolution, was not required. The only changes have been in the emphasis laid on certain projects, notably and easing-up in the work on the study of an advanced management model - separation and recycling of long-lived wastes (actinides) - to take account of the JRC's direct-action work in the same field.

II.3. Results and achievements

Although it is hard to make any firm assessment of the results of a programme that is not yet completed and that represents only the first stage of a longer-term programme, there are some conclusions that can already be drawn regarding the initial objectives.

(i) Furthering the exchange of knowledge and the dissemination of the results in the Community

- The exchange of up-to-the-minute information on the work of the programme is ensured at operational level by the standing working parties referred to earlier. Moreover, seminars at which the progress and orientation of the research are discussed by experts⁽¹⁾ are organized for any matters of importance (e.g. the seminar held at Harwell in September 1977 on the thermal effects of underground disposal of radioactive waste).

In the nature of things, this exchange of information is restricted. A wider exchange takes place within the framework of international cooperation (see below).

- The results of research contracts appear in the reports published on completion of each contract. By agreement with the contractors, these reports are either published or "communicated" to the bodies concerned in the Member States (Article 13 of the Euratom Treaty). The Commission also publishes an annual report on its activities⁽²⁾. Publications in scientific periodicals and reports at international

(1) Including non-Community experts, who may be invited in a personal capacity for their exceptional qualifications.

(2) First report, years 1975, 1976, EUR 5749 e, f; second report year 1977, EUR 6128.

conferences supplement these arrangements and place the work of the contractors on a footing of open competition with other scientific achievements anywhere in the world.

- Finally, a full-scale public conference is to be held early in 1980, when the programme is completed; the contractors and the Commission will then have an opportunity to present the results of the programme to the international scientific community.

(ii) Avoidance of unnecessary and costly duplication of work through coordinated distribution among the various laboratories.

There are many examples that might be given; the most notable is probably the following distribution of subjects for study among the national bodies responsible for investigating the disposal of waste in geological formations:

- crystalline formations: France and the United Kingdom;
- saline formations : Germany and the Netherlands;
- argillaceous formations: Belgium and Italy.

At the present stage, this distribution in no way implies a national commitment in favour of a given type of formation; among other reasons ⁽¹⁾, it is dictated by considerations of economy, for the work in question calls for deep drillings which are extremely costly, and for the time being the duplication of these for the same type of formation would not be justified.

(iii) The reinforcement and speed-up, with financial support from the Commission, of research into certain technological solutions which were already being studied with varying degrees of intensity in the Member States.

Here, too, many examples could be given. In particular, it can be said that the work done by the public bodies in some of the Member States on disposal in geological formations would not have progressed at the rate it has without the Commission's participation.

(1) One obvious consideration is the nature of the subsoil in each country.

Along with these indirect - and incommensurable - results of coordination and collaboration, it is imperative to consider the scientific results of the programme in the light of the following prime objective:

- (iv) ".. to find effective means / as regards the management and storage of radioactive waste / for ensuring the safety and protection of both man and his environment against the potential hazards involved in the management of such waste"⁽¹⁾.

Research on the treatment of radioactive waste

This research is aimed primarily at developing satisfactory treatment processes. There is a twofold requirement: greater safety in the handling, transport and storage of waste, and reduction of volume.

The first of these requirements can be satisfied by "solidifying" the liquid or gaseous waste to make it less mobile; the second requirement is met by various techniques such as combustion and/or compaction.

The results obtained are described in the annual reports on the status of the programme. Noteworthy are the following:

- the start-up in April 1979 of an industrial pilot installation for immobilizing the waste from a nuclear power station (SENA) in thermosetting resins with a high resistance to mechanical, chemical and bacteriological attack and to fire;

- the study at three research centres (B, D and F) of different processes for the conditioning of irradiated fuel-element claddings and the characterization of the radioactivity associated with them (UK, Commission), with a view to comparison and possibly selection at a later date;

- the active try-out in a laboratory installation of a process for the conditioning of various residues containing alpha emitters (D);

- the study of three different processes for the treatment by combustion of plutonium-contaminated combustible waste and other alpha emitters (B, F, D), and the investigation of possibilities of recovering the plutonium contained in the waste (UK). An industrial-scale incinerator for lightly-

(1) Ref. OJ L 178/28 of 9 July 1975, 2nd recital of the Council Decision.

contaminated waste is to be placed in active alpha service at Mol in the middle of next year. With this method of treatment, the volume is reduced by approx. 95 %, and the contaminated ash is immobilized in stable slag.

The other two processes - combustion in molten salts and acid digestion - will permit the recovery of nearly all the Pu contained in the waste. Pilot installations will be ready for non-active operation in 1979;

- the coordinated project of the United Kingdom Atomic Energy Authority (Harwell, UK), the Institut Hahn-Meitner (D) and the Commissariat à l'Energie Atomique (F), the purpose of which is to evaluate and compare, under identical conditions, the properties of high-activity waste vitrified by the procedures being developed in their respective countries; the first results show that a dose of alpha radiation equivalent to that received by the vitrified products during 100 000 years of storage increases their leaching rate only by a factor of two. No deterioration of the glass due to devitrification at high temperature has been observed at temperatures below 700 °C. Except for one type of glass, all the samples maintained at 800 °C for 100 days had kept their resistance to leaching;

- the preliminary results on methods for the storage and/or disposal of radioactive krypton after separation of the gaseous effluents (B, D, NL, UK) - these methods may be useful when the nuclear industry has grown to the point at which the current procedure of chimney release is again called into question;

- the try-out in model detritiation units of two processes for separating tritium from the liquid effluents of the fuel-reprocessing installation by using different catalysts (D, B);

- the possibility, now being investigated, of using glass with a low fusion-point for the immobilization of iodine (F).

Research on the storage and disposal of radioactive waste

The chief objective of this research is to determine the optimum conditions for the disposal of radioactive waste in deep geological formations, so that no harm results either for man or for the environment.

The survey of geological formations with technical characteristics favourable to the establishment of storage sites in the deep subsoil of the Community countries is a preliminary task in which all the specialized bodies of the Member States are taking part. It is already apparent that there are numerous formations with promising characteristics.

The experimental work, which is shared among the Member States in the manner indicated in section II.3 (ii) and accompanied by supporting studies in Denmark and Ireland, is the central feature of the first Community programme.

Although it is too early to sum up the results achieved, which are still only partial, the data confirm the validity of the concept of disposal in continental geological formations, and give an insight into the specific storage conditions that are necessary in the various formations.

In the Federal Republic of Germany, interesting results have been obtained concerning the effect on saline rock of the heat generated by radioactive decay of waste⁽¹⁾:

- the physico-chemical, thermomechanical and rheological properties of the rock have been ascertained up to 300°C;
- the conditions under which corrosion of the cylinders containing vitrified waste may occur owing to heat-induced migration of the brine have been clarified;
- on-site simulation experiments to study the effect of heating on a network of vertical channels for waste storage have shown that such heating has only a limited influence on the diameter of the heated channel over a period of time, and no detectable effect on the other channels.

(1) The experiments were conducted by electrical simulation both in the laboratory and in the Asse salt mine in Lower Saxony at a depth of 750 m.

Sheet No. 5Testing and evaluation of solidified high level wastes

Practically all non-volatile fission products and a significant quantity of actinides from the nuclear fuel cycle will be concentrated in the high level liquid wastes. For storage for longer than about 20 years and for final disposal these liquid wastes should be solidified. Glasses and glass based ceramics are at present the favoured matrix materials.

Under the first programme, three major European research laboratories specialized in the testing of radioactive materials, the Centre de Marcoule (CEA-France), the Hahn-Meitner-Institut Berlin (ARG) and the AERE Harwell (UKAEA Great Britain) carried out the investigations on waste glasses and ceramics by way of joint action.

The relevant basic properties

- leaching resistance
- alpha-radiation stability
- thermal stability
- mechanical stability

as well as various mechanical stability other characteristics of six European waste glasses and one glass ceramic were measured under identical conditions and the effects of devitrification and diffusion were identified and analysed.

As a further result of the close collaboration and widespread interest of other European laboratories in this joint action, all the experts consulted by the Commission have stressed the importance of continued efforts for the development of common test methods and called for an enlarged joint experimental programme to compare and verify the results obtained with these test methods in all the laboratories concerned.

This action could be extended to other than glass based products if there is sufficient evidence that these products are viable alternatives or complements. In view of the low commercial interest of these test methods and the benefits of standardization, this action could become a subject of wider international cooperation. The most important efforts in the field of testing and evaluation should be directed towards new test methods, which could provide directly applicable data for the assessment of deep geologic storage and disposal performed under the terms of Sheet No. 7.

In Italy, work has centred on the geological characterization of the thick argillaceous formation in the subsoil of the Nuclear Research Centre at Trisaja in southern Italy:

- a borehole 750 m in depth is being drilled in order to obtain undisturbed clay samples for characterization;
- measurements performed on clay samples, and confirmed by calculation codes, have shown that the thermal conductivity of the clay at around 100°C is approx. 3.5×10^{-3} cal/s.cm.°C.

In France:

- three metamorphic crystalline massifs of different granitic structure have been studied, and a mathematical model has been made of the water flow conditions in one of the rocks, enabling the lines of flow to be traced and the order of magnitude of the transfer times to be calculated;
- work on the forecasting of possible migrations of radioelements in solution through the geological formation - from the waste storage site to the surface environment - have made it possible to construct models of the natural flow in poorly permeable rock and to represent the transportation of radioelements in solution. Confirmation tests have been carried out in several 40 m drillings on the preselected site;
- the application of the preliminary results of these studies has shown that a long-term guarantee of confinement of radioactivity can be obtained;
- a preliminary selection has been made of materials likely to form good geochemical barriers between the waste and the geological formation.

United Kingdom:

- three rock formations are being studied (Cheviot granite, Strath Halladale and Carrick Forest). Geological, geophysical and hydrogeological prospecting including drillings to a depth of 200 metres, is due to start right away at Altnabreac (Strath Halladale granite) now that the authorizations have been granted;
- an evaluation of the thermal effects of radioactive waste disposal has shown the need to limit the temperature of the granite in order to avoid fracturing. Simulation tests on the heating of granite in a 50 m borehole have been carried out to check of the calculation methods experimentally;
- lastly, the study of a model of the possible transfer of radioactivity from the disposal site to man - based on pessimistic assumptions with regard to the circulation of underground water and ion exchange phenomena - indicates that the maximum dose received by man would be only a fraction of the limitdose adopted by the ICRP.

In Denmark, studies are under way to ascertain the ion exchange properties of Sr and Cs. Two 30 m boreholes have been drilled to verify the results of the laboratory studies on site.

Work to help in defining general legal, administrative and financial arrangements

Through the good offices of a restricted group of experts, preliminary information has been obtained on the practices and rules employed by the safety authorities in connection with waste. A study of the various national nuclear laws and international agreements with a bearing on waste management has been carried out under contract, and certain problems have been brought to light. It has been found in particular that the long-term or final storage of waste requires a more specific legal, administrative and financial framework.

II.4. International cooperation

The Commission is taking part in many international activities, notably within the framework of the NEA¹, the IEA², the IAEA³ and the ISO⁴, it is also promoting the exchange of information at international level by inviting experts from non-member countries and international organizations to attend some of the technical meetings held in the context of the Community programme, and by organizing specialized seminars⁵ in association with the NEA. Nevertheless, this fruitful cooperation has its limitations: the work planned under the first programme in connection with the immobilization of the calcination products of high-activity waste in a metal matrix could not be carried through as intended on the site of Eurochemic⁶, this research was to come within the wider framework of an NEA international programme, which has been postponed indefinitely by Eurochemic's Board of Directors.

Lastly, the Commission is open to any cooperation with non-Community countries under bilateral agreements, provided that such cooperation would help toward the fulfilment of the Community's R&D objectives; a number of exploratory contacts have already been established to this end in the United States and Canada.

II.5. Coordination with the direct-action programme

The JRC, which is conducting the direct-action programme, is kept up to date with the indirect-action projects through its representation on all the working parties in the indirect-action programme. The ACPM common to the two programmes also facilitates coordination. It will be noted in addition that:

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- 1 Nuclear Energy Agency
 - 2 International Energy Agency
 - 3 International Atomic Energy Agency
 - 4 International Standards Organization
 - 5 Ispra, 23-27 May 1977; Brussels, 29-31 January 1979.
 - 6 Joint Enterprise of the NEA.

- the study of an advanced management model under the indirect-action programme (separation and recycling of long-life wastes (actinides) - sheet no. 9 of the programme) is being progressively cut back in view of the JRC's major effort in the field;
- a common working party for both direct and indirect action is being set up with the task of analysing risks associated with the final storage of radioactive waste in geological formations; its aim is to align the research being carried out under contract in the member States with that of the JRC in a field that is vital for safety and the protection of the environment.

III. The second programme

III.1 Statement of reasons

The need for a Community action on radioactive waste management has been reaffirmed by the Council of Ministers on a number of occasions⁽¹⁾, and has always earned confirmatory opinions from the Parliament and the Economic and Social Committee. The arguments in favour of such a project, which are set out in detail in the Commission's proposal to the Council of 8 Jan. 1975 relating to the first research and development programme are by now well known and accepted; they have become all the more cogent in the meantime.

In the same proposal from the Commission it was pointed out that the initial programme for a period of five years (1975-79) ought to be regarded as the first phase of a longer-term programme.

The promising, though preliminary, nature of most of the results from the first programme and the excellence of the research carried out should be taken as confirmation of this viewpoint, and as an encouragement to continue.

(1) Meeting of 22 November 1973 (OJ C 112 of 20 December 1973);

meeting of 26 June 1975 (OJ L 178/28 of 9 July 1975).
meeting of 17 May 1977 (OJ C 139 of 13 June 1977).

This too, was the view taken by the Scientific and Technical Committee as well as by the Advisory Committee on Programme Management (ACPM) when they delivered their opinions⁽¹⁾ in favour of going ahead with a second programme.

III.2 Contents of the second programme

This new programme, proposed for a five-year period (1980-84), has been drawn up in close collaboration with the standing groups of experts (see section II.2) and the ACPM. It is a logical continuation of the first programme inasmuch as it takes up the main threads of the latter and carries them through to completion. It does, however, differ from the first programme in the following respects:

- medium and low-activity waste comes in for a larger share⁽²⁾ in view of the mounting production of such waste. Information will be exchanged on the experience gained with existing methods (especially in the matter of storage), the aim being optimization of the methods and, if need be, their replacement with more efficient ones (permitting a greater reduction of the volume of stored waste);
- the waste-treatment projects provide for comparative analysis and evaluation of the properties of the various conditioned wastes, to be carried out jointly by the various laboratories concerned, according to identical procedures; this should enable the environmental impact of the conditioned products during long-term storage to be assessed with a large measure of scientific accuracy;
- the budget resources assigned to the treatment and conditioning of waste on the one hand and their storage and disposal on the other is now balanced, whereas in the first programme it was in the ratio of one third to two thirds; this readjustment does not imply any lessening of interest in the storage of waste in geological formations, but reflects a better appreciation of budgetary exigencies, bearing in mind the possible rates of development of the two types of project. Mention should also be made of the slow-down brought about by the coldness shown by the public toward the study of waste disposal in geological formations (experimental drillings).

(1) See Annex I + II.

(2) The Economic and Social Committee had already stressed the value of extending this work in its opinion on the first programme (Doc. CES 284/75).

The programme comprises four sections (A, B, C and D), which are fully described in Annex E.

Sections A and B, which account for 97% of the budget applied for, are detailed in "sheets"⁽¹⁾ in the Annex. They are concerned with the experimental work both at the laboratory stage and in the pilot installation.

Section A: Treatment and conditioning of radioactive waste.

- Immobilization of low and medium-activity waste - development of processes and operation of pilot installations
(Sheet No. 1)..... 2 million EUA
- Conditioning of high-activity radioactive waste: fuel-clads and residues from dissolution
(Sheet No. 2)..... 4 million EUA
- Treatment of medium-activity liquid waste
(Sheet No. 3)..... 3 million EUA
- Treatment of waste contaminated by alpha emitters
(Sheet No. 4)..... 6 million EUA
- Examination and evaluation of high-activity solidified waste
(Sheet No. 5)..... 2 million EUA
- Immobilization and storage of gaseous waste
(Sheet No. 8)..... 4 million EUA

Section B: Storage and disposal of radioactive waste

- Burial of low-activity solid waste at shallow depth
(Sheet No. 6)..... 1.5 million EUA
- Storage and disposal in geological formations
(Sheet No. 7)..... 25 million EUA

(1) To facilitate continuity of management between the first and second programme, the same sheet numbering has been retained wherever possible.

Total Community participation⁽¹⁾ for sections
A and B over five years is estimated at 47.5 million EUA

Sections C and D are chiefly concerned with studies and consultative tasks, the purpose of which is partly to gather all the technical viewpoints needed for a coordinated waste management policy (section C), and partly (section D) pursue the examination of the legal, administrative and financial aspects of waste management, which was started in the first programme. The whole of this work will take 3% of the budget.

Section C: Evaluation of processes, tentative criteria and waste management strategies 1.0 million EUA

Section D: Studies on the legal, administrative and financial aspects of waste management 0.5 million EUA

Total Community financing (100%) for sections
C and D over five years is estimated at 1.5 million EUA

It should be noted that Council approval of the Community plan of action regarding radioactive waste, submitted by the Commission in July 1977 (COM(77) 397), would provide a most valuable general reference framework, ensuring that the various work described above is carried out in the best possible manner.

III.3. Funds required

a) Staffing

The staff complement for the implementation of the first programme was four persons⁽²⁾. It quickly became obvious that four were far too few. Certain tasks were so urgent that Operating Budget staff had to be seconded to them for a long period, an arrangement which seriously disrupted the work of various departments. This is an abnormal situation which the Commission is not prepared to perpetuate. For the second programme, fifteen staff are requested (5A, 6B, 4C) including the persons assigned to the first programme). This number also takes account of the need to remedy the situation described above and to cope not only with the increased work that inevitably results from the more ambitious scale of the new programme, but also with the wider range of tasks that follow from the successful outcome of the first programme (launching of pilot operations, wider international cooperation, etc.).

(1) Approx. 50%

(2) 1 Category A; 2 Category B; 1 Category C.

This estimate of the personnel requirements for programme management assumes scientific back-up provided by the JRC.

b) Budget

The total appropriations required for the second programme on radioactive waste storage and management are estimated at 53.5 million EUA for the full period of the programme (i.e. 49 million EUA for financing the contracts and 4.5 million EUA for staff and operating costs).

This represents a real increase of only 60% over the first programme (19.16 million EUA) if we take into account:

- the inflation between 1974 (when the proposal for the first programme was drawn up) and 1979;
- the actual implementation period for the first programme, which was four years if we bear in mind first the Council Decision of 26 June 1975 to start the programme retroactively with effect from 1 January 1975, and secondly the period required to launch an entirely new programme.

This increase can be accounted for by the rise in costs that occurs on passing from the research phase to the pilot installation phase, from the use of equipment under non-active conditions to its use in the presence of radioactivity, and from geological studies on the surface to deep drillings.

IV. Conclusions

In view of the arguments presented above, the Council is requested to adopt the proposal for a second five-year programme on the management and storage of radioactive waste, described in Chapter III and Annex E of this document.

OPINION OF THE SCIENTIFIC AND TECHNICAL COMMITTEE, delivered at its meeting on 19 January 1979, concerning the proposal for a five-year (1980-84) programme on radioactive waste management and storage

The Scientific and Technical Committee,

- considers that the work undertaken by the Commission under its first programme (1975-79) has been a step in the right direction and should be pursued (along the lines described below) via a second programme (1980-84) in keeping with work carried out in the various Member States and at the JRC;
- considers that, although reliable techniques already exist for the processing and storage of radioactive waste, it is nevertheless necessary to maintain efforts to adapt such methods to future nuclear programmes and to develop processes for the ultimate disposal of certain types of waste, thus meeting one of the fears constantly reiterated by the general public;
- considers that this programme should pave the way, for harmonizing, at the appropriate time, conditioning methods used for the ultimate disposal of wastes;
- considers that the proposed allocation of appropriations as between processing and conditioning, on the one hand, and storage and disposal, on the other, duly reflects the present relative importance of these two areas and accords with what was adopted for the previous programme;
- requests the Commission to inform it in good time of progress on the programme and to make provision for introducing such changes as may be warranted by the status of the various research projects or by the means by which such could be implemented;
- hence, the Scientific and Technical Committee delivers a favourable opinion on the Commission's proposal for a programme.

Opinion of the Advisory Committee on Programme Management for Radioactive Waste Management and Storage (direct and indirect action), relating to the indirect-action programme

The Advisory Committee on Programme Management (ACPM) for Radioactive Waste Management and Storage met on 16 and 17 October 1978 for the eleventh time since its constitution.

The Committee

- having regard to the work performed during the first programme (1975-1979);
- having regard to the Council resolution of 18th July 1977 (O.J. C/192 of 11 August 1977) concerning its terms of reference;
- having examined the draft proposal for a second five-year research programme (1980-1984),

expressed the following opinion with regard to the abovementioned programme proposal :

The Committee considers that the main objective of the proposed programme is the joint development and finalization of a system for the management of radioactive waste produced by the nuclear industry which, in its various stages, will provide optimum protection for man and his environment.

Accordingly, the Committee agrees upon the general content of the proposed programme, which is designed to this objective.

Part A : Treatment and conditioning of waste; testing and evaluation of the conditioned waste.

Part B : Storage and disposal of waste.

Part C : Evaluation of processes, tentative criteria and waste-management strategies.

Part D : Studies relating to the legal, administrative and financial aspects of waste management.

The Committee considers it imperative that the programme be formulated and managed with sufficient flexibility to allow :

- (1) adaptation of the technical effort in the light of the initial results of the programme;
- (2) re-allocation of funds among the various projects provided for;
- (3) revision of the programme itself whenever that may be judged necessary.

Various comments have been expressed by the members of the Committee concerning the total expenditure for the Community's contribution to the proposed research and development programme, which is to be carried out by way of research contracts. However, since it is now possible to perform in situ work on geological disposal and to conduct practical demonstrations in other fields, and in view also of inflation, the Committee considers a figure of 50 million EUA appropriate (staff and administrative costs excluded).

The Committee notes with satisfaction that the management procedure to be applied is the same as that which was set up during the first programme and has provided very satisfactory results; this procedure provides for :

- careful selection of contractors after detailed technical examination of competitive tenders and consultation of the ACPM;
- management of the programme at working level with the support of and in cooperation with permanent working groups composed of national experts and contractors;
- the holding of periodic information meetings at various levels to ensure effective and rapid dissemination of the results obtained.

The number of staff (5A, 6B, 4C) proposed by the Commission to monitor the execution of the programme appears to be well judged in view of to the method of implementation proposed.

The Committee considers that the proposed secondment of personnel to the contractors engaged in pilot-plant operation should be encouraged.

Ispra, 17 October 1978

Y. Sousselier

Chairman of the ACIM
"Radioactive waste management and Storage"

C. Proposal for a Council Decision
adopting a programme on radioactive waste management and storage
(1980 - 1984)

THE COUNCIL OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Atomic Energy Community, and in particular Article 7 thereof,

Having regard to the proposal presented by the Commission after consultation with the Scientific and Technical Committee,

Having regard to the Opinion of the European Parliament,

Having regard to the Opinion of the Economic and Social Committee,

Whereas the development of nuclear energy inevitably involves the production of radioactive waste; whereas it is therefore essential to implement effective solutions to safeguard the public and protect the environment against potential hazards associated with the management of such waste;

Whereas the programme of action of the European Communities on the environment, which was approved by the Council and the representatives of the Government of the Member States, meeting within the Council, in the Declaration of 22 November 1973⁽¹⁾, and of which the follow-up and implementation are contained in the Resolution of 17 May 1977⁽²⁾, underlines the need for Community action on the handling and storage of radioactive waste, and defines the content and methods of implementation of the project;

Whereas the nature of the waste is such as to call for supervision of its potential effects and for reinforcement of the projects and research activities undertaken to ensure the protection of the environment;

(1) OJ No C 112, 20.12.1973, p 3

(2) OJ No C 139, 13.6.1977.

Whereas the programme on radioactive waste management and storage adopted by the Council Decision of 26 June 1975 has yielded beneficial results and opened up encouraging prospects of attaining the desired objectives⁽¹⁾;

HAS DECIDED AS FOLLOWS :

Article 1

A programme on the management and storage of radioactive waste, as defined in the Annex hereto, is hereby adopted for a period of five years commencing on 1 January 1980.

Article 2

The overall requirements for the total duration of the programme are estimated at 53.5 million EUA and a staff of 15 officials. The unit of account is as defined in Article 10 of the Financial Regulation of 21 December 1977. The figures quoted are only an approximation.

Article 3

The programme defined in the Annex is subject to revision in accordance with the appropriate procedures at the end of the second year.

⁽¹⁾ OJ No L 178, 9.7.1975, p 28

PROPOSAL FOR A COUNCIL DECISION
 ANNEX
 PROGRAMME FOR RADIOACTIVE WASTE MANAGEMENT AND STORAGE
 (INDIRECT-ACTION PROJECT)

The aim of the programme is to further the joint development of a system of management of the radioactive waste produced by the nuclear industry and to ensure, at the various stages, the best possible protection of the public and the environment.

The programme will cover :

A Research designed to solve certain technological problems involved in the treatment, storage and disposal of radioactive waste.

Treatment :

- immobilization of low- and medium-activity waste; development of processes and operation of pilot installations;
- conditioning of high-activity waste : fuel claddings and residues from dissolvers;
- processing of medium-activity liquid waste;
- processing of waste contaminated by alpha emitters;
- examination and evaluation of high-activity solidified waste;
- immobilization and storage of gaseous waste.

Storage and disposal :

- burial of low-activity solid waste at shallow depth;
- storage and disposal in geological formations.

B Work aimed at defining the general framework for the projects relating to the storage and disposal of radioactive waste:

- evaluation of processes, tentative criteria, and strategies for waste management;
- studies of the legal, administrative and financial aspects of waste management.

Work described in sections A and B will be carried out mainly under contract.

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D. FINANCIAL RECORD

1. Relevant Budget heading :

- Item : 3356
- Title : Management and storage of radioactive waste.

1.1. Title of the project

Management and storage of radioactive waste

2. Legal basis

Application of Article 7 of the Treaty establishing the EAEC.

3. Description of the project

This programme is the continuation of the current action, which ends 1979 and which was approved by the council on 26 June 1975, as published in the O.J. L 178 of 9 July 1975.

3.1. Description

The programme covers::

A. Work designed to solve technological problems involved in the treatment, storage and disposal of radioactive wastes.

Treatment :

- immobilization of low-and-medium-level wastes;
- development of processes and operation of pilot plants;
- conditioning of high-level wastes (fuel cladding and dissolution residues;
- treatment of medium-level liquid wastes;
- treatment of alpha-emitters-contaminated wastes;
- examination and evaluation of high-level solidified wastes;
- immobilization and storage of gaseous wastes.

Storage and disposal :

- low-depth burial of low-level solid wastes;
- storage and disposal in geological formations.

B. Work aimed at defining the general arrangements in line with which storage and disposal of radioactive waste should be conducted:

- assessment of processes, tentative criteria and waste management strategy;
- studies on the legal, administrative and financial aspects of waste management.

3.2. Objective

Continuing development and joint preparation of methods for managing radioactive waste from the nuclear industry which at all stages afford the best protection for the general public and the environment.

4. Justification of the project

- The need for a Community radioactive waste management and storage programme as highlighted in the programme of action of the European Communities on the environment, which the Council approved in its declaration of 22 November 1973, and decided to continue and implement in its Resolution of 17 May 1977 (OJ C 139, 13.6.1977).
- Pursuance of the programme adopted by the Council in its Decision of 26 June 1975 (OJ L 178/28, 9.7.1975).
- Energy and industrial policy.

5. Financial implications of the project in respect of expenditure (including staff expenditure and administrative and technical operating expenditure)

5.1. Overall cost for the whole of its expected duration : Ca. 100 million EUA

5.2. Chargeable to the Community budget : Ca. 53.500.000 EUA

- chargeable to national budgets
- chargeable to other sectors at national level

Ca. 45 Million EUA

5.3. Multianual timetable

5.3.1.1. Appropriations for commitment in EUA

	1980	1981	1982	1983	1984	Total
Staff	691.300	727.000	765.950	804.900	843.850	3.833.000
Administr. operation	103.700	113.000	126.050	139.100	155.150	637.000
Contracts	15.000.000	15.000.000	8.000.000	10.000.000	1.030.000	49.030.000
Totals	15.795.000	15.840.000	8.892.000	10.944.000	2.029.000	53.500.000

5.3.1.2. Appropriations for payment (EUA)

	1980	1981	1982	1983	1984	1985	Total
Staff	691.300	727.000	765.950	804.900	843.850	-	3.833.000
Administr. operation	103.700	113.000	126.050	139.100	155.150	-	637.000
Contracts	7.000.000	15.000.000	12.000.000	9.000.000	5.000.000	1.030.000	49.030.000
Totals	7.795.000	15.840.000	12.892.000	9.944.000	5.999.000	1.030.000	53.500.000

5.3.2. Method of calculation

a) Staff expenditure

Staffing needs have been evaluated on the basis of the following staff for this programme :

- 5 category A officials
- 6 category B officials
- 4 category C officials

In addition to these staffing figures, the calculations take into account the variations of the Commission's staff salaries, established for drawing up the Preliminary Draft Budget for 1979 by applying, for 1980-82 an increase corresponding to the head of the general price level in the Community as used in the triannual provisions for the respective period, i.e. 1980 : 1.065 , 1981: 1,120 , 1982: 1,180 . For the years 1983 and 1984 an annual increase of 6% was used.

b) Administrative and technical operating expenditure

This heading covers expenditure connected with travel, missions and the organisation of meetings and reception. The estimate is based on the average requirements of presently operating programmes comparable in staff and financial allocations, i.e. (50 missions at 400 EUA and 20 meetings at 36000 EUA, the remainder covering administrative and social expenses).

c) Contract expenditure

The expenditure covers the financial participation of the Community in research performed under cost sharing contract (study, research contracts etc..) which will be concluded with specialized firms and laboratories in the Member States. Since the type of subject and the contractor's qualifications vary, it is not possible to establish a uniform method of calculation.

The cost estimate has been carried out by assessing, as near as possible, the costs of the programme's various research action and technical projects in close collaboration with the Advisory Committee for the management of the 1975-1979 programme. During the term of the programme, an estimated c.a. 200 contracts will be negotiated with public institutions and specialized firms. The Commission average financial share in these contracts will be somewhere near 50%.

At all events, the Advisory Committee on Programme Management will be consulted on the use of the appropriations.

6. Financial implications on the staff and normal operating appropriations :
(see unxer. Section 5 above)

7. Financing :

The appropriations required for the Community's financial participation in this action will be entered into the future budgets.

8. Implications in respect of revenue

- Community tax on officials' salaries
- Officials' contributions to the pension scheme

9. Type of control to be applied

Scientific control : ACFM

Responsible officials in DG XII

Administrative control by the DG for financial Control and by the contracts division of DG XII of the implementation of the budget and of checking the expenditure.

E. ANNEX

Technical Content of the
second five-year R & D
programme on waste ma-
nagement (indirect ac-
tion)

PART A - TREATMENT AND CONDITIONING OF RADIOACTIVE WASTE

Sheet No. 1

Immobilization of low-and medium-activity waste : process development and pilot plant operation

The treatment of liquid effluents from power plants and other nuclear facilities produces substantial quantities of low-and medium-activity waste. Most of these wastes can be treated and solidified to form solid waste packages which are acceptable for transport, long term storage and final disposal.

The primary objective of the current programme (1975 - 1979) is the construction, operation and evaluation of a pilot facility for the immobilization of reactor wastes with thermo-setting resins. This pilot plant will start up during the first half of 1979 and for the rest of that year will be operated with various active wastes. Although the planned eight months or so of active operation before the end of the programme may constitute an encouraging demonstration and provide initial results for the evaluation of the process, representative data on process availability, safety and product quality can hardly be expected so soon, and in all probability further improvements to the process and the plant can be made after 1980.

There is, however, considerable scope for improving and widening the range of applications of existing techniques and for developing new methods for treating those wastes which it has not yet been possible to condition adequately. Proposed matrix materials such as resin/cement components, aqueous silicates, various polymers and ceramics, as well as existing alternatives (cement, bitumen) will be examined.

It is also necessary to acquire comprehensive experimental data on the characteristics of industrially solidified waste which could be applied to :

- a. selection of the most suitable process for the available disposal method;
- b. more accurate assessment of the environmental impact of waste disposal.

Generally speaking, the second programme should aim at

- developing conditioning techniques to cover LLW and MLW not adequately treated in the existing processes up to a pilot stage level;
- optimizing existing processes;
- identifying and measuring the characteristics which are desirable in immobilized wastes.

The last mentioned task should constitute a separate joint action by laboratories concerned with the quality control and acceptance testing of conditioned waste.

Programme

1.1. Development of immobilization techniques

- a. Process development for
 - various immobilization materials (cement, bitumen, resins, glass, etc...)
 - various types of waste (sludges and concentrates, diatomaceous earths, ion exchange resins, solid wastes, cyclone fines, incineration ashes, decontamination solutions, detergents, etc.);
- b. Optimization with regard to
 - volume reduction,
 - process reliability and safety.

1.2. Joint testing and evaluation of long-term characteristics of the immobilized waste products

- property tests : e.g. leach, mechanical and fire resistance, climatic bacteriological (chemical) and radiation stability;
- comparative testing of techniques and equipment for measuring the properties; for example the leaching rate, the formation of radiolysis gas, temperature and radiation effects.

Community contribution : 2M EUA over 5 years.

Sheet No. 2Conditioning of highly active solid waste
(fuel claddings and dissolution residues)

The Zircaloy and stainless steel claddings of spent fuel elements and the dissolution residues from the first process step of fuel reprocessing have a high specific activity and a substantial content of transuranic elements.

Four methods for the conditioning of cladding waste are being studied under the first Community programme, namely :

- press compaction and embedding in lead
- roll compaction embedding in concrete
- decontamination and volume reduction with the aid of eutectic fusion
- embedding in glass.

Two of these methods should be selected and further developed under this programme.

The development of an immobilization process for dissolver sludges and various other types of waste by embedding in a sintered ceramic matrix was started in 1978 and should be continued.

This action will also include the waste-product testing required during the development of the conditioning processes. The detailed assessment of the immobilization capacity of well established products should, however, come within the scope of Sheet No. 5.

Programme

- Active demonstration of methods for the conditioning of cladding waste.
- Investigation of the pyrophorocity of Zircaloy fines.
- Assessment of the contamination of a representative sample of cladding waste from industrial reprocessing.
- The development of methods for the embedding of dissolution residues and other types of alpha waste in a sintered ceramic matrix.

Community contribution : 4 M EUA over 5 years.

Sheet No. 3

Treatment of medium-level liquid wastes

Large volumes of low-and medium level waste solutions are produced in reprocessing plants*. A substantial fraction of these liquid wastes must at present be evaporated in order to meet the stringent requirements concerning liquid effluents. The evaporated residues are at present incorporated into bitumen or concrete for final disposal. Other purification treatments (ion exchange and flocculation) are also frequently applied.

However, even after this treatment, the volume of conditioned waste is still roughly a tenth of the volume of liquid waste. The specific activity of the conditioned waste ranges from 1 to 1000 Ci/m³, most of it being in the region of 10 to 100 Ci/m³. The bulk of the solid waste consists of various inactive salts. By chemical separation of the inactive salt solution - which becomes an effluent - and the highly active residue containing most of the fission products, activation products and actinides, it is possible to achieve a very large volume reduction and a less soluble form of waste.

In addition to separating the active substances from the inactive matter it is in many cases (e.g. solvent clean-up solution) desirable to separate the actinides from the other (short-lived) radioisotopes.

Any development in this field should lead to active residues which can be readily conditioned either separately or together with other high-level wastes (e.g. by vitrification). The development of suitable final-waste forms up to a pilot stage production and the testing and evaluation of the conditioned wastes therefore fall within the scope of the R & D task outlined in this programme sheet.

Programme

3.1. Development and demonstration of processes for the treatment of medium-activity (non-combustible) liquid wastes

(e.g. ammonium nitrate, decontamination washings, solvent wash-liquors and concentrates)

* About 50 000 m³/y for a 1500 t/y reprocessing plant.

Proposed processes :

- Ultrafiltration
- Chemical precipitation (flocculation)
- Ion-exchange processes
- Electrolysis, electrodialysis, reverse osmosis
- Denitration
- Established basic techniques such as evaporation, centrifuging and filtration

3.2. Development of conditioning processes (generally dependent on the concentration process) for the solid high active residues from the treatments listed under 3.1.

3.3. Testing and evaluation of the final conditioned waste form

Community contribution : 3M EUA over 5 years.

Sheet No. 4

Treatment of alpha-emitting wastes

The largest volume fraction of wastes from reprocessing, mixed-oxide preparation and MOX fuel fabrication consists of plutonium-contaminated material (PCM). The high-level liquid wastes and the fuel cladding waste which contain about 2% of the Pu produced, are treated in the context of Sheets 5 and 2 respectively. The remaining Pu losses (1%) are dispersed among the medium and low level wastes.

Owing to the very long half-life of most plutonium isotopes (24 000 years in the case of Pu 239) and their radioactivity, the quantity of Pu dispersed into the biosphere should be minimized. Final disposal of Pu waste must satisfy high standards of isolation and long-term integrity.

As the alternative of burning plutonium in LWRs and FBRs is available, it is advisable to recover as much fissile material from the wastes as is practicable. For both options, namely disposal and recycling, it will be necessary

- to reduce the volume of wastes
- to remove compounds which decompose by aging or radiolysis
- to develop fixation methods.

Under the first programme, a study was made of technologies for reducing the volume of the combustible waste, recovering the plutonium from combustible solid waste and conditioning the low-activity residues of such incineration processes. The development of treatment processes for this type of waste calls for an extensive experimental and engineering effort, and only one of the projects under the first programme could be started early enough to reach the state of active pilot plant operation. Two of the projects will be demonstrated under inactive conditions by 1980 and other processes are being explored in the laboratory.

In the second programme, the development work on existing α -active facilities and those processes which are likely to lead to successful pilot plant operation before 1985 should be continued to that stage in order to gain experience and obtain design data for larger or improved units.

The programme should also include projects for treatments and wastes which have evolved from more recent developments in alpha-waste management. This applies in particular to conditioning processes for low activity incinerator residues and to the combustion of contaminated organic solvents.

Joint action by European laboratories for comparative testing should relate to a study of test methods for conditioned wastes and an investigation of the relevant long-term properties of conditioned waste products. A further important field for this joint action is the development and comparison of techniques and equipment for measuring the alpha-activity of treated and untreated wastes. Determination of the relatively low concentrations of plutonium, unevenly distributed among various substances in the waste calls for sensitive measurement and a complex interpretation method, and although most nuclear laboratories are equipped with alpha-measuring systems, there is not yet a standard technique for all types and packagesizes of waste.

Programme

4.1. Development and optimization of

a. Volume reduction techniques

- comminution and compression (including cryogenic crushing)
- incineration (combustion in air and molten salt, pyrolysis, acid digestion) of solid and liquid combustible alpha-wastes.

b. Pu recovery from wastes

- leaching from untreated wastes and incineration residues
- separation of Pu from leaching and processing agents.

8.

- c. Conditioning for long term storage and disposal, of
- untreated and partially decontaminated wastes
 - liquid and solid residues of treatments sub a. and b.
 - non recycled actinides.

4.2. Joint testing and evaluation for the characterization of alpha wastes :

- Tests on conditioned wastes : leaching resistance, chemical stability, radiation stability, formation and release of gases.
- comparative testing of techniques and equipment for measuring the content of alpha-emitters in various wastes.
(Typical sample packages of identical waste composition and activity would be measured by all laboratories wishing to participate).

Community contribution : 6M EUA over 5 years.

In the Netherlands, a conceptual study has shown that waste equivalent to the amount produced by a 25 000 MWe nuclear capacity installed over a period of 40 years could be stored underground in a saline dome.

Calculations show that erosion by the aquifers surrounding the saline dome would result in the saline environment of the waste repository (assumed to be about 200 metres of salt all round the repository) being leached away after approximately one and a half million years. In the event of resurgence of the saline dome, the radiation dose at the surface would not in any event exceed the limits laid down by the ICRP.*

In Belgium, investigations are being carried out at a depth of 160-250 metres in the argillaceous formation in the subsoil of the Centre d'Etudes Nucléaires at Mol:

- a drilling of 580 m has revealed the geological characteristics of the formation and the properties of undisturbed clay samples: the excellent homogeneity of the clay stratum (Boom clay) has been demonstrated;
- other drillings have permitted determination of the hydrogeological state of the formation, and a seismic refraction programme has been launched to elucidate its structure;
- tests carried out with several representative radionuclides such as ^{85}Sr , ^{134}Cs , ^{239}Pu , and ^{240}Pu , ^{152}Eu and ^{154}Eu have demonstrated the high ion exchange capacity of the clay; that capacity diminished with increasing temperature and with the radiation dose to which the samples were subjected;
- authorization has been granted to construct an experimental cave at a depth of 220 m plus an access well (Hades project); work on the construction of the access well, which will have a diameter of about 4 metres, is to start in 1979.

* ICRP : International Commission on Radiological Protection.
The ICRP issues recommendations, upon which the standards and legislation concerning radiological protection are based.

Firstly, the validity of data measured with inactive and medium-activity simulated waste should be confirmed by tests on fully active samples. Secondly, the effects of any interaction with the host-rock on the vitrified waste must be determined. To this end, the conditions to which the waste can be exposed in a geological repository will be identified, and then reflected by representative site-and formation-specific test conditions.

Programme

5.1. Development of common test procedures for measuring

- Leaching rate (short and long term)
- Devitrification (under dry and wet conditions)
- Radiation effects
- Mechanical properties

5.2. Joint test programme for applying and verifying the results of

the common test procedures developed as well as tests and measurements on waste glasses/glass ceramics and possibly other reference substances for HLW solidification.

A common set of procedures for sample production, tests and evaluation should assure a fair comparison.

5.3. Development and application of advanced test methods

- Tests with highly active samples, tests with real solidified FP solutions
- Long term leaching tests with natural waters at the pressures and temperatures to be expected in waste repositories and storage buildings
- Waste disposal environment interaction tests.

Community contribution : 2M EUA over 5 years.

Sheet No. 8Immobilization and storage of gaseous wastes

This sheet deals with radioactive materials removed from process off-gases and in particular from the dissolver off-gas of fuel reprocessing plants (including tritium, much of which is associated with liquid effluents), namely :

- Iodine-129 (long-lived) and aerosols (containing numerous radionuclides, including long-lived ones), the removal of which is current practice.
- Krypton-85 and tritium for which the practice of discharge to the environment will be restricted and which should then be isolated for a period of about a hundred years.
- Possibly carbon-14 (long-lived), if its discharge to the atmosphere proves to be inappropriate.

The following work has been carried out under the first programme :

- Research on the immobilization of Krypton, tritium and iodine by incorporation in solid materials, including a half-scale pilot plant testing a Krypton immobilization process.
- Studies on the storage and on the sea-disposal of Krypton contained in pressurized cylinders.
- Preliminary development of two processes for isotopic concentration of tritium.
- Experimental studies of the gas release during reprocessing head-end operations.

Under the second programme the most promising conditioning methods should be selected and further developed with a view to industrial application. Work on aerosol removal is added as a new subject, with a view to reducing the consumption of high-efficiency filters.

Programme

- 8.1. - Krypton-85 immobilization and storage/disposal : continuation, with a view to industrial application, of the work started under the previous programme.
- 8.2. - Tritium separation and immobilization : further development of at least one separation process; selection and development of at least one immobilization method.
- 8.3. - Iodine-129 immobilization and disposal : development of a method for immobilization; study of the influence of the disposal mode on the long term environmental impact.
- 8.4. - Aerosol filtration : study of techniques aimed at a reduction of the waste volume.

Community contribution : 4M EUA over five years.

PART B - STORAGE AND DISPOSAL OF RADIOACTIVE WASTE

Sheet No. 6

Shallow land burial

Burial at or near the surface in an economic method of disposing of certain types of low-activity solid waste. The principal problem is to avoid contamination of waters, which could give rise to unacceptable levels of contamination in the drinking water or the food chain.

This is achieved through

- control of the type, chemical form and concentration of radio-elements in the waste
- permanent monitoring of the site
- conditioning and pretreatment of the waste and selection of sites which are unlikely to be flooded or suffer from wind erosion
- through isolation from the water table by an impermeable geological structure.

The surrounding soils should provide a further barrier by their sorption and ion-exchange capacity for migrating nuclides.

The investigations proposed for this programme will aim at compiling and evaluating the data and experience from existing sites, analysing the efficiency of the artificial and natural barriers and studying advanced concepts of shallow land burial.

Programme

Study of problems relating to shallow land burial of solidified waste. Waste arisings from various origins and activity levels will be taken into account.

- 6.1. Evaluation and comparison of current experience in situ
- 6.2. Investigation of radionuclides migration and safety aspects, account being taken of the influence of the artificial barriers between the waste and the ground
- 6.3. Improvement of shallow burial techniques.

Community contribution : 1,5M EUA over 5 years.

Sheet No. 7Storage and disposal in geological formations

The safe storage and disposal of radioactive waste is becoming one of the main issues of nuclear development.

Several years ago it was recognized that stable geological formations may provide an appropriate solution to the problems of isolating waste -particularly solidified medium and high activity waste and α -emitters- from the biosphere. Therefore in some Member States studies and projects were started on promising formations such as salt, and later on crystalline rocks and clays. They are now completely or partially incorporated into the first Community R & D programme.

The ultimate aim is to demonstrate the feasibility of the geological disposal concept by operating experimental facilities safely under real working conditions.

This could be achieved within the framework of a properly coordinated scientific and technical effort spread over several years and including different R & D stages such as :

- collection of geological data concerning the formations of interest
- characterization of regions of interest, with experimental support (deep drilling, hydrogeological and seismic investigations, etc.)
- experimental studies on rock/waste interactions (thermal, chemical and radiation effects, etc.)
- design studies on repositories and development of technical equipment for repository construction
- safety and modelling studies
- construction of experimental facilities
- operation of experimental facilities.

Mainly for historical reasons the studies on granite, clay and salt have not reached the same degree of advancement.

The results obtained so far under the first programme are giving more and more evidence that these geological formations are suitable for the disposal concept.

It therefore appears necessary to find answers to the specific questions concerning each type of rock and, more generally, to carry on the various studies and projects to the next and possibly final-stage (i.e. provision of demonstration facilities), proceeding along the lines defined at the beginning of the first programme.

The proposed programme can therefore be regarded as the logical continuation of the previous one and relies on the preliminary results derived from it. The distribution of tasks should remain largely unchanged. However, owing to the shift from predominantly laboratory investigations to in situ experiments, increased financial support is needed.

Recently, waste disposal in the sea-bed has also been taken into consideration as a possible long-term alternative to disposal in continental geological formations. The proposed programme will devote some efforts to a study of the general principles underlying this concept and to an assessment of the possibilities of disposal in geological structures under selected ocean areas as a variant of disposal in geological formations on land.

Programme

7.1. Storage and disposal in continental geological formations

- Determination of geological, geotechnical and other site characteristics that affect the integrity of the repository.
- Ability of the site to meet integrity requirements; experimental confirmation on a laboratory scale or in situ and corresponding data modellings.
- Design studies on repositories.
- Development and/or choice of adequate technical systems and equipment for repository construction.
- Barrier-by-barrier evaluation of the waste-isolation properties of the repository (waste conditioning and container life, repository features, migration of radionuclides to the biosphere) and overall safety evaluations by means of risk analysis and modelling.

- Execution of demonstration projects for repositories in geological formations in the light of the completed design, engineering studies and safety assessment.

7.2. Disposal in sea-bed geological formations

- A preliminary assessment of the design and engineering problems associated with disposal in sediments or rocks under selected areas of the oceans.
- Identification and evaluation of critical emplacement parameters and failure of the containers; associated studies.
- Safety assessments of waste-isolation properties by means of risk analysis and modelling (migration of radionuclides in marine sediments).

7.3. Improvement of methods for assessing the potential of geological disposal

- Critical review and improvement of methods used in geological sciences to meet the higher standards required for the disposal of radioactive waste in geological formations.
- Development and application of analytical methods for the classification of geological formations suitable for storage purposes.

Community contribution : 25M EUA over 5 years.

PART C - EVALUATION OF PROCESSES, TENTATIVE CRITERIA AND WASTE-
MANAGEMENT STRATEGIES

Whereas the specific projects and other programme items proposed under Parts I and II are generally performed as separate entities, the work envisaged under this part will aim at

- independently evaluating the objectives, requirements and results of each programme sheet;
- analysing the implications of results from one programme sheet or project upon the rest of the waste-management system;
- acting as an interface between the various activities in the programme by selecting reference data and providing complementary studies in areas not covered by the programme;
- providing data and background information to assist the ACPM and the Commission in keeping the overall scope and orientation of the programme up to date (e.g. assessments of future waste arisings, interpretations of regulatory requirements, evaluation of the overall environmental impact);
- establishing guiding principles for overall waste-management strategies.

These tasks can be covered by non-experimental studies, e.g. literature surveys, inquiries, design studies, cost assessments, computer modeling and cost-benefit analysis.

Outline programme (essentially non-experimental studies)

- a. Evaluation and comparison of various waste-treatment processes from the standpoints of
 - Personnel exposure
 - Gaseous emission and liquid effluents
 - Ultimate secondary waste
 - Reduction of mass and/or volume of wastes
 - Costs.

- b. Evaluation and comparison of various forms of conditioned waste
 - Radiological and chemical stability
 - Compatibility with the storage and disposal environment
 - Overall long-term integrity
 - Hazards during processing, transport and storage
 - Volume of final waste form
 - Significance of radiation damage on waste matrices in safety models.
- c. Evaluation and comparison of various management schemes for each waste stream on the basis of a. and b. above; integration into overall strategies, account being taken of the interconnections between the various waste streams.
- d. Logical approach to waste-form quality criteria and technical guidelines for waste management.
- e. Reduction of radioactive wastes at the source; alternative processes and operational materials that produce less "difficult" wastes.

Community contribution : (100%) : 1M EUA over 5 years.

PART D - STUDIES RELATING TO THE LEGAL, ADMINISTRATIVE AND FINANCIAL
ASPECTS OF WASTE MANAGEMENT

The industrial waste-management operations will have to be carried out within an appropriate legal, administrative and financial framework. In order that the development of nuclear energy in the Community may not be hampered by the absence of such a framework when the technical problems are solved, the first programme provided for studies designed to contribute to its definition. National laws and regulations affecting waste management and disposal operations were reviewed and compared, and the necessary basis for further work thus established, and some deficiencies as regards the disposal of waste were pinpointed.

The proposed programme will therefore constitute a continuation of the first.

Programme

- review and compare the practices in the Member States as complements in the field of radioactive waste to the more general national nuclear laws;
- review recent trends as regards the legal, administrative and financial aspects of waste management;
- survey problems of radioactive waste management not solved under the existing legal, administrative and financial provisions and propose solutions, taking into account the studies under chapter III.

As for the first programme, the analyses will be performed under contracts, with the support of a selected working party of experts.

Community financing : (100%) : 0,5M EUA over 5 years.