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PROPOSAL FOR A COUNCIL DECISION

adopting a programme concerning the decommissioning
of nuclear power plants

(submitted to the Council by the Commission)

COM(78) 167 final.

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PREFACE

On May 1977 the Council approved, as part of the Community's action programme on the environment * the principle of an action concerning the decomissioning of nuclear power plants. It asked the Commission to pool and to analyse earlier studies and experience and to present, on the basis of the results of this work, appropriate proposals to the Council.

The present document has been drawn up with the help of a group of national experts. Part I contains mainly an analysis of earlier studies and experience and Part II a proposal for a funded action programme.

The scope of the analysis and the proposal has been restricted to nuclear power plants, excluding other nuclear installations such as research reactors and fuel cycle facilities. However, available relevant experience with such other installations has been taken into account. It may also be noted, that the results from the proposed action are expected to be of benefit to other installations too.

* OJ N° C 139, 13.6.1977

PART I : SITUATION AND PROSPECTS REGARDING DECOMMISSIONING OF NUCLEAR POWER PLANTS

1. Introduction

Decommissioning of nuclear plants means their safe disposition after retirement from service. Its ultimate objective is the unrestricted release of the plant site for other uses. One must however keep in mind that only a relatively small part of a nuclear power station (15 to 20 %) will give rise to problems associated with the presence of radioactive matter.

Every nuclear power plant will some time arrive at the end of its useful life, but the reasons for retiring a plant from service may vary. A prototype plant may be decommissioned when it has achieved its objective, or when the objective has been abandoned. Commercial plants will be retired from service when either economic or safe operation is no longer possible. Such a situation could also be brought about by an incident if rehabilitation of the plant proved too costly or impossible due to radiation.

After a plant has been retired from service, the nuclear fuel, radioactive materials in process and radioactive waste produced in normal operation should first be removed by routine operations. As regards the further procedure, three stages of decommissioning have been defined in the frame of the International Atomic Energy Agency, namely :

Stage 1 decommissioning

The plant is practically kept intact. The mechanical opening systems (valves, plugs, etc.) of the first contamination barrier are permanently blocked and sealed. The plant is under surveillance and inspections are carried out to check that it remains in good condition.

Stage 2 decommissioning

The primary contamination barrier is reduced to minimum size and sealed, removing all parts which can be easily dismantled. The biological shield (e.g. concrete) is extended so that it completely surrounds the barrier.

After decontamination to acceptable levels the containment building can be removed. The other parts of the plant (buildings or equipment) can be dismantled or converted for new purposes. Surveillance around the barrier is necessary but can be relaxed as compared with Stage 1. External inspection of the sealed part should be performed.

Stage 3 decommissioning

All remaining parts of the plant, the activity of which remains significant despite decontamination procedures, are removed. The plant is then released without restrictions. No surveillance or inspection is necessary from the point of view of radiological protection.

Stages 1 to 3 are, though not completely corresponding, sometimes also referred to as "mothballing", "entombment" and "(complete) removal", respectively.

2. Experience with decommissioning

About 20 nuclear power plants in the Western world - all of them in the United States and in Europe - have already been retired from service. Five of these plants are located in the Community, namely:

- Marcoule G 1 and Chinon 1, in France
- Heissdampfreaktor (HDR) and Kernkraftwerk Niederaichbach, in Germany
- Dounreay Fast Reactor, in the United Kingdom.

Decommissioning of most retired plants has not yet proceeded beyond Stage I. Five plants have been decommissioned further, namely: HNPF, BONUS, ERR (all in the USA), CNL (Switzerland) and HDR (Germany).

These decommissioning operations have complied with the regulations for protection of the personnel and the general public; no particular incident has been reported. They have yielded valuable experience as regards decommissioning techniques and cost. However, this experience is not directly applicable to future decommissioning of nuclear power plants, and of large commercial plants in particular, for the following reasons:

- the reactors were of one-off types, not used in commercial plants;
- they were relatively small;
- they had been operated for relatively short periods, and consequently radioactivity inventories were small.

Relevant experience has also been obtained from the decommissioning of major nuclear power plant components. Within the Community the dismantling and cutting of the thermal shields of the Trino Vercellese and the Chooz pressurized water reactors deserve particular mention in this respect.

Decommissoning operations at research reactors and fuel cycle plants have also yielded experience which is of considerable value in the decommissioning of nuclear power plants. Major operations performed in the member countries are:

- total dismantling of the LeBouchet uranium fabrication plant (France)
- total dismantling of a small prototype reprocessing plant at Fontenay-aux-Roses (France)
- extensive decontamination operations at reprocessing plants at Mol (Belgium), Dounreay (UK) and Trisaia (Italy).

The available experience has been taken into account and carefully extrapolated in the studies of decommissioning of commercial plants, which form the subject of Chapter 3.

3. Decommissioning studies

3.1 Light water reactors

Light water reactors are of particular interest since they constitute the major part of the nuclear generating capacity installed and under construction and because their proportion is forecast to increase over the coming decades. The decommissioning problems posed by pressurized water reactors, which account for about 80 % of the light water reactors in the Community and are taken as a reference here *, and by boiling water reactors do not differ fundamentally.

Radioactivity

The radioactivity inventory after 40 years of operation and one year after shutdown is illustrated by the following data (orders of magnitude):

Components (material)	Weight t	Activity Ci
Reactor vessel internals (stainless steel)	180	10^7
Reactor vessel (mild steel, cladding stainless steel)	580	5000
Biological shield (concrete, reinforcement mild steel)	430	700
Systems contaminated only (stainless steel)	6000	3000

The total activity inventory is lower by a factor of about 1000 than that shortly after shutdown, this being due to the removal of fuel and to the decay of short-lived nuclides. The bulk of this activity is represented by a few reactor internals surrounding the core, with maximum specific activities of about 2 Ci/g.

More important than these total activities are those of specific nuclides. There are no significant amounts of the radiotoxic long-lived alpha emitters. Cobalt-60, because of its penetrating type of radiation, determines the exposure of personnel during decommissioning works and therefore dictates the degree of shielding and remote operation required.

* The capacity of the reference plant is about 1200 MWe

Its decay - its half-life being five years - is the principal reason for delaying dismantling. Because of their long and very long half-lives* nickel-63 and nickel-59 will have a major influence on the choice of the final storage or disposal mode of steel components.
Even though nickel-59 and nickel-63 may be present in significant quantities for long periods, their potential biological hazard must be kept in perspective, considering the low level and penetration capability of the radiation.

Decommissioning alternatives

According to the studies it would be feasible but not optimal with respect to both health protection and costs to undertake complete dismantling and removal of the plants immediately after shutdown ("Prompt Stage 3"). On the other hand it would not be practical to delay Stage 3 until it was reached merely by the decay or the radionuclides. The principal reasons for proceeding to Stage 3 appear to be the degradation of contamination barriers, the surveillance costs during lower Stages and, possibly, national licensing requirements. The economic value of the land area recovered would be comparatively insignificant. A nuclear site may be of high value to the utility, but it would generally be possible to build a new plant without removing the reactor building of the old one, since this building usually occupies only a small part of the site area.

The decision to start on Stage 2, as against Stage 1, will depend to a large extent on the national licensing requirements. Recovery of site area and esthetic reasons will not be an incentive, since underground

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* Nickel-63: half-life of 90 years
Nickel-59: half-life of 80,000 years

entombment appears impractical and substantial overground structures or even the whole containment building, as envisaged in the United States, will remain in place during Stage 2.

Decommissioning costs

Decommissioning costs accrue from decommissioning works at the plant, from management and disposal of the wastes produced and, until Stage 3 is reached, from surveillance and maintenance of the plant. The mode of waste disposal is decisive of disposal costs and may also condition preceding operations and their costs. As the disposal mode is unknown as yet, cost estimates have been based on assumed disposal modes and therefore are to a certain degree hypothetical. The following costs have been estimated recently in an American (A) and in a European (E) study*(in millions of 1975 US $, including removal of non-nuclear buildings):

Decomissioning alternatives	Study A	Study E
Prompt Stage 3	27	79
Delayed Stage 3 (1) - after Stage 1	23	64
- after Stage 2	25	-

(1) Delay after shutdown: 108 years for A, 40 years for E; no permanent security force during Stage 1.

These costs range from about 4 to 13 % of plant capital costs in 1975. The difference between the two estimates is to a large extent due to the different waste disposal modes assumed, which are virtually opposite extremes as regards their impact on costs. Study A is based on the financial and technical conditions in force at commercial surface burial grounds but assumes the radioactivity limit to be strongly increased. (This certainly unrealistic assumption affects only the Prompt Stage 3 alternative). Study E is based on the conditions in force at an experimental geological disposal facility, which require in paeticular that all wastes are packed in small units.

* Study A: AIF/NESP-009SR; study E: EUR 5728 d

Moreover, these costs are not discounted. However, comparison of costs arising at different points in time inevitably involves discounting and not discounting amounts merely to using a discount rate of zero. Discount rates may be chosen on the basis of anticipated interest and inflation rates, of utility practices or of macro-economic considerations. Thus no specific rate can be proposed here, but the preponderant influence of discounting, even with rates as low as 1 % per year, has to be stressed. This influence tends to reduce the ratio of decommssioning to capital costs, the reduction being the greater the longer Stage 3 is delayed and permits sinking-funds to grow.

The current costs during Stages 1 and 2 would be lower than assumed in the studies if the decommissioned plant shared the site with at least one operating plant, which will be the most frequent case in the foreseeable future. On the other hand, a permanent security force, which might be required for a single plant in Stage 1, would result in an additional cost. Constant annual maintenance costs, excluding major works, have been assumed but it is recognized that this may be unrealistic, in particular for longer periods of delay. Maintenance costs are expected to increase at long term, as excessive degradation of the plant is to be avoided, and this might be a reason to proceed to Stage 3 earlier. This aspect requires further study.

Occupational exposure

Occupational radiation exposure is seen to be the main safety concern in decommissioning. Not only have the individual dose limits to be complied with, but also the total radiation dose should be kept within acceptable limits. Besides the use of shielding, remote operation and enclosures with controlled ventilation, careful planning of the successive decommissioning operations is essential. Total occupational doses estimated in the already mentioned study A, are 630 man-rem for Prompt Stage 3 and about 450 man-rem for Stage 1 or 2 and Delayed Stage 3 (108 years after shutdown). It has to be mentioned that substantially higher doses have been estimated by others.

3.2. Gas-cooled reactors

Gas graphite reactors will probably form the bulk of the nuclear power plants which will become redundant by the end of this century.

Important differences in the radioactivity inventory compared with light water reactors are the lower specific activities but larger volumes, the preponderance of mild steel over stainless steel and the large amounts of graphite, which, however, are present as easily manageable pieces. The following amounts of materials have been indicated for the pressure vessel and the pressure vessel internals of a typical commercial Magnox reactor (capacity: 250 Mwe): 2500 tonnes of mild steel, 100 tonnes of stainless steel and 2500 tonnes of graphite. As regards the biological shield concrete, only its inner layer is activated. The thickness of this layer will be about 1.5m two years after shutdown and will decrease with time as the result of radioactive decay. Nevertheless this concrete would present the major disposal problem in terms of mass. Heat exchangers would by their size and by the tube surface area and geometry pose a major decontamination problem.

The study of the decommissioning of a representative commercial Magnox reactor is still in progress, but a detailed technical study on the Windscale Advanced Gas-cooled Reactor (W.A.G.R.), has been completed and it is likely that its conclusions will in principle be applicable also to Magnox reactors. The W.A.G.R. study is based in one case on a progressive procedure, considering Stage 1 as an interim phase, Stage 2 as a storage situation of unspecified duration and Stage 3 as the ideal ultimate objective. The alternative case is the progression from reactor closure to Stage 3 as a continuing operation. In particular, it is concluded that a satisfactory long term Stage 2 condition can be established and that there is no technical obstacle to proceeding directly to a Stage 3 condition. The conception of Stage 2 differs from that envisaged in the United States for pressurized water reactors in the dismantling of the containment building and the heat exchangers, resulting in a considerable reduction of the occupied area and the visual impact. For commercial steel pressure vessel Magnox reactors, irrespective of output capacity, the remaining structures would be cylinders with a diameter of about 30 metres and a height above ground of 18-30 metres.

A detailed decommissioning study has been performed on Chinon 1, a 70 MWe gas graphite prototype plant, which was retired from service for economic reasons in 1973, after having operated for 10 years with an average load factor of about 50 %. From activity measurements carried out on samples, the activity of the graphite moderator (1050 tonnes) at the end of 1975 has been estimated as 3000 Ci of cobalt-60, 1200 Ci of tritium, 300 Ci of carbon-14 and 0.5 Ci of plutonium-239 and -240. Measurements inside the fuel channels have shown dose rates in the order of 10 rem/h from the graphite reaching a maximum of 400 rem/h near the core support steel plate. The activated steel components amount to about 1500 tonnes. First measurements indicated that the biological shield concrete is not activated.

The Chinon 1 study compares the direct approach of Stages 1, 2 and 3. Stage 2 was assumed to embrace the reactor vessel and the heat exchangers within a concrete enclosure and to involve dismantling other contaminated systems, storing the parts within sealed premises in the containment sphere. The conclusion was that this condition would not be safer than Stage 1 and that it would complicate proceeding to Stage 3 subsequently. Stage 3 was studied in detail, including the conceptual design of the required remotely operated equipment.

On the basis of this study it was decided to convert the plant into a nuclear museum. This conception, which in particular allows the public access to part of the containment sphere, is planned to be achieved in 1978 or 1979. The option to proceed to Stage 3, 30 years later, remains open.

3.3. Decommissioning subsequent to a major accident

The studies considered in the foregoing sections (3.1, 3.2) are based on plants which are retired from service in a normal condition. Major plant accidents, resulting in a wide spread of heavy contamination within the containment building, would pose special decommissioning problems and even complicate routine operations, such as the discharge and the removal of the fuel. Whereas such accidents are taken into account in the plant design, their impact on decommissioning is not well known. First studies, which are in progress, have shown the complex nature of this problem.

4. Decommissioning techniques

4.1. Decontamination

The purpose of decontamination in decommissioning will in most cases be to facilitate the dismantling and further treatment of components, by reduction of the radiation level and removal of loose contamination. Another possible objective is "complete decontamination", i.e. decontamination to a level below the limit for unrestricted release of material, in order to reduce the volume of radioactive waste. The benefits of decontamination have to be weighed against operational risks, arisings of consequential waste and costs. Thus different opinions exist as to what is a reasonable decontamination effort. This question merits further study, but it cannot be answered without a better knowledge of the technical options.

The only proven decontamination techniques are those which are currently used in operating reactors and which may be classified as follows:

- System decontamination, applied within closed systems of the plant and using chemical agents;

- Immersion decontamination, applied to dismantled component and using chemical agents, generally combined with mechanical means such as brushing or ultrasonic waves;
- Jet decontamination, applied to systems locally through openings, or to dismantled components in special cells, or even to the surfaces of premises, using jets of vapour or liquid or of a mixture of liquid and grinding particles.

Experience with these techniques is substantial but difficult to interpret. Achieved decontamination factors vary over a wide range, depending on the particular conditions in a way which is not yet well understood.

These proven techniques have been developed for application to components to be serviced or repaired, that is to say, subject to the condition of preserving component integrity. Whereas these techniques are also usefully employed in decommissioning, more aggressive methods, resulting in more effective decontamination, would be desirable. These could be variants of the proven techniques, i.e., system and immersion decontamination using more aggressive chemical agents or jet decontamination using higher pressure or more abrasive grinding particles, etc., but also basically new techniques.

System decontamination offers the advantage of preceding the opening up and dismantling of the system, thus reducing personnel exposure. It reaches a large surface at a time, but cannot be applied selectively to local peaks of contamination. It is also less effective in crevices and dead ends of a system, where contamination often concentrates. Consequently, system decontamination will as a general rule not result in complete decontamination. The large volume of certain systems, such as the primary cooling circuit, and the need for several decontamination and flushing steps give rise to very large quantities of radioactive liquid, which may pose problems of interim storage and of treatment. Moreover, differential attack on the various materials of a system and the spread of contamination to initially clean regions are aspects which have to be considered.

Immersion decontamination can use existing equipment for small components, but the corrosive attack of the tanks must be considered, if more aggressive chemical reagents are employed. Major components would pose problems of space, equipment and of volume of liquid produced.

The folowing new techniques have been proposed:

- Decontamination by chemical agents applied as a surface layer, i.e., pastes and molten salts. Laboratory experiments have shown promising results, indicating high efficiency and low volume of consequential waste.
- Electrolytical decontamination, using similar processes to the electropolishing known in the non-nuclear industry.
- Decontamination by explosive methods. Preliminary experiments have demonstrated that the oxide film, which incorporates the contamination of steel components, can be spalled off from the base metal. With this technique the volume of consequential waste would be very small.

4.2. Dismantling

Dismantling of steel components

The reactor vessel and the reactor vessel internals pose the most difficult dismantling problems. Because of the high radiation level, remote operation is required. The more active vessel internals of light water reactors should preferably be cut under water, the water providing shielding and reducing aerosol production. Certain components have large wall-thicknesses, ranging up to 500 mm (reactor vessel flange of pressurized water reactors).

Mechanical techniques such as mill cutting and sawing can be carried out under water, but they are time-consuming and require heavy supports. With thermal techniques special attention has to be paid to the confinement of aerosols. Plasma arc cutting, which can be carried out under water, appears attractive. At the present time it can be employed to wall-thicknesses up to about 170 mm, but has development potential up to 500 mm. Another promising technique is oxy propane cutting. Electro-melt separation can be employed for large wall-thicknesses but has the disadvantage of strong aerosol production.

Concerning the dismantling of pipework, the removal of thermal insulation may pose special problems. Moreover, no adequate technique is currently available for cutting large-diameter large wall-thickness pipework, such as that employed in the primary circuit of pressurized water reactors. Cutting of pipes by explosive methods constitutes a new technique which should be developed. Experiments carried out on pipes of moderate size have shown that it is possible with explosive methods to disconnect a pipe and to close its ends in a single operation.

Dismantling of concrete structures

The concrete structure which usually poses the main dismantling problem is the biological shielding. Special problems due to stored energy may arise with certain prestressed concrete pressure vessels which are employed in some gas graphite reactors.

There are several proven techniques for dismantling concrete. In the explosive technique charges placed in holes loosen up the whole structure or break it up into layers. This method is relatively expensive and time-consuming. In the thermal lance technique, holes closely put in a line are burnt into the concrete by a jet of oxygen, to which iron is supplied as fuel. Dismantling by this method is relatively quick, but is accompanied by intensive smoke formation. Additionally sawing, hydraulic or pneumatic wedges, or high pressure water jets may be used.

These proven techniques will require further development and adaptation, to perform the more difficult tasks of future dismantling operations.

Other techniques to be considered are hydraulic cracking, oxy-arc cutting and successive boring and cracking by freezing.

4.3. Equipment for remote operations

Remote operations such as dismantling, decontamination, conditioning and packing require special equipment to hold and move tools, measuring instruments, telecameras and the parts to be treated. Such equipment may be designed ad hoc for a special situation or for multiple use. It belongs to a technology which is already employed in reactors and hot cells but has to be scaled up and further developed for decommissioning operations.

4.4. Management and storage of wastes from decommissioning

Conditioning, packaging, transport and storage or disposal constitute a series of operations which have to be optimized as a whole, taking as a basis the specific characteristics of the type of waste considered. The process of evolving the optimal management concepts for wastes from decommissioning is still in a preliminary phase.

The waste arising from dismantling of major activated components is characterized by the large initial dimensions and by the fact that the bulk of radioactivity is incorporated in the base metal. One leading idea for the management of this waste would be to limit the cutting to the extent necessary for transport, thus minimizing work under radiation and the spread of radioactive material. Accordingly, large transport containers should be developed for certain components and the storage facilities should be designed for acceptance of large units.

For contaminated pipework a treatment reducing the storage volume appears desirable. Press compaction, cryogenic cracking and smelting have been proposed as techniques. The feasibility of such a treatment should be studied, including the question, whether the operation should be carried out on the site of the nuclear power plant or in a central facility.

As regards radioactive concrete waste, it would be desirable to have an inexpensive method for the long term immobilization of the radionuclides.

Controlled burning has been proposed for the graphite arising in the decommissioning of gas graphite reactors and advanced gas cooled reactors. In order to decide whether this method is appropriate, it is necessary to consider not only its local radiological impact, but also the long-term consequences, through the contribution to the worldwide background radiation, of releasing to the atmosphere considerable amounts of the long-lived radionuclide carbon-14.

Consequential wastes need no special consideration here, since they can be managed appropriately by the methods which are currently employed for wastes arising at operating nuclear power plants.

The following methods have been envisaged by certain countries for final storage or disposal of different types of waste arising from decommissioning surface storage, storage in a former mine, disposal in drilled deep holes and sea dumping.

5. Estimation of the quantities of radioactive wastes from decommissioning

5.1. General considerations

The following information is required to estimate the arisings of radioactive wastes from the decommissioning of nuclear power plants:

a) schedule of retirement of the plants from service;
b) inventory of the radioactive components, systems and structures of the plants and estimate of associated radionuclides;
c) schedule of decommissioning works and in particular of dismantling;
d) extent to which the original volume and radioactivity of the materials concerned are changed by decontamination, conditioning, overpacking, etc., and production of consequential wastes.

The result of a first tentative approach to item a) is given in point 5.2. below.

As regards item b), because of the variety of existing nuclear power stations, most of them are to be considered individually. Some information is already available, but a great deal of work is still needed before a complete survey of radioactivity inventories can be established.

For the evaluation of items c) and d), reference strategies have to be evolved; this is to be considered as a long-term task.

5.2. Retirement of nuclear power plants from service

It is premature to make firm estimates on the schedule of retirement of nuclear power plants from service, since the operational life is uncertain within a wide range. The following table illustrates a possible pattern. It takes into account the plants which are currently in operation or under construction in the Community and is based on an assumed operational life of 30 years, except for certain prototype plants, for which specific shorter periods have been adopted.

Reactor type	Reactors retired over period:		
	1981-1990	1991-2000	2001-2010
Gas graphite and advanced gas-cooled reactors	11	20	14
Light water reactors	3	7	37
Other types	2	2	4
Total	16	29	55

6. Guiding principles

Guiding principles concerning decommissioning can be formulated only in a very general way as regards the immediate future and can only be developed in greater detail as a long-term process. Moreover, consideration at Community level must take into account the different conditions prevailing in the Member States, such as reactor types employed, territorial conditions and urgency of decommissioning.

Community efforts in this field should not duplicate or hamper the measures undertaken on a world scale by the International Atomic Energy Agency, but it should be recognized, that the Community could bring its point of view to bear with greater weight in this wider framework if it had clear conceptions substantiated by approrpriate studies.

6.1. Guiding principles in the design and operation of nuclear power plants with a view to simplifying decommissioning

Studies have indicated, that as regards decommissioning modern nuclear power plants pose no fundamental difficulties which would require basic changes in design. Improvements with a view to facilitating decommissioning have been proposed and appear possible, concerning features such as the arrangement, design and materials of plant components.

Features which are increasingly introduced into modern nuclear power plants, in order to facilitate maintenance and repair during the operation period, will ultimately also facilitate decommissioning.

6.2. Guiding principles in the decommissioning of nuclear power plants

Decommissioning operations are subject to general nuclear regulations, but no specific detailed guidelines for decommissioning exist in the Member States as yet. For instance, permissible radiation limits for the personnel and the general public are laid down in the general regulations, but there are no criteria for the unrestricted release of equipment and sites. Such matters have been settled in past decommissioning operations on a case-by-case basis. In this context mention should be made of the present efforts by the International Atomic Energy Agency.

PART II: PROGRAMME PROPOSAL

1. Underlying considerations

Major advances in concepts and techniques will be required to decommission the nuclear power plants in the best way, with respect to both health protection and economy. The solutions adopted may influence the development of nuclear power through their economic impact and through the reception they meet with among the public.

As the number of plants to be decommissioned will increase at only a slow pace during the coming decades and, moreover, dismantling and removal of the plants, if necessary, may be postponed for considerable periods after their withdrawal from service, it might be concluded that no substantial effort to solve the problems of decommissioning is called for at the present time. This conclusion would, however, be a dangerous mistake, for the following reasons:

- Features which facilitate decommissioning should be developed and increasingly introduced in the design of new plants.
- The task of identifying, developing and implementing the optimum solutions will take a long time. The technical developments will be conditioned by the legal and administrative framework, and in particular by the criteria for release or for acceptance at central depositories of the wastes. The industry therefore needs guidance on these questions at an early stage. On the other hand, better knowledge of the possible technical options is needed in order to evolve the legal and administrative framework.
- Better knowledge of decommissioning costs will enable utilities to accumulate provisions for decommissioning in accordance with national requirements.
- Decommissioning operations may be urgently required in particular situations, for instance after an incident.

- It is becoming increasingly important, in order to secure public acceptance of new plants, to have elaborated and well-founded concepts for the "back ends" of nuclear energy generation, even if definitive solutions are not yet really needed. One could go so far as to consider dismantling and removing a plant earlier than would otherwise be appropriate, in order to demonstrate the feasibility of a decommissioning concept.

The Commission therefore holds the view that in addition to the research activities of the Joint Research Centre an indirect action joining forces at Community level, in the form of exchanging information and sharing work, could save money and time. Moreover, a Community approach could favourable influence acceptance by the public of the solutions adopted by the Member States, whatever their differences to suit the particular features of the nuclear power plants and other national conditions. Work already going on in a member country could be pursued under the common programme, if the country agrees and if the work is of interest to the Community. The public service nature of this work and the secondary importance of competing commercial interests at stake will facilitate a Community approach.

2. General features of the proposed programme

The programme, which is proposed to cover a period of five years beginning 1 July 1978, must be regarded as the first stage of a longer-term effort. It consists of a series of studies and experimental projects aimed at evolving the most appropriate solutions, with respect to both health protection and economy, for the decommissioning of nuclear power plants.

These studies and projects will be financed largely by the Commission and coordinated by it with the help of an Advisory Committee on Programme Management comprising representatives of the Member States and Commission officials. This committee will have to meet as soon as this programme is approved. The work will be carried out by qualified public or private agencies in the Member States.

In order to avoid duplication, the programme takes into account the relevant activities of the international organisations. On the other hand, the scope of the programme has been strictly delimited to prelude overlapping with the Community programme on radioactive waste management and storage. In particular, it takes into account activities dealing with the decontamination of reactor components being carried out at JRC within the frame of their multiannual programme 1977-1980 and will be closely coordinated with these activities.

The programme may be submitted for review at the end of two years, to reorientate or amplify it, where necessary, in the light of the results obtained.

3. Research and development actions

The proposed actions, which are described in annex II, concern the following subjects :

Action N° 1 : Long term integrity of buildings and systems.
Action N° 2 : Decontamination for decommissioning purposes.
Action N° 3 : Dismantling techniques.
Action N° 4 : Treatment of specific waste materials : steel, concrete and graphite.
Action N° 5 : Large transport containers for radioactive waste produced in the dismantling of nuclear power plants.
Action N° 6 : Estimation of the quantities of radioactive wastes arising from decommissioning of nuclear power plants in the Community.
Action N° 7 : Influence of nuclear power plant design features on decommissioning.

These proposals have been formulated on the basis of the analysis of earlier studies and experience, which is contained in Part I of this document.

In addition to these proposals it is envisaged that the Community participates in a large-scale operation, carried out in the context of decommissioning of a nuclear power plant or of a major component of such a plant and involving the demonstration of new techniques or the extension of proven techniques to a wider range of conditions, such as size and radiation level of components. As no specific action can be proposed at present, the subject is mentioned here only for the record, but a proposal should, if possible, be submitted for the revision of the programme. The Community's financial contribution would depend on the general interest of the information expected to be obtained from the proposed action.

4. Identification of guiding principles

This activity relates to :

- Guiding principles in the design and operation of nuclear power plants with a view to simplifying their subsequent decommissioning.
- Guiding principles in the decommissioning of nuclear power plants.

Guiding principles need to be progressively evolved in order to plan the research and development actions efficiently; conversely, the results of the actions may influence the shaping of the guiding principles. In view of this interdependence the programme includes provision for the progressive evolvement of guiding principles.

The intention is that rough material for guiding principles prepared in the Member States should be assembled and analysed, and an assessment then made of the scope for approximation and joint development. At a later stage of the programme it will be endeavoured to frame proposals for common guiding principles.

The Commission should also have a limited budget for this action so that it could have the necessary analyses performed under study contracts.

5. Breakdown of proposed funding

Costs over five years in millions of European units of account (EUA) :

Item	Costs
Contribution to research and development actions :	
Action Nº 1	0.3
Action Nº 2	1.4
Action Nº 3	1.1
Action Nº 4	0.6
Action Nº 5	0.2
Action Nº 6	0.4
Action Nº 7	0.6
Subtotal actions 1 to 7	4.6
Identification of guiding principlaes	0.2
Staff *	1.31
Meetings	0.27
Total	6.38

* This programme will require a staff of 5 (2A + 2B + 1C)

ANNEX I

SUPPORTING INFORMATION TO PART I

to 2. Experience with decommissioning

The nuclear power plants which have already been retired from service are listed in Table 1. Further information on nuclear power plants which have been decommissioned beyond Stage 1 is given in Table 2.

to 3.1. Light water reactors

Table 3 gives information concerning radionuclides of significance as regards activation of steels. Table 4 gives supplementary information concerning the cost data.

to 5.2. Retirement of nuclear power plants from service

The nuclear power plants taken into account in the summary table under point 5.2. of Part I are listed in Table 5.

to 6.1. Guiding principles in the design and operation of nuclear power plants with a view to simplifying decommissioning

The following design features have been recommended in the frame of the International Atomic Energy Agency (document IAEA-179):

Arrangement of components and structures

Components and structures should be so arranged that:

- The site can utlimately be developed to its maximum potential despite the eventual existence of decommissioned structures;
- There is sufficient space around them to permit access with transporting equipment, shielding or tools;
- Suitable cells or cabins can be erected around them to restrict the disperison of radioactive material during their dismantling and, if necessary, to permit operations at a lower pressure than in the surrounding atmosphere;
- They can be removed in one piece through adjoining rooms or the roof, using plant or external lifting devices if necessary.

Construction of components and structures

Components and structures should be so designed that:

- The contaminated or activated components can be cut off;
  Example: Detachable concrete layers on the biological shield;
- Their activation level is reduced;
  Example: Distance between the steel reinforcement of the concrete and the neutron flux zone;
- The components and structures can be broken down into parts which are relatively light, small and suitably shaped for transportation;
- Suitable passages and openings are provided for removing them from the containment or reactor building;
- As many components as possible are replaceable;
- Materials are selected to reduce the formation of nuclides with a long half-life.

Decontamination provisions

To simplify the decontamination of components, pipe systems and rooms, the following provisions should be made:

- The spreading of active corrosion products or deposits during operation or decommissioning should be limited by for example, the incorporation of drain points, devices for flushing the piping systems and traps in pipe systems;
- Facilities for the decontamination of components and rooms, including means of introducing and draining decontamination solution.

Administrative measures

A reliable documentation system should be established and used to record all changes in the design and materials of the plant during its operation.

Table 1. Nuclear power plants retired from service

Country	Plant	Type *	Capacity MWe	Operating period
France	Marcoule G1	GGR	4	1956 - 1968
"	Chinon 1	GGR	70	1963 - 1973
Germany	HDR Grosswelzheim	BWR	25	1970 - 1972
"	KKN Niederaichbach	HWR	100	1974 - 1974
United Kingdom	DFR Dounreay	FBR	15	1963 - 1977
Switzerland	CNL Lucens	HWR	8	1968 - 1969
USA	Vallecitos EVESR	BWR	5	1957 - 1963
"	Elk River Reactor	BWR	22	1964 - 1968
"	Hallam HNPF	SGR	75	1962 - 1964
"	BONUS	BWR	16.5	1962 - 1968
"	Vallecitos VBWR	BWR	10	1957 - 1963
"	Santa Susana	SGR	7.5	1958 - 1966
"	Piqua OMR	OMR	11.4	1963 - 1966
"	Carolinas CVTR	PWR	17	1963 - 1967
"	Enrico Fermi	FBR	61	1966 - 1971
"	Pathfinder	BWR	62	1962 - 1967
"	Saxton	PWR	4.2	1962 - 1972
"	Peach Bottom	HTR	40	1966 - 1974

* BWR = boiling water reactor
GGR = gas graphite reactor
FBR = fast breeder reactor
HTR = high temperature reactor
HWR = heavy water reactor
OMR = organic moderated reactor
PWR = pressurized water reactor
SGR = sodium graphite reactor

Table 2. <u>Plants which have been decommissioned beyond Stage 1</u>

Plant	HNPF (Hallam Nuclear Power facility)	BONUS (Boiling Nuclear Superheater Reactor)	CNL (Centrale nucléaire Lucens)	ERR (Elk River Reactor)
Country	USA	USA	Switzerland	USA
Reactor type	graphite moderated sodium cooled	boiling water nuclear superheating	heavy water moderated, gas cooled	boiling water (fossil superheating)
Capacity (MWe)	75	16.5	8	22
Operating period	1962-1964	1962-1968	1968-1969	1964-1968
Activity* inventory (Ci)*	3×10^5	50.000	500	9000
Condition reached	Underground entombment; top planted and accessible without restriction	Entombment in biological shield; plant converted to museum	Low active parts (total ~1.5 Ci) entombed; other parts packed and stored on site; reactor caverns accessible without restriction	Stage 3 completed in 1974
Decommissioning cost	4.2 millions US $	not available	not available	5.7 millions US $

* HNPF: at time of entombment closure; others: at start of decommissioning

Table 3. Radionuclides of significance as regards activation of steels used in light water reactors

Radionuclide	Iron-55	Cobalt-60	Nickel-63	Nickel-59
Half-life, years	2.4	5.2	92	80,000
Radiation	gamma, X-ray	gamma, beta	beta	gamma, X-ray
Mother element	Iron	Cobalt	Nickel	
Content (%) of mother element in:				
- stainless steel (1)	70	traces	10	
- carbon steel (2)	97	traces	0.5-0.8	

(1) Components: Reactor vessel internals, reactor vessel caldding

(2) Component: Reactor vessel

Table 4: Cost estimates for decommissioning of light water reactors

(1200 MWe plants; operating time: 40 years)
Costs in millions of 1975 US$ (1)

Study Reference Reactor Discounting	E EUR 5728 PWR (2)	 no	 BWR (2)	 no	A AIF/NESP-009SR PWR no	 BWR no
Prompt Stage 3	68.4	78.6	83.4	95.4	26.9	31.2
Delayed Stage 3 - after Stage 1						
- Stage 1	4.5	4.6	4.5	4.6	2.3	2.4
- Interim costs (3) -case I	0.3	0.7	0.3	0.7	9.5	9.2
-case II	(4)	(4)	(4)	(4)	18.0	17.4
- Stage 3 (5)	12.2	59.0	13.1	63.3	11.0	11.7
- Total -case I	17.0	64.3	17.9	68.6	22.8	23.3
-case II	(4)	(4)	(4)	(4)	31.3	31.5
Delayed Stage 3 - after Stage 2						
- Stage 2					7.4	7.6
- Interim costs (3)			(4)		6.3	6.0
- Stage 3 (5)					10.8	12.2
- Total					24.5	25.8

(1) Data from study E converted with the rate 1 DM = 0.4 US$
(2) Discounted to shutdown date at an annual rate of 3.7 % (This rate results from assumed annual rates of 12 % for interest and of 8 % for inflation)
(3) Based on following annual costs of maintenance and surveillance:

Study	E	A
After Stage 1 - case I: no security force	0.019	0.088
- case II: with security force	(4)	0.167
After Stage 2	(4)	0.058

(4) Alternative not considered
(5) Delayed Stage 3 40 years (study E), 108 years (study A, PWR) and 104 years (study A, BWR) after shutdown (The delay periods assumed in study A were estimated to permit manual - as opposed to remotely operated - dismantling).

Table 5: Nuclear power plants built or under construction in the European Community

Plant	Country	Type	Capacity MWe	Start of operation	Year or assumed period of closure
Marcoule G1	F	GGR	4	1956	1968
HDR Grosswelzheim	D	BWR	25	1970	1972
Chinon 1	F	GGR	70	1963	1973
KKN Niederaichbach	D	HWR	100	1974	1974
DFR Dounreay	UK	FBR	15	1963	1977
BR-3 Mol	B	PWR	10	1966	
MZFR Karlsruhe	D	HWR	51	1966	
(Otto Hahn	D	PWR		1968	
El-4 Monts d'Arré	F	HWR	70	1967	1981-1990
VAK Kahl	D	BWR	15	1961	
WAGR Windscale	UK	AGR	32	1963	
Marcoule G2	F	GGR	40	1959	
Marcoule G3	F	GGR	40	1960	
Calderhall	UK	GGR	4 X 50	1956-1959	
Chapelcross	UK	GGR	4 X 50	1959-1960	
Berkeley	UK	GGR	2 X 138	1961	
Bradwell	UK	GGR	2 X 150	1961	
Latina	I	GGR	210	1964	
Hunterston A	UK	GGR	2 X 150	1964	
Garigliano	I	BWR	160	1964	
Trino Vercellese	I	PWR	257	1965	
Chinon 2	F	GGR	200	1965	1991-2000
Hinkley Point A	UK	GGR	2 X 250	1965	
Trawnsfynydd	UK	GGR	2 X 250	1965	
Dungeness A	UK	GGR	2 X 275	1965	
Chinon 3	F	GGR	480	1966	
Sizewell A	UK	GGR	2 X 290	1966	
KRB Gundremmingen	D	PWR	237	1966	
SENA Chooz	F	PWR	305	1967	
AVR Jülich	D	HTR	13	1967	
Oldbury A	UK	GGR	2 X 300	1967-1968	
KWL Lingen	D	BWR	182	1968	
KWO Obrigheim	D	PWR	328	1968	
GKN Dodewaard	NL	BWR	52	1968	
SGHWR Winfrith	UK	HWR	92	1968	
St Laurent 1	F	GGR	480	1969	
St Laurent 2	F	GGR	515	1971	
Wylfa	UK	GGR	2 X 590	1971	
KNK Karlsruhe	D	SZR	19	1972	
KWW Würgassen	D	BWR	640	1972	
KKS Stade	D	PWR	630	1972	
Bugey 1	F	GGR	540	1972	2001-2010
Borssele	NL	PWR	450	1973	
Phénix	F	FBR	233	1973	

Table 5: continued

Plant	Country	Type	Capacity MWe	Start of operation	Year or assumed period of closure
Biblis A	D	PWR	1146	1974	
Doel 1	B	PWR	390	1974	
Tihange 1	B	PWR	870	1975	
PFR Dounreay	UK	FBR	230	1975	
Doel 2	B	PWR	390	1975	
Biblis B	D	PWR	1240	1976	
GKN Neckarwestheim	D	PWR	775	1976	
KKB Brunsbüttel	D	BWR	770	1976	
Hinley Point B	UK	AGR	2 X 625	1976-1977	
Hunterston B	UK	AGR	2 X 625	1976-1977	
Fessenheim 1,2	F	PWR	2 X 890	1977	
KKI Isar	D	BWR	870	1977	2001-2010
KKP-1 Philippsburg	D	BWR	864	1977	
KKU Unterweser	D	PWR	1230	1977	
Bugey 2, 3	F	PWR	2 X 925	1978	
Caorso	I	PWR	840	1978	
Bugey 4, 5	F	PWR	2 X 905	1978-1979	
Tricastin 1,2,3,4	F	PWR	4 X 925	1979-1980	
Gravelines 1,2,3,4	F	PWR	4 X 925	1979-1981	
KKG Grafenrheinfeld	D	PWR	1229	1979	
Mülheim-Kärlich	D	PWR	1154	1979	
Dungeness B	UK	AGR	2 X 600	1979	
Hartlepool	UK	AGR	2 X 625	1979	
Heysham	UK	AGR	2 X 625	1979	
Dampierre 1,2,3,4	F	PWR	4 X 925	1979-1981	
Doel 3	B	PWR	900	1980	
Tihange 2	B	PWR	900	1980	
KKK Krümmel	D	BWR	1260	1980	
THTR-300 Uentrop	D	HTR	300	1980	
St Laurent B 1,2	F	PWR	2 X 925	1981	
Le Blayais 1,2	F	PWR	2 X 925	1981	
KWG Grohnde	D	PWR	1294	1981	
KRB B,C Grundremmingen	D	BWR	2 X 1250	1981-1982	after 2010
Chinon B 1,2	F	PWR	2 X 925	1981-1982	
KBR Brokdorf	D	PWR	1294	1982	
KWS Wyhl	D	PWR	1283	1982	
SNR-300 Kalkar	D	FBR	282	1982	
Cirene	I	HWR	32	1982	
Paluit 1,2	F	PWR	2 X 1300	1982	
Superphénix	F	FBR	1200	1983	
KKP-2 Philippsburg	D	PWR	1280	1982	
ENEL 6,8 Montalto	I	BWR	2 X 980	1983-1984	

Note: The assumed periods of closure result from the assumption indicated in under point 5.2 of Part I. There are generally no planned dates of closure as yet.

ANNEX II

DESCRIPTION OF PROPOSED RESEARCH AND DEVELOPMENT ACTIONS

Action N° 1

Long term integrity of buildings and systems

It has been proposed that the dismantling of nuclear power plants be delayed for periods ranging from several decades to about a hundred years, mainly in order to reduce personnel radiation exposure. Significant degradation of the plant, and in particular of the contamination barriers, during this time would pose problems of safety, maintenance costs and, ultimately, dismantling. This aspect, which has not been assessed in most existing decommissioning studies, is among others important for the purpose of estimating what would be a reasonable period of delaying dismantling.

The objective of this action would be to improve the knowledge on degradation and to propose appropriate preventive measures.

Programme:

- Estimation of the progress of degradation and of the required maintenance effort to be expected as a function of time for containment buildings, based on a review of available experience with similar buildings.
- Study of the internal corrosion of closed contaminated systems due to residual amounts of humidity and aggressive agents; development of methods for removing residues of corrosive agents.
- Study of other measures aimed at maintaining plants in a safe condition.

Community contribution: 0.3 million EUA.

Action N° 2

Decontamination for decommissioning purposes

The object of this action, complementary to those carried out at JRC within the frame of their multiannual programme is to develop and to assess decontamination methods which are specifically suitable for decommissioning purposes. These methods may apply to closed systems, to dismantled components, especially those of large dimensions, or to the surfaces of premises. The methods may be more aggressive than those currently employed at operating reactors. Development should aim in particular at obtaining the following characteristics: high decontamination efficiency; simple and safe application; unproblematic nature and low volume of consequential waste. Methods which can be applied within the premises of nuclear power plants and with a minimum of additional equipment are of special interest.

Among the methods which seem to deserve development, the following ones may be mentioned: decontamination by pastes and by molten salts; electrolytical decontamination; decontamination by explosive methods.

Moreover, a synoptic study should be performed in order to assess the reasonable decontamination effort in decommissioning, taking as a basis typical reference components. This study should in particular identify the components for which "complete decontamination", permitting the unrestricted release of the treated item, would be practicable.

The special decommissioning problems posed by nuclear power plants which have had a major accident will also be analyzed. The study should be based on a loss of coolant accident which leads to severe contamination of the plant. The study should propose procedures by which the plant can be brought to a condition, in which it can be safely handled by normal decommissioning procedures. If necessary, reasonable modifications of the plant design should be proposed.

Community contribution : 1.4 million EUA

Action N° 3

Dismantling techniques

Various dismantling techniques have already been utilized in decommissioning, but would require further development to perform the more difficult tasks required in the future. In addition, promising new techniques have been proposed.

Because of the variety of techniques, which can be envisaged, it is proposed that a comparative screening study, considering several typical dismantling tasks, be carried out in order to assess the possible applications and the relative merits of the different techniques. On this basis, the most promising techniques should be selected and developed further.

The following techniques have, however, already been identified for further development:

- explosive methods, for dismantling both steel piping and concrete structures;
- thermal techniques for cutting thick walled steel components.

Community contribution: 1.1 million EUA.

Action N° 4

Treatment of specific waste materials: steel, concrete and graphite

Large amounts of radioactive waste consisting of steel will arise at every nuclear power plant which is dismantled. Cryogenic cracking and smelting have been proposed as promising new techniques for the conditioning of such waste.

Cryogenic cracking is aimed principally at reducing the storage volume and appears particularly appropriate for elements such as piping.

Smelting would have several purposes, i.e.:
- maximum reduction of the storage volume;
- maximum reduction of the surface which could become accessible to corrosion after disposal;
- decontamination by slag removal;
- incorporation of residual contamination into the base material;
- possibly separation of long-lived radioelements.

The object of the action, where these techniques are concerned, is to carry out feasibility studies, including:
- basic studies on specific aspects, such as the effectiveness of decontamination by smelting and the possibility of separating long-lived radioelements;
- conceptual studies with a view to arriving at the principal process parameters and conditions of application and to assessing the industrial interest of the techniques in question.

The problems posed by tritiated steel waste will also be studied.

As regards concrete waste, a conditioning method should be developed, by which the radioactivity is durably immobilized.

Large amounts of graphite will arise from the decommissioning of gas graphite reactors and advanced gas-cooled reactors. The object of this action is to develop a method for the disposition of this waste, taking into account the global and long term radiological impact of carbon-14 in the atmosphere, in case the graphite would be burnt.

Community contribution: 0.6 million EUA

Action N° 5

Large transport containers for radioactive waste produced in the dismantling of nuclear power plants

Studies have shown that it is desirable to transport the radioactive waste resulting from dismantling of certain major reactor components in larger units than those currently used for other types of radioactive waste, in order to reduce the required amount of cutting and, consequently, the personnel radiation exposure and the decommissioning costs. The size and weight of the shipping units should at least be such as to take full advantage of the normal transport facilities.

Programme

- System study aimed at defining the types of large transport and/or disposal containers needed, depending on the characteristics of the waste, such as radiation level, previous conditioning, etc.
- Conceptual study of large containers, including shielding design and safety analysis; definition of the test programme required for licensing purposes.

Community contribution: 0.2 million EUA

Action N° 6

Estimation of the quantities of radioactive wastes arising from decommissioning of nuclear power plants in the Community

This action involves the definition of reference strategies for decommissioning and is therefore to be considered as a long-term task. Consequently, the objective in this five-year programme can only be to arrive at a first tentative approach to the problem.

Programme

- Survey of data concerning radioactivity inventories after shutdown of nuclear power plants in the member countries; this survey should be complemented progressively, taking into account new studies which become available.
- Assessment of different schemes for decommissioning of plants and conditioning of wastes produced.
- Estimate of the arisings of radioactive wastes to be expected from decommissioning of the nuclear power plants, starting from some selected decommissioning schemes, in order to arrive at longer-term at a forecast of the wastes arising in the member countries.

Community contribution: 0.4 million EUA

Action N° 7

Influence of nuclear power plant design features on decommissioning

The object of this action would be to identify and develop reasonable improvements in plant design with a view to decommissioning. In order to perform this task effectively, while safeguarding the industrial information, the participation of plant constructors would be sought.

Programme

- In a first phase, exchange of information and views on the extent to which features facilitating decommissioning are already taken into account and on the possibilities of further improvements; identification of some specific potential improvements which are suitable for study under this action.
- Assessment of these specific improvements from the point of view of their technical feasibility, with due regard to safety and reliability of operation, and of their economic and environmental impact.
- Experimental studies on specific selected subjects (e.g., detachable surface layers).

Community contribution: 0.6 million EUA.

PROPOSAL FOR A COUNCIL DECISION ADOPTING A PROGRAMME CONCERNING THE DECOMMISSIONING OF NUCLEAR POWER PLANTS

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 consulting 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 programme of action of the European Communities on the environment, approved by the Council of the European Communities and the representatives of the Governments of the Member States meeting in the Council in the Declaration of 17 May 1977*, underlines the need for Community measures on the decommissioning of nuclear power plants and whereas it lays down the content of and procedures for implementing such measures;

WHEREAS certain parts of nuclear power plants inevitably become radioactive during operation, and whereas it is therefore essential to find effective solutions which are capable of ensuring the safety and protection of both man and his environment against the potential hazards involved in the decommissioning of these plants;

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* OJ No C 139, 13.6.1977, P. 34-35

HAS ADOPTED THIS DECISION.

Article 1

A programme on the research relating to the decommissioning of nuclear power plant shall be adopted in the form set out in the Annex for a five-year period from 1 July 1978. The Annex forms an integral part of this Decision.

Article 2

The expenditure commitments necessary for the implementation of this programme are estimated at 6.38 millions European units of account (EUA) with a staff of five.

Article 3

The programme set out in the Annex may be submitted for amendment at the end of the second year, in accordance with the appropriate procedures.

ANNEX

PROGRAMME

The aim of the programme is the joint development of a system of management of redundant nuclear power plants and of the radioactive wastes produced in their dismantling which, at its various stages, will provide man and his environment, with the best protection possible; the programme seeks to promote :

A. Research and development actions concerning the following subjects :

Action N° 1 : Long term integrity of buildings and systems.
Action N° 2 : Decontamination for decommissioning purposes.
Action N° 3 : Dismantling techniques.
Action N° 4 : Treatment of specific waste materials : steel, concrete and graphite.
Action N° 5 : Large transport containers for radioactive waste produced in the dismantling of nuclear power plants.
Action N° 6 : Estimation of the quantities of radioactive wastes arising from decommissioning of nuclear power plants in the Community.
Action N° 7 : Influence of nuclear power plant design features on decommissioning.

B. Identification of guiding principles, namely :

- certain guiding principles in the design and operation of nuclear power plant with a view to simplifying their subsequent decommissioning.

- guiding principles in the decommissioning of nuclear power plant which could form the initial elements of a Community policy in this field.

FINANCIAL SHEET

1. Relevant budget heading code : 3359

2. Title of budget heading:
   Decommissioning of nuclear installations

3. Legal basis

   Article 7 of the Treaty establishing the EAEC

4. Description, objective and justification of the action

4.1. Description

This is a EURATOM research programme (indirect action) on the decommissioning of nuclear installations. The programme relates to the following topics:

- development of specialized techniques;
- forecasting of radioactive waste generation;
- study of certain power plant characteristics from a decommissioning standpoint;
- definition of guiding principles.

The programme primarily concerns electricity producers and public and private bodies competent in the field of nuclear research.

4.2. Objective

The objective of the action is to promote the development of methods and techniques for decommissioning nuclear installations in such a way as to ensure protection for man and his environment.

4.3. Justification

The proposed programme is the outcome of the action programme on the environment approved by the Council on 17 May 1977; it has been drawn up with the aid of a group of national experts. Action at Community level will make for economy work through the exchange of information and the apportionment of tasks.

5. Financial incidence of the action (in EUA)

5.0. Incidence on expenditure

5.0.0. Total cost during the envisaged period

- from the budget of the Communities : 6,380,000 EUA
- from national administrations :
- from other sectors at national level :

5.0.1 Multiannual timetable Total cost : 6,380,000 EUA

Appropriations for commitment

	1978	1979	1980	1981	1982	1983
Staff expenditure	—	262,000	277,000	294,000	311,000	164,000
Administrative expenditure	24,000	49,000	52,000	55,000	59,000	30,000
Contracts	476,000	2,000,000	1,327,000	1,000,000	-	-
Total	500,000	2,311,000	1,656,000	1,349,000	370,000	194,000

Appropriations for payment

	1978	1979	1980	1981	1982	1983
Staff expenditure	—	262,000	277,000	294,000	311,000	164,000
Administr. expenditure	24,000	49,000	52,000	55,500	59,000	30,000
Contracts	476,000	1,000,000	1,000,000	1,000,000	1,000,000	327,000
Total	500,000	1,311,000	1,329,000	1,349,000	1,370,000	521,000

5.0.2 Method of calculation

a) Staff expenditure

The appropriations for this programme were evaluated on the basis of the following staff :

2 officials of grade A
2 officials of grade B
1 official of grade C

The calculations take account of the data as established for the setting-up of the draft budget for the year 1979. No net increase of salaries is assumed. Only a variation of the weightings has been considered in order to take account of the trend in the general level of prices in the Community.

b) Administrative and technical expenditure

They cover expenditures on missions and on the organization of meetings as well as the utilization of scientific and technical support if appears necessary for the good development of the programme.

c) Contract expenditure

Depending on the nature of the subject and the qualifications of the contractors, no standard method of calculation can be laid down.

Anyhow, the Advisory Committee on Programme Management will be consulted on the awarding of appropriations.

d) Multiannual previsions

The rates held for the calculations of the previsions are resp. : 1979 = 1.07; 1980 = 1.13; 1981 = 1.20;1982 = 1.27; 1983 = 1.34.

5.1 Implications on the funds

6. Control regime foreseen

Scientific control: ACPM and the responsible staff of the DG XII
Administrative controls:
Budgetary execution : Financial Control
Regularity of expenditure : Division Contracts of DG XII.

7. <u>Action financing</u>

7.0

7.1

7.2

7.3 Appropriations to be entered under future budgets.