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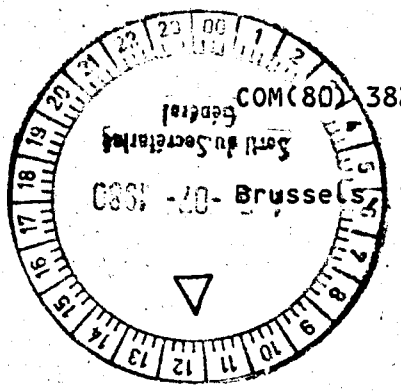
COM (80)382

Vol. 1980/0135

COMMISSION OF THE EUROPEAN COMMUNITIES



COM(80) 382 final

Brussels, 11 July 1980

Proposal for a

COUNCIL DECISION

ADOPTING A SECOND PROGRAMME OF RESEARCH AND DEVELOPMENT FOR THE EUROPEAN ATOMIC ENERGY COMMUNITY IN THE FIELD OF URANIUM EXPLORATION AND EXTRACTION (INDIRECT ACTION 1981-1984)

(submitted to the Council by the Commission)

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I. INTRODUCTION

The present proposal provides for a follow-up to the first research and development programme in the field of uranium exploration and extraction which was adopted by the Council on 6 March 1978 (1), and which ends on 31 December 1980.

In order to ensure the necessary continuity of the Community research effort in this field, a new four-year action is now proposed. It is planned, however, to group this action on 1 January 1982 with others into a comprehensive R & D programme in the sector of raw materials, subdivided into subprogrammes, of which the present proposal would be one. Such grouping is in line with the conclusions of the Research Council of 20 December 1979 which recommended to concentrate Community R & D programmes in sectors of priority interest (including energy, raw materials, environment, agriculture and certain industrial R & D sectors) and to rationalize the procedures for the preparation, adoption and implementation of these programmes. The proposed grouping is delayed by one year to make it coincide with the end of the current R & D programme on primary raw materials (2).

Community sponsorship of R & D in uranium exploration and extraction is one of the actions to ensure adequate and secure supplies of natural uranium for the Community, in which the Commission is at present engaged.

Inside the Community, the Commission is partially funding uranium exploration, under article 70 of the Euratom Treaty. Furthermore, the Commission is acting outside the Community to facilitate the supply of uranium to the Member States by improving the conditions for the Community's industry to operate abroad in uranium exploration and production.

The need to finance R & D should be seen in the light of the Community's expanding requirements for natural uranium. More advanced uranium exploration methods and uranium extraction and recovery technology must be developed to discover new deposits as well as to evaluate and exploit potential uranium resources.

1.1 Uranium needs

On 1 January 1979, the total electrical power plant capacity of the European Community was 303 GWe (gross), distributed as follows (3) :

	GWe (gross)
Conventional thermal plants	232.2
Hydroelectric power plants	45.3
Nuclear power plants	25.6
Total EC	303.1

(1) OJ L72 of 14 March 1978
(2) OJ L72 of 14 March 1978
(3) Investment projects in the electricity sector of the Community COM (79) 719 final

Out of the net electricity production in the Community in 1979 of some 1.18 million GWh, approximately 10.8% was produced from nuclear energy against 10.2% in 1978 (1). This represents a saving of the order of 28 million tonnes of oil equivalent. The general trend for electrical production in the European Community is towards the development of solid fuel and nuclear power stations and a gradual reduction of oil and gas fired power plants.

At its meeting of 13 February 1975 the Council advocated the development of economical and secure uranium resources within the Community and the examination of whether and how action should be taken in several fields including prospecting for minerals. In the Commission's paper concerned with energy objectives of the Community for 1990 and the convergence of policies for the Member States (2), it was stated that the Community's energy objectives should include:

- increasing use of solid fuels and nuclear energy for electrical production,
- development of domestic resources of conventional forms of energy and promotion of new energies,
- diversification of security of external supply,
- price policies aiming at covering the costs of supplying energy, ensuring the equilibrium of energy balance and encouraging energy saving.

In this paper the Commission also stated that actions were required to increase the use of solid fuels and nuclear energy which, together, should cover 70-75% at least of the production of electricity. In real terms this means that each Member State should contribute to the achievement of this overall percentage for the Community, in particular:

- creating a greater solid fuel burning capacity in power stations and certain industries,
- restoration of nuclear energy programmes as far as possible.

At present (1980) within the Community we have in the region of 31.6 GWe installed electrical capacity generated by nuclear energy. The present forecasts as indicated in table I could be, by the end of 1985, in the region of 75 GWe and by 1990 in the region of 130 GWe. In 1980, this represents a requirement of about 11,400 tonnes natural uranium but obviously this requirement will increase significantly.

(1) Eurostat provisional figures - Electrical energy 6.2.80

(2) COM(79)316

TABLE I

FORECASTS FOR NUCLEAR ELECTRICAL CAPACITY AND URANIUM NEEDS

(Period 1980 - 1990)

	1980	1985	1990
Installed nuclear electrical capacity (in GWe)	31.6	75	130
% of the total electrical capacity	12	26	35
Uranium needs (in 1000 tonnes)	11.4	16	24
Uranium demand cumulated from year 1980	11.4	90	200

The Member States import about 80% of their natural uranium requirements, the EC uranium production being in the region of 2.300 tonnes with France, by far the most important producer (see Table II). Not only is our dependence on imports in natural uranium likely to increase, but the actual amount of natural uranium required is also going to increase sharply until at least 1990 (see Table I). Our present reasonably assured uranium resources as shown in Table III can only cover a part of our needs and the additional uranium resources remain to be found, mainly with the development of new exploration techniques. The uranium potential of several member countries [for example Ireland, Denmark (Greenland)] needs to be further evaluated and may add some additional resources. These additional possible resources, together with R & D efforts in extraction (for example uranium from phosphate rocks) can decrease our dependence on foreign countries and improve the deficit of our balance of payments whilst providing new methods for the Community's industry applicable inside and outside the EC.

TABLE II

URANIUM PRODUCTION IN THE COMMUNITY (in tonnes)(1)

	pré 1977	1977	1978	1979 (planned)
FRANCE	23,133	2,097	2,183	2,180
FEDERAL REPUBLIC OF GERMANY	151.1	14.7	41.1	n.a.
TOTAL EC	23,284.1	2,111.7	2,224.1	
TOTAL W. WORLD	469,933	28,852	33,900	

(1) Source: Uranium - reserves, production and demand
NEA and AIEA - OECD report Dec. 1979

TABLE III

URANIUM RESERVES AND ADDITIONAL RESOURCES (1000 tonnes U)[1]

I. Reasonably assured resources

cost range	< $ 80/kg U	$ 80-130/kg U	Total at < $ 130/kg U
DENMARK (Greenland)	-	27	27
FRANCE	39.6	15.7	55.3
FEDERAL REPUBLIC OF GERMANY	4	0.5	4.5
ITALY	-	1.2	1.2
TOTAL EC	43.6	44.4	88.0
TOTAL WEST. WORLD	1,850	740	2,590

II. Estimated additional resources (1000 tonnes U)

cost range	< $ 80/kg U	$ 80-130/kg U	Total at < $ 130/kg U
DENMARK (Greenland)	-	16	16
FRANCE	26.2	20	46.2
FEDERAL REPUBLIC OF GERMANY	7.0	0.5	7.5
ITALY	-	2	2
TOTAL EC	33.2	38.5	71.7
TOTAL WEST. WORLD	1,480	970.0	2,450

(1) Source: Uranium - reserves, production and demand
NEA and AIEA - OECD report Dec. 1979

1.2 Uranium exploration in the Community

Uranium exploration is one of the fields where the Community has an effective integrated supply policy. Since 1976 under article 70 of the Euratom Treaty the Commission has been supporting uranium exploration programmes within the Member States. These programmes have already been successful in outlining significant new uranium resources in Greenland and Italy. In Germany and Ireland new uranium occurrences have been discovered. It is intended that these programmes together with the programmes not funded under article 70 will continue and expand so that a complete evaluation of the uranium potential of the Community can be achieved.

In this framework, it is vital that the R & D into uranium techniques be stimulated in providing new tools for the recognition of new uranium provinces and specific targets to the benefit of the whole Community. In the same way, R & D is essential for improvement in ore processing methods and recovery of uranium from low grade resources. Moreover, the results of the R & D programme could also find useful applications outside the Community. It should be noted that where R & D and exploration programmes have been successful, other mechanisms are available or are proposed at Community level to support uranium production (Euratom loans, facilities of the Euratom Supply Agency, etc.).

II. THE FIRST R & D URANIUM EXPLORATION AND EXTRACTION PROGRAMME :

OBJECTIVES AND EXPECTED RESULTS

On 6 March 1978, the Council adopted the first R & D programme on uranium exploration and extraction (1). The main objective was to increase the EC's uranium supply for expanded needs. This required R & D in the areas of exploration and extraction for the following reasons:

- rising costs of oil for which the EC is mainly dependent on foreign sources
- increasing world and EC demand for uranium for electricity production
- increasing uranium prices which allow the exploitation of lower grade uranium resources
- the necessity of developing new prospecting techniques owing to the difficulty of finding uranium deposits inside as well as outside the EC
- the necessity of developing less costly uranium extraction methods and new processes for the recovery of uranium from potential resources.

For uranium exploration, the R & D objectives were:

- to improve geological and interpretative skills in uranium exploration
- to improve prospecting techniques appropriate for different geological environments and conditions
- to develop methods of detection for buried mineralizations which cannot be found by classical methods of prospecting

For uranium extraction, the R & D objectives were:

- to improve extraction of uranium from low grade ore as well as other sources so far untapped (e.g. phosphates)
- to provide new advanced technology in extraction for the benefit of the whole Community
- to develop methods of uranium recovery which achieve a significant cost reduction

All of these R & D actions are of interest to the Member States and not only reinforce current national R & D efforts but also avoid

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(1) OJ L 72, 14 March 1978

useless duplication of effort.

The R & D projects funded under the first programme were selected by the Commission after taking the opinion of the Advisory Committee on Programme Management on the basis of the quality and originality of their scientific content and their practical interest for the EC. Since most of the contracts began during the year 1979 only preliminary results are available. However, a number of interesting developments are taking place that could be effectively applied to uranium exploration. Progress has also been made in uranium extraction. In addition, the meetings organized by the Commission between the different participant laboratories have brought a fruitful exchange of ideas and experience, a better coordination of R & D efforts and have sometimes led to a better orientation of the R & D programme.

In the area of uranium exploration, the main aim of geology and metallogeny research is to facilitate the distinction between fertile and sterile rocks and to improve our knowledge of the major controls of uranium transport and deposition.

Preliminary results confirm the worth of several projects mainly based on rock geochemistry in defining indicator elements for the discovery of new uranium provinces especially in the granitic areas of the EC and for the location of uranium mineralizations in a given uranium province. These projects may lead to a considerable reduction in exploration costs and also may provide new tools for uranium prospecting.

A comparative study of several mineralized and non-mineralized Permian basins in France appears to be valuable in defining criteria for uranium exploration. Such a study could be extended to other continental sedimentary formations in several Member States. These formations remain geologically little known but may contain important uranium resources.

The uranium potential of several alkaline rocks has to be evaluated and a geochemical method is being tested for identifying primary uranium mineralizations.

The on-going projects on radioactive disequilibrium between uranium and its daughter products may give useful information about migration and deposition of uranium.

Significant progress has also been achieved in improving hydrogeochemical prospecting under different climatic conditions for the location of uranium deposits in granitic areas.

Several projects are related to the development of prospecting methods which are tested in the field.

Experiments with lead isotope ratios for the location of buried uranium mineralizations are in progress and the analytical problems are being resolved.

A plasma mass spectrometer of high sensitivity and accuracy is being developed for rapid routine analysis in uranium exploration and its performance will be improved.

A new type of activated charcoal absorber of higher performance has been developed for the detection of radon emanations and is being tested in the field together with other techniques.

The use of thermoluminescence for the discovery of buried uranium mineralizations is being tested on several sites, the main problem being the interpretation of the results. This method will be compared with other techniques in the field (emanometry, activated charcoal absorbers, track etch).

A delayed neutron instrument has been developed and is being tested for the quantitative determination of uranium in bore holes. Such an instrument should facilitate the evaluation of uranium reserves.

The Risø National Laboratory (Denmark) has all the facilities for the calibration of field scintillometers and spectrometers (partly provided through the R & D programme) which will aid comparisons between surveys within the EC.

In the field of uranium extraction, it is, again, a little early to judge the results of the eight contracts awarded because of the late signing of the contracts. The extraction of uranium from phosphoric acid liquors is attracting considerable industrial attention and there are several on-going research contracts. A project on uranium recovery from wet process phosphoric acid by selecting sequestering groups for the separation of the uranium and then incorporating these groups into solid substrates appears to be making positive progress. In the same area two more projects are financed by the EC, one in Belgium and one in Holland.

In addition to the projects on phosphate rock, there is a project to examine the extraction of uranium from an important deposit of refractory ore in Greenland and another project has been financed in order to study acid leaching under pressure for recovery of uranium reject waste originated from refractory ores.

As far as in situ leaching is concerned a project is considering the implementation of a leaching system capable of extracting uranium from small or low grade uranium ores in granitic environment. This project has good potential, and if the results are encouraging, uranium could be extracted from many small deposits scattered in the EC territory.

III. SECOND PROGRAMME ON URANIUM EXPLORATION AND EXTRACTION

A. SCIENTIFIC AND TECHNICAL CONTENT

1. R & D ON URANIUM EXPLORATION

It is very important for the EC to develop and improve methods for the recognition of new uranium provinces and uranium deposits. This may contribute not only to an increase of our own uranium reserves but also may find useful application in countries outside the EC. Such a R & D programme is justified because classical radiometric methods only give indications of outcropping or near surface uranium mineralizations and uranium deposits are becoming more difficult to find. In many cases, no results can be obtained by these methods, especially in strongly weathered zones or in the case of deep seated uranium mineralizations, therefore, new methods and criteria must be developed for the delineation of new uranium provinces and for the discovery of specific uranium targets. Most of the topics discussed below under the heading "exploration techniques" are applicable both to the discovery of new uranium provinces and the prospecting for uranium orebodies within a known uranium province. Moreover a better knowledge of the behaviour of uranium and its decay products can also provide new tools for uranium exploration and improve the interpretation of prospecting results.

As a follow-up to the first programme, the aims of the R & D actions in uranium exploration are:

- to provide new techniques for exploration to the Community's industry inside and outside the EC
- to improve our basic knowledge and the interpretation of data in uranium prospecting
- to define the best methodology to be used with respect to the geological and climatic environment
- to obtain a better coordination of R & D efforts in uranium exploration
- to reduce prospecting costs

A close liaison in a practical way of the R & D exploration programme with national prospection programmes and with those supported under article 70 of the Euratom Treaty would be highly beneficial for the Community. The identification of research needs was also made taking into account the work done by the Nuclear Energy Agency (OECD) and the International Atomic Energy Agency (IAEA) Joint group of experts on R & D in uranium exploration techniques.

1.1 Discovery of uranium provinces - uranium geology and metallogeny

New uranium provinces could be found in the granitic and volcanic areas of the EC and in the adjacent sedimentary basins. In addition, a considerable uncertainty still exists on the U potential of alkaline rocks. In spite of fairly well known U mineralizations in the Hercynian belts inside the EC, a much better understanding of the U concen-

tration processes on a regional scale is necessary and the U potential of the Precambrian, Caledonian and Tertiary intrusives and extrusives should be evaluated (e.g. the Donegal granite).

Research initiated during the first programme must be extended and amplified for a better understanding of the major controls of uranium mineralizations and to improve basic data on uranium ore genesis in different geological environments (granitic, volcanic, alkaline and sedimentary rocks). The relationship of uranium mineralization to source rocks, tectonics and changes in rock geochemistry must be more carefully examined. Advances in this area are required to provide better basic information for uranium exploration planning by the Community's industry inside and outside the EC.
R & D is needed for the discovery of new uranium provinces in several geological environments:

a) granitic areas

Uranium mineralizations related to granitic intrusives are mainly due to postmagmatic processes or later remobilization of the U contained in accessory minerals. Progress could be made through:

- the application of improved mineralogical and geochemical criteria allowing a differentiation between fertile and sterile granites;
- improved understanding of remobilization and reconcentration processes and the structural controls leading to uranium mineralizations.

b) acid volcanics (e.g. Rheinland-Pfalz, Alps)

Acid volcanics and associated sediments constitute a possible target for uranium exploration. In this area research should:

- assess the uranium potential of acid extrusives in the EC and the possible structural controls of the mineralizations;
- increase our knowledge of the geochemistry and of processes which lead to U mineralizations.

c) alkaline rocks

Uranium mineralizations may occur in alkaline rocks including carbonatites (e,g. Greenland, Latium). Research will be aimed at a better understanding of

- the uranium concentration processes;
- the geochemistry of these rocks which may contain other valuable elements;
- the structural controls of the U mineralizations.

d) sedimentary basins

The uranium potential of many sedimentary basins in the EC is still little known but recent exploration (e.g. Aquitaine basin, France) has clearly shown their importance as a potential resource of uranium. One project in the first programme concerns the Permian basins and will be extended to the Tertiary basins. Several other sedimentary formations of various ages (Precambrian, Cambrian, Devonian, Mesozoic) also present a future interest for uranium.

Research will be directed at:

- better knowledge and comparison of the paleogeographical setting, stratigraphy, tectonics, geochemistry and structural features of the different basins;
- the determination of key horizons (for example organic-rich sediments) and structural controls (for example paleochannels) for possible uranium mineralizations;
- an assessment of the uranium source rocks and the possible remobilization of uranium (for example by tectonic features).

From these basic data, it will be possible to define much better guidelines applicable to the discovery of new uranium provinces inside and outside of the EC. Moreover, this would facilitate an inventory of the uranium resources of the EC and could outline some new favourable geological formations.

A determination of the average content of radioactive elements on fresh material for all types of rocks would also be useful. It is doubtful whether Clarke values have been accurately determined on many rocks in the past.

1.2 Exploration techniques

Exploration techniques should be improved not only through advances in the tools used but also through a better interpretation of the data both for the discovery of new uranium provinces and for specific targets within a known uranium province. Such progress will be highly beneficial for exploration by the Community's industry inside and outside the EC. One of the major problems is the development of better prospection methods for the discovery of buried mineralizations in different geological environments (granitic, sedimentary, volcanic) and climatic conditions. There is also a need to compare the efficiency of the various prospecting methods on different test sites for both near surface and concealed deposits in order to define the best methods to be used according to the environment.

1.2.1 Gamma spectrometry

This method is widely used in reconnaissance surveying both for new uranium provinces and specific targets. More work should be done

- to improve the interpretation of airborne measurements by computer modelling and to provide an atlas of responses which could be used as an aid in airborne gamma prospecting for the discovery of uranium mineralizations;

- to improve the interpretation of car-borne measurements;

- to arrive at a more quantitative analysis of radiometric results, especially in ground measurements;

- to calibrate instruments.

1.2.2 Remote sensing

The use of remote sensing techniques as an aid in defining uranium provinces and mineralized zones should be further examined. Some interesting results have already been obtained using Landsat imagery in the framework of the Article 70 uranium exploration programme. Various remote sensing techniques and image enhancement methods can help to identify lineaments, fractures, structures or rock alteration that may be associated with uranium mineralizations. They could probably also give information on the structure and tectonics of favourable sedimentary basins. On a regional or local scale airborne imagery is generally the most useful method (higher resolution). Integration of remote sensing data in uranium exploration may considerably facilitate the discovery of uranium mineralizations (for example vein mineralizations) and could reduce exploration costs. R & D in this field is important for

- the assessment of remote sensing data (multispectral-thermal infrared - side looking radar) for the location of favourable structures related to uranium mineralizations;

- the detection of rock alteration related to uranium mineralizations by remote sensing techniques including vegetation patterns;

- the evaluation of the application of side looking radar and other techniques on specific test sites in sedimentary units;

- the improvement of data processing (spectral signature) and of the interpretation of remote sensing data.

It also appears important to apply remote sensing techniques as a new tool in areas where traditional methods have been successfully applied. In this way it will be possible to assess the impact remote sensing might have made if used earlier in exploration history.

1.2.3 Geochemical prospecting techniques

Stream sediment investigations and hydrogeochemical prospecting methods are widely used for the discovery of uranium provinces and uranium mineralizations. Some research is needed to improve analytical methods and the interpretation of results.
Further development for rapid multielement analysis is necessary

because in several cases pathfinder elements may give better results than uranium.

The potential use of radium for finding uranium mineralizations should be also tested. A comparison of the efficiency of radium and uranium analyses for the detection of uranium mineralizations in different environments would also be worthwhile.

1.2.4 Rock geochemistry

Uranium mineralized zones are characterized by chemical changes of the country rock composition often forming an alteration halo of variable extension. These changes in rock geochemistry and their spatial extension should be more carefully investigated with a view to applications in the search for buried uranium mineralizations.

R & D is necessary:

- to study the correlation between uranium and other elements in mineralized and unmineralized zones;
- to determine pathfinder elements applicable in a given geological environment;
- to improve the quantitative interpretation of geochemical data;
- to develop laboratory and field instruments for rapid multi-element analysis.

1.2.5 Biogeochemistry

Biogeochemical prospecting based on the analysis of decaying organic material has been successfully applied in peat-bog areas both in reconnaissance surveying and for the localisation of deposits of uranium and other metals. This method could find applications in similar environments in the EC.

Biogeochemical prospecting using living plant materials could also be applied in the EC and abroad especially for the discovery of buried mineralizations in favourable areas.

Further research is needed to evaluate the potential use of biogeochemical methods in uranium exploration.

1.2.6 Gas geochemistry

The use of gases in uranium prospecting (mainly Rn and He) for the detection of concealed mineralizations has so far been successful in only a limited number of cases. Items to be investigated are :

- the behaviour of Rn, He and other gases on test sites in different geological environments

- comparison of the efficiency of different techniques for the measurement of He and Rn (emanometry, track etch, charcoal detectors) at the surface and in groundwater with an assessment of these techniques in different geological environments for the detection of buried U mineralizations

- integration and assessment of the usefulness of other techniques such as thermoluminescence, the He/Ar ratio and other parameters (U, Ra in groundwater for example)

- assessment of radioactive aerosols in U exploration

- improvements on the interpretation of results taking into account geology, fracture pattern, hydrogeology

- development of field instruments for surface and bore-hole gas measurements

- improvement of sampling techniques and measurements

- establishment of a methodology for the detection of buried orebodies in different geological environments and climatic conditions

1.2.7 Lead isotope ratios

The measurement of lead isotope ratios may provide valuable information for the discovery of new uranium provinces and specific targets. There is a need:

- to assess the use of lead isotope ratios in groundwater for uranium exploration;

- to improve the interpretation of data and compare the results with other methods;

- to assess the possibility of application of this method to surface water in relatively unpolluted areas and to common lead minerals.

1.2.8 Indirect geophysical methods

Magnetic and electromagnetic aerial surveys facilitate the mapping of geological formations which is an essential background for uranium exploration.

Detailed gravity, magnetic, resistivity, polarization and seismic measurements can provide information on favourable

structures for uranium deposition. Research in this field is necessary to improve the techniques and the interpretation of results as well as to develop instruments.

1.2.9 Microtectonics

Fracture analysis in mineralized zones has been quite successfully applied to granitic formations. It yields useful information on the location of uranium mineralizations and, in addition, allows drilling costs to be reduced. Research is needed to:

- improve the interpretation of results;
- assess the method in other geological environments.

1.3 Transportation and deposition of uranium

A much better knowledge of the transportation and deposition of uranium in the magmatic cycle and during weathering is important for the development of new prospecting methods in uranium exploration. Fluid inclusions provide basic information about the genesis of uranium deposits and may possibly be used as a new tool for discovering uranium mineralizations. The differences in behaviour between uranium, thorium and their decay products during weathering processes may give useful information for uranium exploration. A better understanding of the data is important for the development of new methodologies for the discovery of specific uranium targets and the recognition of new uranium provinces. R & D in this area is highly necessary.

1.3.1 Fluid inclusions

Studies on fluid inclusions are important for a better understanding of the processes and conditions leading to the formation of uranium deposits. Research must be done:

- to improve our knowledge on the composition of fluid inclusions in different geological environments and on the physico-chemical conditions of uranium deposition;
- to assess the role of hydrocarbon compounds in uranium deposition;
- to examine the potential use of fluid inclusions as a possible new prospecting tool.

1.3.2 Transportation and deposition of uranium in the hydrogeochemical environment

Uranium is usually mobile in the hydrogeochemical environment, however, it is still difficult to interpret anomalous uranium

values as the controls acting in this environment are not fully understood. Additional work on the transportation of uranium and other accompanying elements in water, their transfer to soil, lake sediments and vegetation in known uranium districts is required, to improve knowledge of physico-chemical controls.

1.3.3 Radioactive disequilibrium

The variation in the abundance of daughter products from U_{238}, U_{235} and Th_{232} is one of the most useful tools for studying geochemical processes involved in the migration of uranium (e.g. the Rosholt method). Interpretation of radioactive disequilibrium data could be very helpful in uranium exploration for the location of uranium deposits especially in sedimentary environments as well as for defining new uranium provinces. Research in this area is important for the development of new methods for uranium prospecting:

- Identification of uranium solution pathways through decay products;
- Development of a methodology for the measurement and interpretation of results;
- Assessment of the applications of radioactive disequilibrium data in uranium exploration on a regional scale;
- Applications of radio-isotope data to the discovery of new uranium provinces.

1.4 Bore-hole logging

There is a need to develop new instruments for measurements in bore holes and also to improve the interpretation of results. Special emphasis must be given here to direct measurement of uranium in situ as gamma spectrometry logging is not accurate enough owing to the frequent radioactive disequilibrium between uranium and its decay products.

1.4.1 Direct measurement of uranium in situ

The direct measurement of uranium in situ is especially valuable in assessing reserves, the most important step before the development of any mine. The techniques available at present (X-ray fluorescence, neutron activation) have yet to be fully developed. Assessment of these techniques and development of improved instruments is required.

Data processing and interpretation of bore-hole logging also present difficult problems. Refinement of these is necessary.

1.4.2 Other instruments for in situ measurements

Besides uranium, measurements of other physico-chemical parameters (such as resistivity, conductivity, pH etc.) in bore holes are necessary. There is in this field a need for development of instrumentation and an improvement in data processing and interpretation.

2. RESEARCH AND DEVELOPMENT IN URANIUM EXTRACTION AND RECOVERY

The Commission, with the help of the members of the ACPM and of contractors has analysed the state of R & D activities on uranium processing and recovery in the various Member States.

It appears that there is still considerable interest in this field because world demand in uranium is still important, the degree of dependency on outside sources is very high and there is a need to support EC industry in order to develop advanced technologies.

Knowing that uranium resources within the Community are limited, R & D efforts (and, in some cases, demonstration projects) are needed at Community level to stimulate interest in the winning of uranium from various resources, including low grade ores.

The research topics selected would bring, in the medium and long term, a significant reduction in processing costs or lead to uranium being obtained from domestic sources which have not so far been widely exploited.

In addition, R & D activities should be implemented at EC level in order to help European industry develop advanced technologies that could represent an important benefit for the EC members. Exporting advanced processes of uranium extraction from uranium-bearing materials may have an impact on the balance of payments of the Member States.

These research efforts would:

- be of direct or indirect interest to all Member States
- complement or reinforce current national R & D efforts
- avoid useless duplication of national R & D efforts.

As a follow-up to the first programme, R & D activity in uranium extraction and recovery will cover the topics of:

- recovery of uranium from phosphoric acid liquors, from phosphatic rocks and from wastes produced during phosphate rock treatment
- in-situ leaching (chemical and/or bacterial)
- leaching applied to dumps and heaps
- bacterial leaching
- high temperature, high pressure leaching. In particular, application to ores that are difficult to treat conventionally
- extraction of uranium and other values from calcines and low grade ores
- other technical aspects related to the uranium mining industry.

2.1 Recovery of uranium from phosphoric acid liquors

Phosphate rock containing 50 to 200 ppm of U is imported into EC countries for the production of approximately 4 Mtpa P_2O_5. A large part of the uranium is present in phosphoric acid process liquors and there is the potential for recovering up to 1500 tpa of U_3O_8.

Uranium prices offer the phosphate industry an attractive reason for recovering uranium as a by-product of fertilizer manufacture. Recovery from phosphoric acid liquors would mean keeping an important resource to augment the EC's uranium supply while at the same time removing a radioactive contaminant from process residues and fertilizers.

Various uranium recovery processes based on precipitation, solvent extraction and ion exchange have been developed but, whilst some of these processes have been utilized at full plant scale, the existing processes are not yet universally applicable because they are only economically viable at throughputs which are appreciably higher than the throughputs in many phosphoric acid plants, particularly in Europe. Also there are difficulties in applying these processes to recover uranium from highly concentrated phosphoric acid liquors.

It is proposed that alternative processes be examined involving the use of solvent extraction and ion exchange techniques but with novel reagents leading to economic recovery of uranium from highly concentrated acid liquors. Particular consideration will be given to proposals on the development of "second generation" plants and extractants and to proposals for processes dealing directly with impure "black" phosphoric acid liquors. Cheap processes and technologies capable of being operated at small to medium sized phosphoric acid plants is an area where work is particularly needed. Depending on the results of the work already supported by the Commission on this topic in the first R & D programme, proposals for demonstration projects (pilot plants) could be supported.

2.2 Recovery of uranium from phosphatic rocks

The potential of phosphatic rocks located in EC countries as hosts for uranium deposits is interesting and some occurrences have already been identified. Mineralogical studies and laboratory tests have been initiated to identify the technological solutions to recover uranium. As a second stage of development pilot scale work could follow the successful completion of laboratory work.

2.3 Extraction of uranium from the wastes of phosphate rock treatment

It is well known that in phosphoric acid and fertilizers production, some of the uranium remains in certain wastes such as leach residues and phosphogypsum. These wastes present disposal problems. If the results of the initial activity so far supported are encouraging it is proposed to support studies at pilot scale.

2.4 Recovery of uranium by dump, heap, bacterial or in-situ leaching

Dump, heap, bacterial and in-situ leaching techniques have many features in common, although they are applicable to different types of ore bodies.

The percolation leaching of dumps or heaps is an operation with low capital and running costs and is thus applicable to low grade ores (particularly small deposits) or residues whose treatment by more conventional energy-intensive routes would be uneconomic. Although the technique is easily applied, the mechanism of dissolution of the uranium in a dump or heap is often complex, being related to many factors including the mechanism of acid attack and the production of bacteria within the ore pile, and the achievement of satisfactory results is not always very certain.

Whilst being a fundamental part of many heap, dump and in-situ leaching operations, bacterial leaching can also be used as an alternative technique for the treatment of small, high grade deposits.

Bacterial leaching processes in their various forms (vat leaching, stope leaching, bacterial regeneration of lixiviants) may have several advantages over chemical attack such as savings in chemicals reduced capital-cost and lowering of cut-off grade of ores. So far, the technique of bacterial leaching has only been applied to sulphide ores, but if technically possible, it would be particularly advantageous if it could be applied to ores which require a high energy input for treatment. It is possible that bacterial leaching could be applied to other types of ores (e.g. in sandstones). Support will be given for work on all aspects of this topic including the gathering of engineering design parameters.

For large deposits, in situ-leaching can offer a means of economical exploitation where the investment in capital required for treating such deposits by conventional means is high enough to preclude working.

The problems encountered in dump and heap leaching, e.g. difficulty in predicting flow patterns and hence overall recoveries, are even more difficult to solve when leaching in-situ due to, amongst other things, problems in controlling rock fracture patterns and reagent flow.

With the above points in mind, and having regard to the results from the activity initiated in the first programme, there is a need to continue this action. Tests will be carried out using in-situ leaching techniques with acid or alkaline solutions. Special care will be placed on the preparation of the ore deposits :

- to prevent environmental pollution, particularly of groundwater
- to improve contact between ores and reagent.

This recovery technique will be tested on other suitable sites in order to assess its merits.

2.5 High temperature, high pressure leaching

The use of high temperatures and pressures for leaching can be an effective means of treatment for several different types of ore. Refractory and/or low grade ores and wastes can be treated in this way as can other ores which are difficult to treat conventionally e.g. basic rocks. The reasons for this are several. The lixiviant is rendered more aggressive, reaction kinetics are improved, and, in addition, the use of conventional oxidants can often be avoided due to the increased activity of oxygen or air. It has also been claimed that leaching of this kind can be useful where solid/liquid separation is a problem, particularly for clay materials.

Laboratory and pilot trials of this technique will be supported. Due to the high energy input necessary for this leaching method, support will also be given to studies of economic feasibility, particularly on low grade ores or wastes before passing to the pilot plant scale.

2.6 Extraction of uranium and other values from calcines and low grade sources

The EC has large reserves of materials which, when calcined, could provide useful sources of uranium and other values e.g. aluminium, vanadium etc. Materials falling into this category include oil and coal shales, lignites, peat, coal etc. Most of these materials have intrinsic value as sources of energy, but after use it is found that the uranium is concentrated in the ash and the fly-ash. Projects to recover uranium and other values from these materials which often present a disposal problem, will be supported.

2.7 Other technical aspects related to the uranium mining industry

The development of the uranium mining industry requires R & D for improving techniques related in particular to the treatment of effluents, the storage of mining wastes, the stabilization of tailings ponds and reclamation after exploitation. Mining and processing of low grade ores as well as the use of leaching processes present special problems in this respect.

R & D will be promoted in the areas of

- improvement in the processing of effluents
- storage of mining wastes and reclamation of mining sites
- long-term stability of tailings ponds.

B. FINANCING AND MANAGEMENT OF THE R & D PROGRAMME

1. The programme will be executed as a Community indirect action programme. The contribution of the Community to the funding of this indirect action is estimated at 8 MEUA for the period of four years (1981-1984). This amount is deemed necessary to allow for the application of the results from the first programme in field work (exploration R & D) and in industrial pilot plants (extraction R & D) as well as to initiate new projects.

   The indicative distribution of funds between research areas will be as follows:

   exploration : 45 - 55%;

   extraction : 45 - 55%.

   The definite allocation, of course, will be made after examination of the proposals received following a call for tenders.

2. The Commission will execute the programme in close collaboration with the Advisory Committee on Programme Management already established by the Council of Ministers for the first programme.

   The Committee will examine all R & D proposals submitted and advise the Commission on their relative merits. It will follow up the projects during their execution and evaluate them upon completion. It will also make recommendations on new research needs and priorities for the continuation of the programme.

3. As indicated in the introduction (page 3) as of 1 January 1982 the programme will become a subprogramme of the new sectorial R & D programme in the field of raw materials, to be submitted to the Council in 1981. This should allow for greater flexibility in research management, i.e. in view of the fact that another subprogramme (on primary raw materials) will include several related topics which could be coordinated as much as practicable with the actions undertaken under the uranium subprogramme.

PROPOSAL FOR A COUNCIL DECISION ADOPTING A SECOND PROGRAMME OF RESEARCH AND DEVELOPMENT FOR THE EUROPEAN ATOMIC ENERGY COMMUNITY IN THE FIELD OF URANIUM EXPLORATION AND EXTRACTION

(INDIRECT ACTION 1981-1984)

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 of the Commission submitted after consultation with the Scientific and Technical Committee;

Having regard to the opinion of the European Parliament;

Whereas, under the common scientific and technological policy, the multi-annual programme of research and development is one of the Community's essential ways of contributing to the development of nuclear industries and to the acquisition and dissemination of knowledge in the nuclear sector;

Whereas the Community depends to a great extent on non-member countries for its natural uranium supply, and whereas therefore the Community's interest is to develop the existing resources on its territory;

Whereas an extension and development of the Community research action in the field of uranium exploration and extraction would contribute to the realization of the above-mentioned objectives;

Whereas in its deliberations of 20 December 1979 the Council invited the Commission to concentrate Community research programmes in sectors of priority interest, including energy and raw materials, and to rationalize the structures for the preparation, adoption and implementation of these programmes;

Whereas the Council takes note of the intention of the Commission to submit in 1981 a proposal for a research programme in the sector of raw materials in which the present programme will be included;

Whereas a review of the above-mentioned research programme in the sector of raw materials, including the present programme as a subprogramme, will be carried out during its execution,

HAS DECIDED AS FOLLOWS :

Article 1

A programme of research and development on uranium exploration and uranium extraction as set out in the Annex shall be adopted for a period of four years starting on 1 January 1981.

Article 2

For the implementation of this programme, the maximum amount of the expenditure commitments is estimated at 8 million European units of account and the maximum staff required is estimated to be three persons. The unit of account is defined according to the financial regulations in force.

Done at Brussels

For the Council

The President

ANNEX

PROGRAMME CONTENT

1. Research and development on uranium exploration

1.1 Discovery of uranium provinces - uranium geology and metallogeny

- Granitic areas
- Acid volcanics
- Alkaline rocks
- Sedimentary basins

1.2 Exploration techniques

- Gamma spectrometry
- Remote sensing
- Geochemical prospecting techniques
- Rock geochemistry
- Biogeochemistry
- Gas geochemistry
- Lead isotope ratios
- Indirect geophysical methods
- Microtectonics

1.3 Transportation and deposition of uranium

- Fluid inclusions
- Transportation and deposition of uranium in the hydrogeochemical environment
- Radioactive disequilibrium

1.4 Bore-hole logging

- Direct measurement of uranium in situ
- Other instruments for in situ measurements

2. Research and development in uranium extraction and recovery

2.1 Recovery of uranium from phosphoric acid liquors

2.2 Recovery of uranium from phosphatic rocks

2.3 Extraction of uranium from the waste of phosphate rock treatment

2.4 Recovery of uranium by dump, heap, bacterial or in situ leaching

2.5 High temperature, high pressure leaching

2.6 Extraction of uranium and other values from calcines and low grade sources

2.7 Other technical aspects related to the uranium mining industry

FINANCIAL DATA

1. BUDGET CHAPTER : 3350-3

2. HEADING OF THE BUDGET TITLE :

Primary and secondary raw materials - Uranium exploration and extraction (indirect action 1981-1984)

3. JURIDICAL BASIS : Article 7 of EAEC Treaty

4. DESCRIPTION, OBJECTIVES AND JUSTIFICATION OF ACTION

4.1 Description

2nd programme on uranium exploration and extraction.

Research programme carried out by means of cost-sharing contracts (indirect action) with research organizations in the Member States, in the following areas :

a) research and development in uranium exploration

b) research and development in uranium extraction and recovery.

4.2 Objectives

R & D aimed at :

a) increasing the self-supply potential of the EC in uranium

b) developing new techniques for exploration and exploitation of uranium deposits

c) developing advanced extraction technology and reducing ore processing costs.

4.3 Justification

Preliminary results obtained from research realized under the first programme proved the usefulness and necessity of a second programme. Actions carried out at Community level optimize the productivity of research undertaken in the Member States, by avoiding useless duplication and filling gaps. They also make it possible to concentrate the potential of research organizations in the Member States on problems of common interest and facilitate the development of advanced technologies.

5. FINANCIAL IMPLICATIONS IN RESPECT OF INTERVENTIONS APPROPRIATIONS

(including expenditure on staff and administrative and technical expenditure)

5.1 Total cost for the expected duration 8,000,000 EUA

5.2 Proportion financed from:

- the Community budget 8,000,000 EUA
- national budgets EUA
- other sectors at national level EUA

5.3 Multi-annual timetable

5.3.1.1 Appropriations for commitment in EUA

Type of expenditure	1981	1982	1983	1984	TOTAL
Staff	158,400	171,200	185,100	200,100	714,800
Administration	50,000	54,000	58,400	59,900	222,300
Contracts	3,502,600	500,800	3,059,500	-	7,062,900
Total	3,711,000	726,000	3,303,000	260,000	8,000,000

5.3.1.2 Appropriations for payment in EUA

Type of expenditure	1981	1982	1983	1984	1985	TOTAL
Staff	158,400	171,200	185,100	200,100		714,800
Administration	50,000	54,000	58,400	59,900		222,300
Contracts	1,752,600	2,000,800	2,078,500	1,099,000	132,000	7,062,900
Total	1,961,000	2,226,000	2,322,000	1,359,000	132,000	8,000,000

5.3.2 Evaluation method

(included multiannual previsions)

a) Staff expenditure

The needs are estimated to be 3 staff for this programme.

1981-1984 (4 years)

2 category A staff
1 category C staff

In addition to staff number estimates, the calculations also take account of the rates of salary increases of Commission staff used to estimate the appropriations entered in the 1981 budget; the estimated overall increases in the general Community price index used in drawing up the triennial estimates, i.e. 8.1% per annum.

b) Administrative and/or technical expenditure

This expenditure specifically covers the cost of missions and the organization of meetings. It has been estimated on the basis of average requirements.

c) Expenditure on contracts

This expenditure covers the financial participation of the Community in research carried out under cost-shared contracts (studies, research etc) to be concluded with research institutions in the Member States specialized in the field. Since the specific nature of the various topics and the qualifications of the contracting parties are likely to vary, it has not been possible to devise a uniform method of calculation. Consequently, the estimate of requirements is a hypothetical one based on the number of contracts to be negotiated and on average financial participation by the Community approximating to 50% of total costs. At all events, the Advisory Committee on Programme Management will be consulted over the allocation of the appropriations.

6. FINANCIAL IMPLICATION IN RESPECT OF APPROPRIATIONS FOR STAFF AND CURRENT ADMINISTRATIVE EXPENDITURE :

(see point 5 above)

7. FINANCING OF EXPENDITURE :

7.4 The requisite appropriations to cover the Community's participation in this project are to be entered under future budgets.

8. IMPLICATIONS IN RESPECT OF REVENUE :

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

9. TYPE OF MONITORING TO BE APPLIED

- Administrative checks by the DG for Financial Control with regard to the implementation of the budget and to ensure that the expenditure has been incurred in a regular and proper manner plus checks carried out by the Contracts Service of DG XII.
- Scientific checks : ACPM;
  Competent officials from DG XII.

OPINION OF THE SCIENTIFIC AND TECHNICAL COMMITTEE ON THE PROPOSAL FOR A 1981-1984 PROGRAMME ON URANIUM EXPLORATION AND EXTRACTION

At its meeting of 29 April 1980 the Scientific and Technical Committee examined and discussed the "Proposal for a Council Decision adopting a second programme of research and development for the European Atomic Energy Community on Uranium exploration and Uranium extraction" (Doc. XII/364/80-EN).

This proposal is concerned with a four-year (1981-1984) programme as a follow-up of the current R & D programme 1978-1980 in the field of uranium exploration and extraction. It would be carried out by means of cost-sharing contracts (indirect action) with research organizations and industry from the Member States.

Funding for this indirect action by the Community is estimated at a maximum of 10 MEUA for 4 years to cover about half of the total cost of the research and development actions to be carried out. Of this amount about 50 per cent should go to research in uranium exploration and the other 50 per cent for R & D actions in uranium extraction as defined in the proposal (Doc. XII/364/80-EN).

The Committee considers that the Commission's proposal is well justified as it would provide for the extension, development and application of research initiated under the first programme.

The Committee notes the relatively large increase of funding requested, but in view of the strategic importance of the subject, the Committee considers this increase to be justified. However while implementing the programme, the Commission should devote special care in the selection of the research proposals which are to be supported.

In view of the foreseeable needs of the Community in natural uranium for electricity generation, the large degree of dependence on outside sources of supply, the increasing difficulties to find new deposits and the long lead time necessary to bring into production a newly detected deposit or a new extraction technology, it is clearly in the interest of the Community to increase every possibility of self supply, whether from small high-grade

deposits, or large low-grade deposits, residues and other resources, and to develop know-how to be used by Community industry in its world-wide operations. The R & D programme proposed would complement usefully the Community efforts to promote uranium prospection on its territory (Article 70 activities) or outside as well as other actions aimed at ensuring sufficient and secure supplies of natural uranium.

The Committee notes that the health und environmental aspects of uranium extraction are being pursued in the frame of the "Biology-Health Protection" programme.

The Scientific and Technical Committee is of the opinion that the proposed R & D programme on uranium exploration and uranium extraction is adequate as to content, financial volume, and duration, and recommends its adoption by Council.