ECSC – EEC – EAEC

EURATOM'S FUTURE ACTIVITIES

Supplement to Bulletin No. 6 – 1969
of the European Communities

SECRETARIAT GENERAL OF THE COMMISSION

PRICE PER ISSUE

£0.2.6	$0.30	FB 15.–	FF 1.50	DM 1.20	Lit. 180	Fl. 1.10

The supplement is supplied free of charge to subscribers and purchasers of the Bulletin.

ECSC — EEC — EAEC

Euratom's Future Activities

SECRETARIAT GENERAL OF THE COMMISSION

Commission
of the
European Communities

The President

Brussels, 25 April 1969

Mr. President,

The Commission has drawn up a document concerning the future activities of Euratom, which, in keeping with the Council's Resolution of 20 December 1968, comprises:

— a proposal for a multiannual research and training programme, submitted to the Council in accordance with the terms of Article 7 of the Euratom Treaty;

— principles and criteria underlying a nuclear industrial policy;

— proposals for new non-nuclear projects that could be carried out at the Joint Research Centre.

I have the honour to forward the document in question to you. The proposed programme is accompanied by a number of technical annexes which will be sent to the Council in the next few days.

I would draw your attention to the fact that the proposed programme is still of a provisional nature, owing to the fact that the Scientific and Technical Committee will not be in a position to issue the opinion called for by Article 7 of the Treaty until 20 May 1969.

The Commission worked in conjunction with the Scientific and Technical Committee to prepare the programme and was assisted by Working Groups set up by the Committee. At the same time it maintained extensive contacts with the member countries' experts and with representatives of the industries.

The Commission has been at pains to propose to the Council a programme entailing a limited reduction in staff, owing to the positions adopted in the Council. It goes without saying that such a reduction is only conceivable in the context of the adoption of a multiannual programme; it must go hand in hand with provisions giving officials and employees who are liable to be the subject of this measure similar advantages to those prescribed at the time of the amalgamation of the Institutions.

The Commission proposes that, by reason of their nature, certain activities be transferred from the research budget to the operating budget.

The forming of consultative programme committees is already the subject of joint work by the Council and the Commission. At the same time the Commission is preparing measures designed to:

— increase the mobility and improve the management of staff;

— perfect the supervision of the activities developed and of their financial management;

— define the criteria for pricing work carried out under contract;

— modify certain aspects of the organization of the Joint Research Centre.

Please accept, Mr. President, the expression of my highest esteem.

Jean REY.

H.E.
M. Gaston Thorn
President of the Council
of the European Communities
2, rue Ravenstein
BRUSSELS

Table of contents

The technical annexes accompanying the proposed programmes, referred to in the above letter by the President of the Commission of the European Communities, can be obtained on request from the Department for Information and Dissemination of Documents of the Commission, 1, avenue de Cortenberg, Brussels 4.

CHAPTER 1

Introduction

I. THE PRESENT SITUATION

1. In the "Survey of the Nuclear Policy of the European Communities" the Commission observed that, ten years after the establishment of Euratom, the Community has only very partially approached the objective, set out in the Treaty, of creating favourable conditions for the growth of a powerful nuclear industry.

The Commission, seeking the reasons for this situation, successively analysed the energy aspects, the industrial and technological aspects and the research aspects; the cause lies neither in insufficient financing nor in any inferior ability of European scientists, but essentially in the piecemeal nature of the relevant efforts, pursued in a national context and with national objectives in view.

2. Although this Survey was favourably received in various political and industria; circles, the situation, generally speaking, has worsened since it was publishedl whilst a certain trend towards concentration has emerged as regards the choice of heavy water and fast reactor variants, firms in the nuclear and electrical engineering sectors are mainly tending to combine within national frontiers.

As to the supply policy, certain member countries have formed separate links with a non-member country for the purpose of designing and building enrichment plants using a different technical process from the one already developed in another Member State, and, moreover, without any co-ordination or exchange of scientific and technical information.

A Community research and training programme of one year's duration has been decided on (with funds for the second half-year frozen), and only half this programme is to be paid for by the Community as a whole, the remainder being financed in part by four and in part by five Member States.

3. The Commission considers it absolutely imperative to correct this situation; but unless the Member States display a firm political resolve to do their bit, the chance of establishing a genuine nuclear common market will be irrevocably gone and the national markets will fence themselves off more closely, with the probable result that foreign techniques will gain an ever-increasing preponderance in the Community.

The situation can only be remedied if the governments undertake to embark resolutely on a general discussion of their national policies, from the standpoint both of energy and industry and of research, instead of merely making decisions on the purely Community activities.

4. It is in this light that the Commission submits to the Council the present paper on "Euratom's Future Activities". It deals with the set of problems referred to

by the Council in its Resolution of 20 December 1968 and comprises two main parts:

1) the principles and criteria for achieving an industrial policy in the nuclear field (Chapter 2);

2) the suggested research and training programme, which includes diversion of part of the Joint Research Centre's potential to non-nuclear research work (Chapter 3). This proposal is supported by a number of detailed technical annexes.

In addition, various matters that might be the subject of subsequent Community research proposals are mentioned for guidance purposes (Chapter 4).

II. GUIDELINES FOR THE PROPOSED COURSES OF ACTION

5. The Commission has already pointed out, in its White Paper, the measures it considers likely to lower the obstacles in the way of the development of nuclear energy, and more specifically the need to:

(i) improve the nuclear industry structures by encouraging trans-frontier combinations, which alone can ensure the creation of a true nuclear common market;

(ii) reach early agreement on a common policy concerning the choice of reactor types;

(iii) adopt a common supply policy, particularly as regards enriched uranium;

(iv) co-ordinate the research programmes of the six Member States more efficiently than in the past, and see to it that the results are effectively handed on to industry;

(v) make smooth preparations for switching part of the research potential over to non-nuclear objectives.

The proposals advanced in this paper offer answers to these five points.

Improvement of industrial structures

6. The prospects facing the Community's nuclear industry over the coming years do not look very promising. Electricity producers have been unfavourably impressed by the frequency and duration of nuclear plant failures, with the exceptionally high costs which they entail. The only signs of optimism are in Germany, on account of the power of the nuclear firms, the satisfactory results achieved in the country's progressive acquisition of foreign techniques, and the relatively large size of the national market. Even so, in Germany as in the other Member States, development of the advanced reactor types calls for massive financial aid from the government, which would produce more efficacious results if duplication of work could be eliminated and if healthy competition could be gradually established on a Community-wide scale.

So far, however, the nuclear industry, like most of the advanced technology industries, has in fact reaped practically no benefits from the Common Market. Although a large market is essential in these sectors, even more than in the traditional ones, in order to permit concentration and specialization, the removal of customs duties has not had the effect of throwing open the national frontiers, the

growth of these industries still depending far more on government action than on market forces. During the talks that preceded the drafting of this document, the government experts themselves admitted that in this field it was easier to export to non-member countries than to sell to electricity producers in the other Member States.

However much the organization of research efforts may be improved, it is useless to look for satisfactory industrial results for the Community as a whole unless this partitioning of the market is brought to an end.

In such a field, however, where the governments have committed and are still committing themselves to substantial expenditure, and which is particularly sensitive from the standpoint of policy, it is desirable and sensible to envisage a harmonious development of the whole electrical engineering, and more especially nuclear, industry in the Community.

Simply throwing the market open and inviting competition without any consideration of nationality would unquestionably lead to disruptions that must be avoided.

That is why the only way to reconcile the dismantlement of market barriers with harmonious development of the Member States' industries is by forming transfrontier combinations of firms. Reorganization on a multinational basis is the essential condition for both the practical realization of the common market and the development of healthy competition.

These aims can only be achieved if all the governments are resolved to pursue them and to utilize for that purpose all the means available to them, at both national and Community level. The Commission earnestly hopes that they will summon up that political resolution. It is in the interest of all the Member States to embark on this course, as otherwise the ones with the most powerful and competitive industries cannot hope to overcome the very real obstacles that today usually bar the way to market outlets in the other, less favoured, Member States. For the latter, meanwhile, the prospects of building up a competitive industry unhampered by heavy external obligations will dwindle even further.

In response to the Council's request concerning the formulation of principles and criteria on which a policy for the nuclear industry could be based, the Commission has prepared various suggestions which it feels are likely to help in achieving the aims defined above, namely:

— annual meetings of electricity producers to provide fuller knowledge of the investment programmes and, where appropriate, to dovetail plans for orders so as to encourage reorganization of the industry;

— the granting of guarantees against the exceptional risks entailed by the use of nuclear energy, subject to the issuing of calls for bids and to the grouping of suppliers in multinational consortia;

— utilization of Community or national aid to develop the advanced reactor types, with a view to promoting in each major sector either a complete merger of efforts in fields where it is clearly irrational to pursue several competing projects, or several groupings so planned as not to parcel out the market, i.e. consisting of enterprises belonging to the largest possible number of Member States;

— technical aid to nuclear power plant operators, directed mainly towards stepping up and making better use of exchanges of experience and towards joint technological development work;

— as regards the reactor components industry, which is highly fragmented and suffers from the same market barrier problems, concerting of public (national or Community) aid, so that in these fields too a Community-level reorganization of industry can be brought about;

— harmonization of technical and safety standards, in order to prevent fresh obstacles from barring access to the market and hampering industrial reorganization;

— necessity of organizing at Community level co-operation with non-member countries on industrial projects.

It would appear essential that the Council should first pass an opinion on these guidelines so that the Commission, in conjunction with the Member States' experts, can ascertain the most appropriate methods and put them into action. For that reason the points considered in Part I are suggestions intended to give the Council a concrete basis for discussion of the "principles and criteria" to which it referred in its Resolution of 20 December 1968.

Common policy concerning choice of reactor types

7. The Commission considers that it has a duty to make recommendations and advocate such measures as will lead to a choice; these measures consist in granting certain types of selective aid, which can assume various forms, such as:

— the granting of joint enterprise status,

— partial coverage of certain risks inherent in plant start-up,

— financial backing for the construction of the first advanced power reactors,

— participation in the research and development work.

To cut down the dispersion of efforts, the Commission considers that the Community's aid must be aimed at concentrating resources on a common technique as regards breeder, high-temperature and heavy-water reactors respectively. This policy must lead to a restricted number of trans-frontier consortia and a grouping of orders that will provide substantial volumes of business and yet not lead to the creation of virtual monopolies.

Hence the Commission proposes limiting as follows the number of reactor types which the Community might support:

Proven-type reactors

Promotion of a substantial volume of orders for large power plants, by partial coverage of certain risks inherent in the start-up period in the case of plants where there is still a large proportion of innovation.

Heavy-water reactors

— Multipurpose research relating to the water-cooled variants, and then, as soon as possible, a single variant;

— Financial aid for the construction by a multinational consortium and the operation of an initial commercial unit of at least 600 MWe;

— If the case arises, support for a heavy-water manufacturing plant.

High-temperature reactors

— Research projects of common interest to be carried out in the JRC establishments, to dovetail with research in member countries;

— Co-ordination of research of common interest to the prismatic and spherical element variants on behalf of the prototypes now being planned or constructed, for both steam cycle and direct cycle electric power plants;

— Extension of the Dragon agreement;

— Financial aid for the construction by a multinational consortium and the operation of an initial commercial unit of at least 600 MWe.

Sodium-cooled fast reactors

— In the absence of plans to build an initial commercial unit of at least 600 MWe in the next five years, implementation of all measures to ensure that, when the time comes, this enterprise will be carried out by a multinational consortium;

— Co-ordination of research so as to avoid useless duplication and make optimum use of national appropriations;

— Execution at JRC of research complementing that of the Member States;

— Working out and evaluation of extrapolations to 600-1 000 MWe of first-generation concepts, more advanced concepts, and any supporting tools that may be needed. This work, to be done by joint multinational teams, should be channelled towards common projects and facilitate the choice of projects;

— Assistance in establishing links between first-generation representative plants (Phénix, SNR and PEC).

The reasons for these choices are as follows:

1) The proven-type reactors have reached a certain degree of commercial maturity, but before they can be widely introduced into the power generating system certain improvements are still needed, notably as regards dependability of enriched uranium supplies, the harmonization of technical standards, and the lowering of the specific costs due to safety measures and fissile materials controls; technical availability must also be improved by eliminating the breakdowns that beset the first plants.

Moreover, the competitive position of these proven-type power plants depends to a large extent on the market situation and especially on the fiscal measures under the national energy policies. A common energy policy must therefore see to it that nuclear power plant building is on a sufficiently vigorous scale to ensure the growth of a powerful nuclear industry.

2) The heavy-water reactors have other advantages, the main one being the dependability of supply afforded by their independence of enriched uranium (especially in the heavy-water cooled type). Because of this they offer good export prospects. Incidentally, they are at a more advanced stage of development than the high-temperature reactors.

3) The high-temperature reactors appear to be very near the stage at which prototypes or even an initial commercial unit can be built. They are exceptionally promising on account of their high thermodynamic yield, their very favourable conversion rate and their ability to use thorium. Lastly, they lend themselves to various uses besides electricity generation, by reason of the high temperature of the coolant, but they have to have enriched uranium and are therefore dependent on that type of supply.

They are a good line of approach until the fast reactors reach maturity, and even after that will perhaps remain in use alongside the latter. In addition, they afford useful training in techniques on which a second generation of fast reactors may be based.

4) The fast reactors are still the most promising type in the longer run, because of their very high potential fuel utilization factor and, as regards the first stage, the sodium-cooled type is technically the most advanced.

Common supply policy

8. In the "First Guidelines for a Community Energy Policy", the Commission put forward certain proposals with a view to framing a common nuclear fuel supply policy, mainly based on:

— steps to encourage uranium prospecting inside and outside the Community, notably by the use of "joint enterprise" status;

— systematic diversification of external supply sources, and provision of domestic enrichment facilities inside the Community;

— amendment of the provisions of Chapter VI of the Euratom Treaty to enable the supply rules to be brought more into line with the market situation.

By the adoption of these proposals, constructors of reactors needing enriched uranium will be assured of supplies at a price not subject to any arbitrary decision by a non-member country.

Co-ordination of nuclear research work

9. The Commission considers that the co-ordinating of nuclear research should be done through indirect action, by which the Community shares in the management of certain national programmes, but in this respect new forms are put forward in the present proposals: where previously the Commission took separate action, by means of association contracts, in various programmes of the national research centres, it is now proposed that more closely integrated forms should be adopted in which the activities of laboratories dealing with the same field will be harmonized in appropriate committees, where the relevant programmes will be discussed as a whole.

This type of mutual planning is a broader implementation of the consultations laid down in Article 5 of the Treaty. The committees might be identical with the Programme Consultative Committees (the setting up of which is being discussed by the Council and the Commission) in the sectors where the Commission's own research activity will be substantial.

As to direct action, the Commission plans to intensify its public service activities; through the contacts thus formed, it will be able to facilitate the execution of research programmes in the member countries and to procure greater efficiency of co-ordination.

To step up the transfer of research findings to industry the Commission previously developed an important degree of indirect action by entrusting part of its programme to industry. In that way it helped the industry to grow by training competent staff and aiding new capital investment. It played the traditional role of any public authority which must give the initial financial stimulus to research that will not show a profit for a long time.

But the situation has changed completely and today the commercial applications are in use, or nearly ready for use (proven-type reactors).

Now, therefore, it is up to the industry gradually to take over the development work that will put it in a competitive position. Undoubtedly it can do some of that work in its own plants, but it can also find it profitable to use the investments in manpower and plant that have been financed on a joint expense basis, on the understanding that such work would be carried out against reimbursement of the expenses incurred. By so doing, not only will the industry enjoy the advantage of expensive equipment that it could not itself afford to acquire, but it will also help to nourish a Community-wide flowering of new techniques yielding fruits in which it will subsequently share.

Progressive conversion to non-nuclear research

10. The general trend in the nuclear field, where research projects are steadily reaching industrial maturity, means that sooner or later research capacity in the public research centres tends to be released. It is likewise generally recognized that, in other fields, the Community's research efforts need stepping up in order to bring about the vigorous remedying of the general scientific and technological research situation which the Council demanded in its Resolution of 31 October 1967. The Council therefore declared itself, in its Resolutions of 8 December 1967 and 20 December 1968, in favour of a partial conversion of the Joint Research Centre to non-nuclear work.

On the strength of this expression of the Member States' political resolve, the Commission has included a certain number of non-nuclear schemes in its proposed programme. Its task was made easier by the fact that the work of the Working Group on Scientific and Technical Research Policy was resumed in January 1969 after a long break, and produced some initial results which were embodied in a report to the Council. The Commission's proposals make use of these results without, however, being confined exclusively to them.

The first decisions in this field need to be taken fairly quickly; even partial conversion of the Joint Research Centre cannot be carried through except by a gradual process involving transitional time-lags.

With this in mind, the Commission felt that it ought to concentrate its proposals on a limited number of non-nuclear schemes. The choice of these new fields of action was prompted by the following principles: first, it seemed necessary to the Commission to make sure that the role assigned to the Joint Research Centre in the vast non-nuclear field is unambiguously devoted to the interests of the Community as a whole. The Commission therefore inclined towards public service activities closely bound up with the essential role of the Economic Community itself, or justified by the need for a European-level service.

The Commission likewise considered that, in the early stages, the gradual conversion should be centred on fields where the existing potential in manpower and equipment was easily adaptable without the need for large new plant or major retraining of personnel. Lastly, the Commission adopted the premise that the substance of its proposals must fit in with the initial recommendations of the Working Group on Scientific and Technical Research Policy.

Thus the Commission selected the subjects of nuisance abatement and information science; to these it added the setting up of a Community Bureau of Standards, which could contribute enormously to the establishment of the Economic Union by abolishing the technical impediments to trade. The need for such an office has been recognized by many industrialists; in a way it would be an extension of the activity developed by the CBNM in a highly specialized sector, and ought to form an important part of a really Community-wide network which would also include the existing specialized bodies.

III. INNOVATING NATURE OF THE PROPOSALS

11. On the basis of the experiences of recent years, and in view of the far-reaching development of nuclear problems, it was necessary to imbue the new proposals with a firmly innovating character, by altering the relative priorities given to the various activities envisaged and deliberately abandoning certain activities which were useful in the past but which must now be carried out by industry or else have lost their urgency.

The present proposals chart a new course by comparison with the previous programmes; this change should be steadily followed up in subsequent programmes.

12. The *new guidelines* proposed can be given practical effect as follows, where the research and training programme is concerned:

— support for current development projects relating to certain reactor types, and abandoning the development of one Community type (ORGEL);

— intensification of public service activities;

— procedure enabling work to be done to order, against payment;

— start of non-nuclear activities;

— listing of some new research subjects, not included in the proposal but suitable for submission at some future date.

13. Various activities that appeared on the former multiannual research and training programmes have not been included in the present project; others are proposed for entry either under the industrial policy heading or among the activities financed by the operating budget.

Such activities fall into three main groups:

(i) Those which, in the Commission's view, should no longer be pursued on a Community scale but could be taken over either by certain governments or by national private or public enterprises, who might, either directly or via government channels, have some part of the work done by the Joint Research Centre, against payment; amongst these may be mentioned the development activities relating to light-water reactors, nuclear marine propulsion and assistance to nuclear power plant operators (apart from industrial policy action); as regards the processing and disposal of radioactive waste, the Commission considers it a matter of importance to the economic future of nuclear energy, and has only refrained from proposing that it should continue its indirect action because of the need to cut down the range of its activities, but in its view co-ordination of the various efforts in this field in the Community is imperative.

As to direct conversion, it is some years since the Commission first set up a small research project for the study of thermionic techniques and heat pipes, but it has not succeeded in drawing together the efforts developed in that field by the member countries; in view of this it considers that this relatively marginal activity must also be given up unless it can be resumed later as one of the non-nuclear activities.

(ii) Activities of special nature warranting their inclusion in some other context than that of research and training.

These can be subdivided as follows:

— activities that should more normally be entered in the operating budget, such as research co-ordination and staff work (this subject is now under discussion in the Council);

— activities in the nature of industrial promotion or support and therefore to be put under the head of industrial policy, such as aid to the development of proven-type power reactors, action to help manufacturers of components and equipment, harmonizing activities relating to nuclear research, and technical and economic surveys.

In the Commission's opinion these various activities, though closely linked and sometimes even going hand in hand with research projects, of which they form either the base or the extension, are more in the nature of industrial back-up or promotion activities than of research work proper. Hence, although they encourage progress in the field of nuclear energy (wording of Title Two of Euratom Treaty), they no longer have a rightful place in the joint research programme. Nevertheless, these various activities, which are conducted by a limited number of officials in close liaison with the competent public or private bodies in the Member States, must in some cases be seconded by a small number of studies to be done by groups of Community experts. The cost of these studies is relatively low (a few hundred thousand u.a. a year) and will be the subject of an application for inclusion in the research and investment budget as "Joint Operations" within the meaning of the Euratom Treaty, Article 174(d).

(iii) It is suggested that the pursuit of certain lines of action should henceforth come under the operating budget on account of their permanent nature, e.g. dissemination of information and the promotion of industrial uses for radioisotopes and radiations.

IV. STRUCTURE AND CHARACTERISTICS OF RESEARCH PROGRAMME

14. As regards the Euratom research programme, activities will essentially fall under two main heads, namely:

— support for reactor and fuel cycle development and related problems (Titles I and II);

— public service work in the nuclear sector (Title III).

Smaller fractions will be devoted to basic nuclear research (Title IV) and non-nuclear activities of a public service nature (Title V).

The subjects were selected after a wide range of possibilities for future action in both nuclear and non-nuclear fields of research had been reviewed. The choice was guided by a number of considerations, the main ones being the desire to fit in with national efforts, the economic, social and scientific implications of the objectives, and the best utilization of the manpower and material available.

The programme will be carried out with the present staff, on the understanding that as and when personnel become redundant through cutbacks in certain sectors they will be employed on new (non-nuclear) jobs and on strengthening the work force engaged in nuclear tasks which are in the process of expanding. Thus by degrees personnel will switch from work on heavy-water reactors, reactor physics, materials, direct conversion and BR-2 operation to work on fast and high-temperature reactors, nuisance abatement, information science and the Community Bureau of Standards.

The Commission has thus refrained from proposing work in several fields which, however, would be worth studying in the Community by reason of their genuine usefulness and the competence already established in some of them. Elsewhere the Commission has expressly grouped together (Chapter 4) a number of special research subjects which might form the starting point of activities both new and capable of replacing others of declining interest or volume. It proposes that the non-nuclear subjects in this group should form the subject of a preliminary debate in the PREST group.

The proposals retained after this short-listing were submitted, for consultation, to various national authorities in the member countries; numerous contacts were thus established with experts in national research centres and institutes, industrial experts and government officials. In addition, the Scientific and Technical Committee appointed several working parties of its own which likewise discussed the proposals. The comments expressed were taken into account in the final choice of the subjects covered by the proposals that follow.

15. The carrying out of this programme will entail certain changes in personnel management, supervision of the projects undertaken and financial management, particularly as regards the determination of rates for work done to order: these questions will be dealt with in separate memoranda which the Commission will submit to the Council as early as possible.

More specifically, the Commission considers that certain appropriate arrangements will have to be made to enable a small proportion of the personnel to be retrained in connection with the inception of non-nuclear work and in line with the general trend of research.

The Commission also plans to introduce more up-to-date management methods by degrees, such as systems analysis and management analysis, which will make for a better assessment of objectives and better checks on efficiency.

16. The various objectives listed by the Commission in its proposed research and training programme described below are of such a nature and magnitude that a five-year period should be planned for their execution: within the various objectives, the study of certain subjects may conceivably level off or come to an end more quickly, whereas with others it may need to expand. These variations, in both personnel and costs, will be set out in the annual budget proposals.

The Commission resolved to propose a payroll cutback of some 5% on the present number on account of certain attitudes adopted in the Council. Staff reductions are only conceivable in the context of adoption of a multiannual programme; they must be accompanied by provisions that afford officials threatened by redundancy similar advantages to those provided at the time the institutions were amalgamated.

Within the limits of the planned overall establishment, the numbers of personnel assigned to each objective are averages for the five-year period and include the quota of the JRC establishments' general services (both technical and administrative) for each programme that will be carried out in these establishments.

The Commission also considers that a certain flexibility (about 5%) in the staffing of the various objectives must be authorized, so that the best use may be made of personnel and also so as to enable work to be carried out to order against payment.

The appropriations envisaged in this proposed programme are divided up for guidance purposes between direct and indirect lines of action which complement one another. The proportion between these categories is not the same as it was in 1968 and 1969. The ratio adopted in the 1968 and 1969 programmes was due entirely to the temporary nature of those programmes; it is worth recalling the corresponding commitments:

	Absolute values		Percentages	
	Dir. action	Indir.	Dir. action	Indir.
1st programme (commitments)	93.3	95.2	49	51
2nd programme (commitments)	234.6	208.1	53	47
1968 (commitments)	43.9	2.5	95	5
1969 budget	43.7	9.5	82	18
Present proposal	283.5	108.1	73	27

17. The overall appropriations envisaged (including those for programmes which it is proposed to transfer to the operating budget) total 391 million u.a.; this total is distinctly lower than that of the second multiannual programme, especially if one takes into account the rise in the cost of living and the slight increase in the average number of personnel between 1965 and 1972 (median years of the two programmes).

As regards the curve of this total, the Commission cannot fail to observe that the fraction of funds devoted by the member countries as a whole to Community

nuclear research fell from 14.8% in 1967 to 6.8% in 1969, and that the decrease in the Euratom budgets is practically equal to the increase in the Member States' own budgets (see table below).

The financial size of the proposed programme can be appraised in the context of the Member States' civil nuclear research and by comparing this total effort of the Member States with that of the United States.

The programme's annual average expenditure, as it appears below (including the start of conversion), amounts to about 8.5% of the Member States' total civil nuclear effort (i.e. 6.4% for direct action and 2.1% for indirect action which does not involve the Member States in additional expenditure).

The total effort of the Member States amounts to 46% of that of the United States.

Nuclear research budget expenditure by Member States in terms of absolute value and proportion between contributions to Euratom and such expenditure

	Absolute value			Proportion (in %)		
	1967	1968	1969	1967	1968	1969
Belgium	21.2	18.1	20.6	52.8	40.9	25.9
France[1]	440.7	453.1	444.5	7.7	5	2.5
Germany[2]	190.5	205.0	202.3	17.4	11	8.9
Italy	82.5	76.6	75.0	31.6	22.5	18.1
Luxembourg	—	0.5	—	100	20	100
Netherlands	28.3	30.4	34.7	27.6	17.1	13.8
Total	763.2	783.7	777.1	14.8	9.5	6.8

[1] Military expenditure is not included in the calculation.
[2] Expenditure by the Länder themselves is not included in the calculation.
N.B. The absolute values include contributions to international organizations and to the EAEC.

CHAPTER 2

Underlying principles and criteria for an industrial policy in the nuclear field

INTRODUCTION

In presenting the proposals put forward here, the Commission is aware of the problems and difficulties entailed in implementing a common technological and industrial policy in the nuclear sector. The first of these difficulties is indisputably inherent in nuclear technology itself, where developments are still uncertain and any choice is frequently a gamble. The second relates to the competition between the different sources of energy and to the downward trend in the cost of the thermal unit of conventional origin, which tends to go against the evolution of a powerful nuclear industry within the Community. The most difficult problem, however, is undoubtedly that of co-operation between the advanced industries in different countries; yet this co-operation represents the Community's only chance of maintaining its position among nations endowed with a competitive and technically advanced industry.

As was emphasized in Chapter 1, the compartmentalization of national markets is one of the main causes of the present weakness of the Community's nuclear industry and of the uncertainties which weigh on its future development. While it may be theoretically possible to export a nuclear power plant outside the Community, it is at present very difficult for a Community manufacturer to pull off a major nuclear contract in another Community country, especially one with a large nuclear industry.

In the opinion of the Commission, the opening up of markets must be reconciled with the need for harmonious development of the nuclear industries within the Community (see Chapter 1). This cannot be done unless enterprises are regrouped on a trans-frontier basis, which constitutes an essential step if they are to be rendered more competitive.

These two types of action — the opening up of the market and the gradual reorganization of the Community's industry — must, therefore, go hand in hand.

Electricity producers, industrialists and governments must all help, each in his own sphere, to set up a unified market and to strengthen the Community's nuclear industry.

It is the Commission's view that these two objectives can only be reached by way of a number of joint projects, and these are dealt with in this chapter.

I. IMPROVEMENT AND COMPARISON OF ESTIMATED INVESTMENTS IN NUCLEAR POWER PLANTS IN THE COMMUNITY

Electricity consumption in European countries doubles on the average every ten years. This law has been verified for the Community between the years 1958 and 1968, as is shown in Table 1 below:

Table 1

(in 1 000 million kWh)

Year	Community	Germany	France	Italy	Netherlands	Belgium	Luxembourg
1958	228.8	95.1	62.0	44.5	13.1	12.6	1.2
1967	439.1	177.7	114.0	94.6	28.1	22.6	2.0
1968	474.2	195.0	119.2	101.2	31.6	25.0	2.2
Ratio 1968/58	2.07	2.05	1.92	2.27	2.37	1.99	1.80

Present forecasts suggest that this law will continue to apply during the next few decades.

In contrast to the situation in the United States, however, production of electrical energy from nuclear sources in Europe has not profited from this expansion, as is shown below in Table 2 and the graph.

Table 2

State of investments in nuclear power plants in the Community by year in which work was begun

Year	Name	Country	Net capacity (MWe)					Total number/ total capacity in Community
			Gas graphite	Light water		Heavy water	High temp.	
				BWR	PWR			
1956	G-2 Marcoule	F	40					2/80
	G-3 Marcoule	F	40					
1957	Chinon-1	F	70					2/80
	BR-3 Mol	B			10			
1958	Chinon-2	F	200					3/415
	Latina	I	200					
	Kahl	D		15				

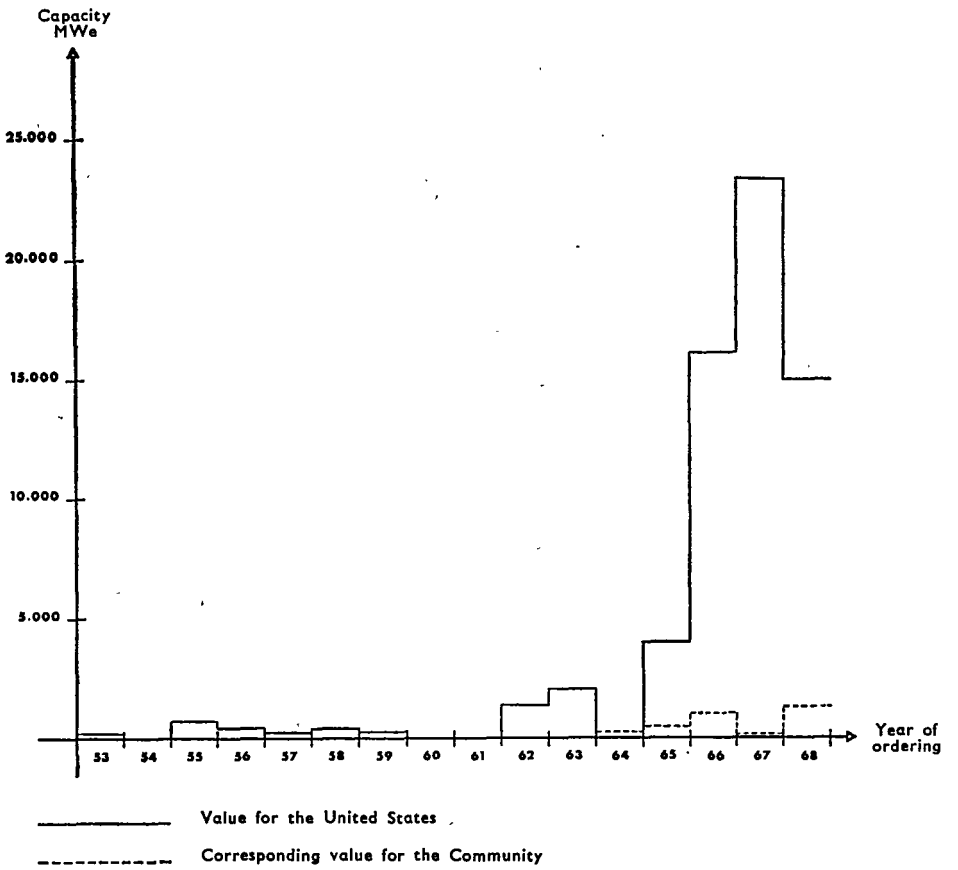
Year	Name	Country	Net capacity (MWe)					Total number/ total capacity in Community
			Gas graphite	Light water		Heavy water	High temp.	
				BWR	PWR			
1959	Garigliano	I		150				1/150
1960	Jülich (AVR)	D					15	1/15
1961	Chinon-3	F	480					2/737
	Trino Vercellese	I			257			
1962	Gundremingen	D		237				4/626
	Chooz	F/B			266			
	Karlsruhe MZFR	D				50		
	Brennilis EL-4	F				73		
1963								0/0
1964	St. Laurent-1	F	480					3/705
	Lingen	D		173				
	Doodewaard	N		52				
1965	Obrigheim	D			300			2/325
	Dettinger HDR	D		25				
1966	St. Laurent-2	F	515					3/1155
	Bugey-1	F	540					
	Niederaichbach	D				100		
1967	—							0/0
1968	Würgassen	D		612				2/1242
	Stade	D			630			
1969	Doel	B			760			2/1510
	Tihange	B			750			
	Total Number/capacity		9/2565	14/4237		3/223	1/15	27/7040

The hazardous nature both of the forecasts and of the orders for nuclear power plants largely explains the overall weakness of Europe's nuclear industry as compared with that of the United States.

The Commission feels that the constructors of power plants and the suppliers of components should be provided with the most accurate possible forecasts of electricity producers' intentions as regards the placing of orders.

This improvement in forecasts is required primarily for the medium and long term. The Treaty obliges the Commission to prepare target programmes indicating nuclear production objectives and the various investments needed to attain them. These programmes are of great value to industrialists, since they enable them to assess future trends with regard to the demand for nuclear power plants and the resultant requirements of the associated industries.

Net electrical capacity of nuclear power plants ordered each year in the United States compared with that of nuclear power plants laid down each year in the Community[1]



[1] In contrast to the curve for US investments in nuclear power plants, this table lists, in the case of the Community, not the date on which the plants were ordered, but the date on which construction was commenced, since widely varying periods elapse between these two dates in Europe.

N.B. The drop in the capacity ordered in the United States in 1968 as compared with 1967 is due mainly to the fact that manufacturers' order books were full up and also to the appreciable increase in the cost of the latest nuclear power plants proposed. It must also be noted that this drop in the capacity ordered has also affected conventional power plants.

In the past the Commission of the European Atomic Energy Community presented a first target programme. The Commission thinks that the moment has come to prepare a second programme in collaboration with all the interested circles.

However necessary the forecasts which have just been discussed, they do not entirely fulfil the expectations of industrialists owing to their uncertain character. Firm decisions are taken under numerous pressures of a technical or financial nature, as a result of which the timescales and technical characteristics contemplated in the forecasts frequently have to be changed.

For this reason it would be very helpful to industry if electricity producers would agree to hold annual meetings at which they could publish the above-mentioned forecasts and indicate their intentions as regards the placing of orders for nuclear or non-nuclear power plants during the coming months; without being formal commitments, such intentions would nonetheless be very close to firm decisions.

The Commission thinks that the advantages which would accrue to the industry from organizing these annual meetings and thus asking for an additional effort from electricity producers would also benefit the producers, since co-operation between them and industry would be greatly improved.

This annual comparison of electricity producers' estimated orders should relate to all the nuclear or non-nuclear power plants which they propose to build during the current year, and in particular should include the probable date of the firm decision, the date on which orders are placed and the date of the commencement of work, together with the capacity and type of the power plant.

The information made available at these meetings would provide the Commission at regular intervals with data on the basis of which it could add to or amend its medium- and long-term forecasts.

The Commission will pursue the contacts already made with electricity producers with a view to establishing such a procedure as soon as possible.

At these annual meetings the electricity producers might be interested in comparing the orders which they intend to place in the near future.

This system of comparison, which already exists in other industrial sectors within the framework of standardization committees, would be of additional interest for electricity producers and Community industries if it were to facilitate some rationalization of types and standards in the field of nuclear and non-nuclear power plants. This rationalization has undoubtedly been one of the causes of American industrial success in the nuclear energy field, where far-reaching standardization of power plant data has resulted in constructors' output and electricity producers' requirements being limited to a few types. This standardization has even led to the publication of a catalogue representing the industrialists' standard reply to calls for bids from electricity producers. There is no need to underline the considerable savings thus made, both by the industrialists and by the electricity producers, the mere preparation of a reply to a call for bids representing an expense of possibly more than 500 000 u.a. to the constructor.

In addition, this comparison might help to solve the problems involved in incorporating large power plants into the grids by further improving co-operation as regards interconnection.

Lastly, the question arises whether the regular comparison of electricity producers' plans might not lead to the regrouping into small series of certain invitations to tender which the producers might wish to issue for plants of similar capacity and the same type. This would enable the constructors to lower their production costs while at the same time encouraging them to reorganize themselves on a Community basis.

These contacts should also prove effective in facilitating the issuing of the calls for bids under agreements leading to reorganization and specialization among manufacturers of components or even of power plants.

II. OPENING UP OF THE MARKET AND ACTION WITH RESPECT TO THE INDUSTRIAL STRUCTURES

At the present moment and in spite of the advent of the Common Market, the market for large electrical equipment remains compartmentalized; the electricity producers, in both the public and the private sectors, usually reserve their orders for domestic firms. This inevitably impedes rationalization, which is essential in both the nuclear and conventional sectors of this industry in the Community.

Most Member States are at present suffering from major structural defects due either to inadequate concentration of resources or to insufficient experience of the nuclear industry. Yet the Community possesses a considerable potential in the form of manpower, knowledge and experience in the nuclear field in all its Member States. The problem appears to be largely that of regrouping and organizing these resources so as to create industrial units capable of facing international competition. This must be done both at the component level and with respect to overall design concepts.

At the component level, while there is an overçapacity in certain sectors in relation to present demand (fuel elements), the major phenomenon to be observed in the Community is the scattering of industrial resources. (For example, in the Community there are ten manufacturers of turbosets, thirteen of fuel elements, nine of steel pressure vessels, etc.).

This scattering undoubtedly limits the financial, industrial and technical resources of the industries in question and only rarely allows them to marshal the research resources necessary for the development of highly sophisticated components.

Concentration of the component industry is seen to be essential. Such concentration can be horizontal and ultimately lead to the construction in Europe of factories large enough to enable them to face competition from similar components manufactured outside the Community. For example, the Westinghouse project for the fabrication of fuel elements represents a production capacity equivalent to that of the entire Community. Similarly, there are only two large turbine producers in the United States as against ten in the Community. In some instances vertical concentration may also help to solve the problem of training research teams and the financial difficulties entailed in the development of certain components.

This concentration process must be carried out by the industrialists themselves. The public authorities or the clients must, however, take care not to maintain or encourage the present industrial dispersion by fragmenting their orders. In this,

as in other industrial fields, co-operation between enterprises of different Community countries appears likely to provide in many cases an answer to the technological, financial and commercial problems facing these industries.

The dispersion of the Community component industry is, however, not the only cause of the difficulties experienced by the nuclear industry. There is also a problem with regard to overall design and engineering. With a few exceptions, the Community industry has not had the opportunity to gain sufficient experience at all stages from the design to the construction of power plants. This situation is attributable either to the tendering system used or to the lack of confidence among electricity producers in European techniques, or again to the inadequate assimilation by the Community industry of the techniques developed in national centres or by external industries.

The use of foreign techniques under licence may entail drawbacks which are of a technological and commercial nature rather than financial. Short of waiving the external supplier's warranty, which few European enterprises can contemplate doing, the constructors must often agree to employ in their power plants a whole range of techniques and components which prevent the Community's industry from developing its own designs.

For this reason, one of the Community's first efforts must be directed to setting up groups which are sufficiently linked to the existing electrical engineering industry and are capable of meeting the design requirements of an entire nuclear power plant.

There is no room within the Community for a large number of groups. The regrouping of the existing resources in a few engineering units would constitute a major advance on the present situation, in which too many enterprises have the capacity to design a nuclear power plant but are not in a position effectively to meet the guarantees required by electricity producers.

In order to remedy this situation, it would not be realistic merely to advocate the issuing of calls for tenders. The narrowness of the market might then have the effect of almost completely eliminating the industry of some Member States to the benefit of those which possess the most powerful industrial structures.

In order to be effective, Community action would have to be both prudent and gradual, and combine the use of various instruments.

The aim should be to encourage the trans-frontier regrouping of the industry in such a way that electricity producers can form a few powerful consortia embracing the entire Community and capable of co-operating as equals with the most powerful firms in non-member countries and competing with them on the world market.

These efforts at concentration would be pointless unless a minimum market were to develop in the Community. Only by obtaining orders of a sufficient volume and regularity will the Community's industry be able to acquire the necessary experience, both in overall power plant design and in the fabrication of components.

These orders are also indispensable to ensure a minimum return on the investments necessary for the research effort in which the Community's industry is engaged.

With the present low and intermittent flow of orders, the Community's nuclear industry finds difficulty in improving its technology, making a profit and recouping its investments in terms of manpower and plant. Failing an increase in the rate of orders, many research teams, even those of major industrial groups, will have to be redeployed.

If the Council approves the aims and policies set out above, the precise forms of the action to be taken will have to form the subject of intensive debate with experts of the various governments and with trade and professional circles.

At the same time, the Commission thinks it worth while to map out forthwith the lines which these various forms of action might take. In this way it can provide the Council with a concrete basis for discussion of the "principles and criteria" to which the Council referred in its resolution of 20 December 1968.

Lastly, the Commission emphasizes that the various measures contemplated form a whole which could not be tackled piecemeal without considerably reducing the chances of success.

These Community efforts towards industrial reorganization and the opening up of the market could take the following forms:

a. Grant of partial guarantees

For some years to come proven reactors will form the only significant market for the power-plant or component industries, until such time as reactors of the future reach industrial maturity (advanced converters and fast breeders).

However, owing to the downward trend observed for some time in the cost of conventional energy, doubts as to the reliability of nuclear power plants, and fears of having to contend with risks so costly as to jeopardize the competitiveness of nuclear energy, electricity producers are reluctant to place regular and large orders.

The competitive position of the proven-type power plants is largely dependent upon the state of the market and particularly on the financial measures deriving from national energy policies. It is therefore necessary to ensure by means of a common energy policy that the construction of nuclear power plants progresses fast enough to guarantee the development of a powerful nuclear industry.

For this reason the Commission thinks it will be necessary for some time yet to provide financial assistance[1] to producers in the form of partial guarantees, given in return for industrial reorganization at the Community level.

These guarantees would be given only if one of the following conditions are fulfilled:

— grouping of orders for power plants and their components at Community level;

---

[1] The desirability of financial intervention by the public authorities in order to facilitate the completion of a decisive stage in the evolution of the use of nuclear energy and the industrial development of the associated techniques was recognized in the United States immediately it began to concern itself with the peaceful applications of nuclear energy.

Intervention by the public authorities has often taken the form of very large research and design contracts (in particular reference design contracts), help in the construction of demonstration reactors (such as the loan of fuel free of charge for the first few years) and more general assistance by leasing fuel at reduced interest rates up to 1973.

Despite the industrial and financial power of American electrical engineering firms, this intervention has made a decisive contribution to the swift expansion of nuclear energy and to the spectacular breakthrough achieved in the last few years. It is worth noting that similar action, though on a smaller scale, is in progress in connection with certain types of advanced converters, and that further action, on a large scale, is in preparation in respect of fast reactors.

— construction of power plants by a consortium of enterprises from several Community countries;

— utilization of certain essential nuclear equipment or components built in other Community countries, of a value representing a significant percentage of the value of the power plant.

An additional but important condition would, of course, be the dissemination of the results gained in operating the power plants, in particular data on any incidents occurring.

The use of improved technologies in Europe might be a further reason for according such guarantees.

This guarantee should only be provided for the time necessary to strengthen the Community industry. During this period it would also allay the anxieties of electrical engineers as to the reliability of nuclear power plants. At present, it does not appear that the guarantee should extend to reactors ordered later than three or four years hence.

The guarantee could be valid for only three years from the date at which the power plants began to supply full power to the grid. It would cover only major risks liable to cause prolonged outages. In addition, it would appear necessary to set a ceiling on it during the period covered (one might tentatively suggest a figure of 9 000 hours over a three-year period) and to limit it to a percentage of the down-time. It would be calculated on the basis of a standard rate per kWh representing, for example, all the fixed charges in the kWh cost.

On the basis of the statistical probabilities of major incidents occurring in all the power plants covered by the guarantee (800 hours average shut-down a year), the amount of the funds required would be limited.

According to the assumptions outlined above, the actual expense for 1 000 MWe covered by the guarantee may be estimated at — 10 million u.a. For every guarantee granted, an appropriation would be made by the Council. The necessary sums would be included in the Research and Investment Budget pursuant to Article 174 d) of the Euratom Treaty.

b. Progressive opening up of the market

Irrespective of the conditions required for the granting of the guarantees envisaged under *a.*, the opening up of the market might be facilitated if the Community institutions were to ask electricity producers to undertake certain commitments in this respect.

They might be requested to reserve, on equal terms, a percentage — which could possibly be increased — of their nuclear orders for enterprises in other Member States, either directly or by awarding contracts to multinational groups. This percentage might be low at the outset, but the principle of opening up the market would have to be affirmed.

It is also important that the Member States and the electricity producers should agree on a policy for effectively opening up their markets to one another. National industries should not be exposed to the deleterious consequences which might result from divergent policies on the part of electricity producers or governments

in this respect; on the contrary, they should all benefit from a larger market, for this alone can guarantee a continuous flow of orders, which in turn is the essential condition for the creation of a genuinely competitive industry. It is therefore imperative that the principle of fencing off markets be reversed, even if it appears difficult here to impose 38 binding legal obligations on electricity producers.

c. Grant of financial aid for the construction and operation of initial commercial units

While proven-type reactors represent the present market for the industry, and will continue to be indispensable for the next five to ten years, it is the reactors of the second and third generations which will probably enable the Community industries to establish themselves best. The Community does not labour under the same technological and economic handicap with respect to its foreign competitors as regards these reactors as it does in the case of certain categories of proven types. The research carried out hitherto in the Community on future reactor types is not inferior, and sometimes even outstrips that done outside the Community. It appears, however, that in the absence of decisions with regard to industrial-scale production, the Community may lose a part of its lead, at least as regards advanced convertor reactors.

A short time ago it was legitimate to ask whether supplementary work, particularly on the heavy-water and high-temperature variants, would not help a more enlightened choice to be made between systems and variants. It may now be asked whether research does not render the choice more complicated as new findings emerge, and whether matters have not reached a stage where further work will not yield decisive information in favour of or against this or that type, but will rather constitute a fragmentation of effort without any industrial fruits.

It seems that the moment is approaching when a decision will have to be taken on the construction of one or both types of advanced convertor in the form of an initial commercial unit.

However, we must preclude any possibility of the Community encouraging the construction of three such units, two of which would be high temperature reactors, at the present stage. The practical question is whether it is advisable to develop two different types on an industrial scale. In order to spread the technological risks involved and also for reasons of supply, however, it seems reasonable to widen the range of the Community's industry and find the funds for the construction of an initial heavy-water unit.

These two projects might conceivably be in the form of two joint enterprises, in which some or all of the Member States would participate.

The form of this joint enterprise is a matter of great importance. It will have to be discussed exhaustively. Several solutions are possible: the joint enterprise might be made up of one or more Community electricity producers. It might also consist of a finance company in which the interested Member States would be represented. A third form, namely a joint enterprise set up by the industrialists, seems to raise tricky problems, particularly as regards feeding the current produced into the grid.

In all probability the joint enterprise would award the construction contract to an industrial consortium comprising the principal industries concerned.

The financing of the joint enterprise could also be carried out in a number of ways. If the enterprise consisted of one or more electricity producers, it or they could reasonably be expected to pick up the tab for that portion of the investment which a reference power plant of equivalent capacity would have represented. It also appears reasonable that the Community should provide limited financial backing for such a joint enterprise, the experience to be acquired from which would be of interest to all Community countries.

Lastly, there would appear to be a sound case for asking those Member States whose industries were most interested in the construction of the initial commercial unit to make an additional contribution.

A guarantee of plant availability up to a certain ceiling would be given by the Community, as with proven reactors.

All Member States could thus be associated with one or both projects and would also benefit from the knowhow and experience gained in the project to which they were not making a major contribution. There would thus be a measure of insurance against technological risks.

Apart from the partial guarantee, the Community's share in the financing of these enterprises should be limited to a modest proportion of the capital cost.

The counterpart of such aid would, of course, be a reorganization of the industries concerned.

The industrial-scale projects following on the initial units would also have to benefit from the above-mentioned partial guarantees under the same conditions as proven reactors.

As regards fast breeder reactors, all the Member States favour a regrouping of efforts (see memorandum of the German, Belgian and Netherlands governments, and memorandum of the French government). However, despite statements to this effect, no initiative has been taken up to the present. Thus, a number of projects are at present being pursued at considerable cost without there having been any effective co-ordination since 1968. Apart from the wastage of resources, if this situation continues, it may impair the Community's chances of industrial success in this highly promising field.

The Commission feels that close co-ordination between the different programmes must be brought about in the near future in order to avoid dispersion during the change-over to the industrial and commercial phase proper of the operation.

The Committee which the Commission in its programme proposals suggests should be created to co-ordinate research efforts should also be made responsible for preparing the way for the integration of industrial developments. In particular, it should consider whether it is expedient and possible to construct a single initial unit of 600-1 000 MW and, if not, it should examine the conditions in which effective competition could be achieved between two multinational consortia.

The funds already earmarked by the Member States make it possible for them, if they wish, to orientate the work in progress in a genuinely Community direction, this being the only way to ensure a more efficient use of outlay. Community aid to future industrial projects in this field is conceivable only in so far as the Member States take effective steps towards co-ordinating their efforts.

d. Technical assistance to nuclear power plant operators

The systematic exchange of technical experience gained during the construction and operation of nuclear power plants in the Community is one method of reducing the technological risks mentioned above.

The results of the Commission's activity in this field during recent years have been appreciated by electricity producers. This activity, which should be continued, consists in the secondment of specialized personnel to certain operational power plants, and exchanges of information and experience within technical working groups.

These exchanges can lead to certain joint activities in the field of components, to expert reports and also to research projects carried out in collaboration with the JRC (see Chapter 3.III.10).

The funds for the first two categories of activities would be included in the Research and Investment Budget pursuant to Article 174 d) "Joint Operations".

e. Concerted activities on behalf of component manufacturers

The activities described above do not touch on the problem of possible Community aid to the development of components and equipment.

Certain technical and financial difficulties inherent in major installations are encountered and may even originate at the stage of component development. Some countries have therefore set up a system for the partial financing of development work in the form of concerted activities. This aid consists in awarding development contracts to the industries concerned; these are partly financed by the public authority in the form of advances which are repayable in the event of industrial and commercial success but become subsidies in the event of failure.

Consideration might be given either to co-ordinating such forms of aid or to supplementing them in such a way as to enable them to play a similar part in industrial reorganization at Community level.

This assistance, on both the national and the Community levels, would be granted preferentially to groupings or consortia of European enterprises.

The Commission will present more detailed proposals after receiving the opinion of the Council and consulting the parties concerned.

f. Harmonization of technical and safety standards

Parallel to the creation of incentives for the opening of the market and the reorganization of industries, steps must be taken to prevent the creation, in the absence of joint action, of technical obstacles which every effort is being made to overcome in other fields. This applies particularly to the safety of nuclear installations.

The utilization of fissile materials together with the grave consequences — which are all the more feared since they are so hard to estimate — liable to follow from accidents due to material, equipment or operational failures in reactors have led each state to create a technical and administrative infrastructure to evaluate the

risks entailed in the construction, siting and operation of reactors and to fix the conditions which constructors and operators must observe in order to obtain construction and operating permits.

Industrialists wishing to export equipment or to build reactors outside their own country are liable, unless they take due care, to find themselves facing very serious difficulties since the customs, administrative regulations and technical restrictions imposed by each national authority in nuclear safety matters differ from country to country.

Apart from the health aspects, where a harmonization of laws and regulations has been achieved through the fixing by the Council of basic standards drawn up by the Commission (pursuant to Articles 30 et seq. of the Euratom Treaty), joint action in the field of nuclear safety has hitherto been impeded, firstly by the slender experience possessed by Community countries owing to the small number of nuclear power plants built, and secondly by the differences which have emerged as to the very concept of safety and risk evaluation.

It is the Commission's conviction that joint action in the safety field, aimed at the gradual elaboration of a uniform philosophy, is highly desirable.

In the case of the constructors, this would help in the drawing up of plans and specifications, thus reducing the cost of preparing tenders; it would also facilitate the series fabrication of equipment and lead to a cut in costs, which should be reflected in prices. For their part, the electricity producers would enjoy lower prices, more favourable insurance terms and easier power plant operation.

The Commission therefore proposes to pursue its past activity in this field by encouraging experts from different countries to examine projects for nuclear installations and sponsoring direct discussions between operators, constructors and safety organizations at a Community level. This would facilitate the gradual emergence of a common approach and the subsequent establishment of similar if not uniform conditions as regards safety analysis and inspection and test requirements.

This activity would be supplemented by work, such as that already in progress in other fields, aimed at eliminating the disparities between industrial standards.

In the nuclear field, efforts to standardize reactor components might be directed to certain equipment already at an advanced stage of development (e.g. electrical and electromechanical equipment). This work should be supplementary to that already carried out by international organizations such as the International Organization for Standardization (ISO) or the Comité Européen de Coordination des Normes (CEN). It might be directed in the first place to fabrication codes, test and inspection methods, and quality controls on pressure vessels and valves, pumps and pipes for reactor primary circuits.

The Commission will present detailed proposals on this last point (standardization) after consulting the industries and national and international organizations concerned.

This effort at harmonization and standardization should facilitate the co-ordination of experimental studies referred to in the programme proposals below.

Such activity involves detailed and continuous expert studies which cannot be limited to periodical meetings lasting one or two days, but must be authentic studies divided up among the participating organizations. For this reason a limited amount of funds will be necessary, these being used in particular to pay for the experts' services and for certain calculations.

These funds would be included in the Research and Investment Budget pursuant to Article 174 d) "Joint Operations".

III. CO-OPERATION WITH NON-MEMBER COUNTRIES

In the nuclear field as in other sectors of advanced technology, Community activity cannot be conceived in isolation from that of non-member countries, particularly European countries which are desirous of joining.

Co-operation may take the form of exchanges of scientific or technical information, joint development of reactors by consortia open to firms in non-member countries, exchanges of patents or licences, agreements aimed at opening up markets (particularly government orders), agreements for drawing up joint specifications or standards, and, lastly, agreements between electricity producers aimed more especially at the interconnection of grids and the exchange of reserves.

At the same time, in order to ensure that such links with non-member countries do not harm the development and cohesion of the Community, they should as far as possible be set up by the Community and not individually by this or that Member State.

The agreements recently concluded by two Member States with the United Kingdom on isotope separation by the ultracentrifugation process, at the very moment when a working group of the Six had drawn up a report on the same subject, have given rise to considerable tension within the Community. This experience indicates the advantage to the Community of an equally open-minded but more coherent attitude with regard to non-member countries.

There is another reason why the Commission believes that co-operation with non-member countries must be organized at Community level. In order to ensure a satisfactory balance of industrial spin-off, it is desirable that co-operation, both within the Community and with other European countries, should cover a fairly extensive production range, as was recognized by the Medium-Term Economic Policy Committee in its second report.

In establishing the above guidelines, the Commission has taken stock of the difficulties in the way of the implementation of a joint policy of industrial development in the nuclear sector. Such a policy implies a renunciation by the Member States of some of their ambitions for the sake of a regrouping of their efforts in a field in which considerations of politics and prestige are often decisive. Nonetheless, the Commission must emphasize that a better co-ordination of efforts would avoid considerable wastage of talent and resources and also cut down the risks involved.

To this commonsense consideration may be added the legitimate desire to ensure a suitable balance in the general development of the Community, which is an essential condition for its internal cohesion. If the present trend were to continue we should probably witness an increasing imbalance as a result of which the states with the most underdeveloped industries would prefer to turn to non-member countries for help.

Lastly, the foregoing considerations prompt the question of whether the Council ought not in the next few months to endeavour to take an overall view of the problems raised by European co-operation in the sectors of advanced technology.

CHAPTER 3

Proposed research and training programme

I. CONTRIBUTIONS TO REACTOR DEVELOPMENT

Introduction

The Commission's proposals for action in this field are based directly on the conclusions drawn in its survey of the Community's nuclear policy, backed up by the information acquired in the course of consultations carried out in the meantime with industrial firms and electricity producers.

This is why the proposed projects hinge on specific objectives selected with a view to their ultimate industrial application, the methods proposed for their implementation being aimed at regrouping the industry on a multinational basis. The purpose of this chapter, therefore, is to propose aims for each reactor type considered which will enable it to be brought to maturity, in line with the need for a coherent overall strategy.

The research programmes to be carried out in the Community must be integrated around these aims, with the Commission's backing taking different forms, more particularly that of financial aid to the direct action carried out by the Joint Research Centre or partial financing of the work done in the Community, and also its contribution towards the overall co-ordination of activities.

Past experience has demonstrated fully the impossibility of striking, in respect of each aim, a fair balance between the participation of each Member State and that of industry and the national bodies. Such a balance must be achieved overall, in all the nuclear projects on the Community's research and investment programme, of which the reactor field forms a part.

With a view to promoting the development of a strong nuclear industry in the Community, the Commission proposes the implementation of a number of projects hinging on the following points:

— the carrying-out of a multiannual research programme relying both on the scientific potential of the Joint Research Centre establishments (direct action) and on that of the national nuclear centres and the industry's laboratories (indirect action);

— the granting of financial assistance and certain privileges provided for in the Treaty in respect of industrial projects coming under the Community's general plan;

— the co-ordination of all reactor development work in the Community;

— the pursuit of a policy of technical assistance to nuclear power plant operators aimed at the acquisition, processing and exploitation of technological knowhow and experience.

I.1. Fast reactors

1. THE PRESENT POSITION AND GENERAL CONSIDERATIONS

It is now universally acknowledged that in time fast breeder plants will have to be adopted, since they alone can ensure full utilization of fertile material resources (U^{238} and thorium). Moreover, breeder reactors have excellent economic prospects, mainly on account of their very low fuel-cycle cost. The fact that they are fuelled with plutonium, either supplied by existing thermal installations or bred in fast reactors, affords the best possible solution for the absorption of growing stocks and for elimination of the need to rely on diffusion plants.

This explains why, with the exception of Canada, the countries seriously engaged in nuclear activity — the United Kingdom, the United States, the USSR, Japan, Australia, India, etc., and all the Community countries — are either already giving priority to their fast reactor effort or are preparing to do so. The stakes in this world-wide competition are huge and the aim generally set is that of achieving "commercialization" (i.e. the installation of the first competitive fast reactor plants of about 1 000 MWe installed power) around 1980/85, with this initial breakthrough seen as the starting point for the large-scale, if not exclusive, adoption of fast reactors of a more advanced type during and beyond the next ten or twenty years after that.

Unlike the situation with regard to thermal reactors, where a number of quite distinct types and variants are still competing with each other, there is at present virtual unanimity about the type of fast reactor which should be adopted and developed in the first stage and up to "commercialization". All the programmes now in progress are based on the assumption that priority will be given to sodium-cooled fast reactors with uranium/plutonium oxide fuel in stainless steel cladding, a solution which has already formed the subject of the most exhaustive and long-standing research. Further, and despite the fact that the concepts worked out for this "first generation" of fast reactor plants differ in the details of the engineering solutions chosen, there is a striking similarity between all the programmes, both with regard to the prior R & D and to the first units to be built. Where the latter are concerned, competition revolves around the commissioning date rather than real technical originality.

The following stages are usually passed through with these "first generation" fast reactors:

1) An "experimental" reactor, of a few tons of MWth, to demonstrate the viability of the concept adopted and to carry out integrated testing of the solutions selected for components and sub-assemblies, on a very small scale and with limited risks.

This stage has already been successfully completed in several countries. The existing experimental reactors are now being used for irradiating prototype fuel pins and elements in a fast flux, for which they remain essential.

2) A "prototype" reactor, of about 250-300 MWe installed power, designed as a precursor to the production-type plant of 1 000 MWe installed power or over decided upon for the future, and intended to demonstrate its functioning and competitive potential, still on a reduced, though significant, scale.

The second stage is now well under way in the United Kingdom, the USSR and France and also in Germany (jointly with the Benelux countries).

These "first-generation" prototypes should be fairly representative of the first large plants which will follow them, both as regards the concept adopted and the engineering solution and components. In point of fact, however, they retain a certain number of experimental features owing mainly to the haste with which international competition forces them to be put in hand and alas to the rapid technical strides made by this type. Hence it is that the following additional stage could prove necessary before "commercialization".

3) An initial pre-production unit, of 600-1 000 MWe installed power, extrapolating the prototype's concept and design features to production-plant size, while embodying the improvements resulting from the experience gained in the construction and operation of the prototype or the research carried out meanwhile. At the present time a decision in principle on this stage has been taken only in the United Kingdom and the USSR, this being virtually concurrent with the decision on, and without waiting for the results from the prototype stage.

In the Community, it would as yet be premature to try to define precisely the characteristics of such a pre-production unit, which would still be uncompetitive and which many are already accepting as a probable intermediate stage coming before the commercial plants. A proper decision cannot be taken for some years, having regard to the evolution of international competition, the experience gained in building the prototypes and exploratory studies still to be carried out. Even if it proved possible to go straight from the "prototypes" to large plants, public backing would probably still be necessary if only to cover the operating risks involved in this first attempt at fitting a "fast" reactor plant into the grid.

So far as any fast reactor programme is concerned, previously built hardware or any other large-scale plant and establishments (fast-flux materials-testing reactor, heavy component testing station, etc.) represent a certain stage of progress with the R & D and the acquisition of industrial knowhow. Nonetheless, these "representative plants", while having a polarizing effect on the work, constitute only a fraction of it and it is true to say that the *R & D of general benefit* carried out in the Centres accounts for much more staff and funds than the hardware itself. Although current R & D programmes are still orientated rather towards the first generation, they have wider and longer-term aims. They include many studies of general benefit and of no immediate industrial applicability, such as physics and neutron physics, properties of fuels and materials and fuel cycle optimization, heat transfer, safety, design and general optimization studies, etc., which hold good for all fast reactor concepts and are aimed primarily at improving the understanding of the phenomena involved and the accuracy of the initial data.

As the "first generation" prototypes progress, the R & D programmes will become concentrated more exclusively on the investigation of improved or "second generation" concepts relying on more sophisticated solutions, such as mixed carbide, nitride, etc., fuels or vented fuels, improved claddings — possibly of the dispersed-phase type, gas and direct cycle cooling, etc.

At present there are many alternative solutions under consideration and the competing concepts might become somewhat diversified in the "second generation" stage. Accordingly, the representative plants necessary at that stage may vary greatly in size and cost, depending on the improvements decided upon, and might range from the mere replacement of the first prototypes' cores to the construction of new experimental reactors (e.g. gas-cooled), new prototype/pre-production reactors or fast-flux irradiation devices, etc. In any event, since fast reactors are only in the initial stage of their development, the R & D programmes of general

benefit can be expected to extend to well beyond the stage of "first generation" prototypes, no reduction in the volume of work and investment being likely for a long time.

There are three separate and practically self-sufficient fast reactor programmes going on in the Community. Each has its own immediate objective in the form of a representative plant, with a parallel longer-term R & D programme of general benefit, but there are some considerable differences in their orientation or structures, e.g.:

— In France the fast reactor programme is managed by the CEA and most of the R & D work is carried out at the Cadarache, Fontenay-aux-Roses and Saclay establishments. Once the Rapsodie "experimental" reactor stage was passed (the installation is now used by the CEA as an irradiation facility), construction of the Phénix prototype was begun at Marcoule. This project is run by a joint CEA/EDF/GAAA Group under CEA supervision.

— In Germany and those Benelux countries which have joined forces with Germany in this, the public and semi-public centres and bodies are still being given R & D work of general relevance to this reactor rype, whereas the building of the SNR joint prototype has been assigned to industrial consortia The research work of general interest carried on by the GfK, CEN, RCN, TNO and certain departments of Belgonucléaire and Luxatome have therefore been co-ordinated as part of a joint "Basic Programme". Alongside this, the design and construction of the SNR prototype are covered by an intergovernmental financing agreement and an agreement between Siemens, Interatom, Belgonucléaire, Neratoom and Luxatome;

— In Italy the fast reactor programme is directed by the CNEN and the R & D work is in the hands of the Bologna and Casaccia establishments. The construction of the PEC fast-flux materials-testing reactor is being undertaken by a joint group under ENI and IRI control with the CNEN acting as project superintendent and retaining responsibility for the design and manufacture of the core and the irradiation loops.

For the time being Italy does not contemplate a first-generation prototype and intends to proceed at a later stage to more advanced versions with vented fuel, this solution being one of the main points of its programme. In addition, work has been done on the development of steam generators and major components for sodium-cooled reactors, some of it by industrial firms.

At the present time these three programmes overlap at many points and are neither complementary nor based on planned diversification.[1] This dispersal of effort is proving very costly to the Community, more as regards the R & D of general interest, indeed, than the multiplication of representative plants. In this context it is worth recalling the order of magnitude of the costs and timescales currently applying to any self-contained fast reactor programme:[2]

[1] Annex 5300/XV/69f gives a table summarizing the R & D activities proceeding in the Community. It shows clearly that each programme attempts to cover the whole of the field. In many cases this is a legitimate state of affairs, the duplication of effort that does exist arising more from a lack of co-ordination than from their own internal set-up. (See the note to the reader at the end of the Table of Contents.)

[2] The figures that follow relate to an essential minimum. They are roughly in line with the expenditure authorized by the UKAEA for what is a fairly lean programme. Without absolute austerity, co-ordination of the programmes carried on in the Community would not result in drastic reductions in expenditure. An overall saving of the order of 10-20% would appear feasible if, for example, there is agreement to make complementary use of facilities (accelerators, critical experiments, loops, mock-ups, etc.) and if joint irradiations, block buying of fissile materials, etc., are possible.

— some 150-200 million u.a. spread over six or seven years, from the very earliest stage to the satisfactory operation of the first experimental reactor. The investment in the reactor accounts for a much smaller part of this estimate (30-50 million u.a.) than the cost of research of general interest and investment in ancillary facilities (major equipment, infrastructure, etc.);

— some 400-500 million u.a., also spread over six or seven years, culminating in the satisfactory operation of the first "prototype" reactor. Here again the direct investment in the prototype and the R & D specifically carried out for it (150-200 million u.a.) is less than the cost of the concurrent programme of R & D of general interest aimed at subsequently leading to a pre-production reactor or more advanced concepts.

It is clear that the persistence of this dispersal of effort into the much more expensive "pre-production" and "second generation" stage would be extremely prejudicial to the Community and could result in an impasse at the industrial stage.

2. The need for concerted action

The size of the sums required by the fast reactor family was touched on above and would of itself warrant rationalization of efforts within the Community. Moreover, the need for work to be concerted and for better dissemination and sharing of information, the necessity of a joint industrial policy and the establishment of powerful intra-Community industrial consortia enjoying unrestricted access to Member States' markets — all this has been acknowledged many times, and by all the responsible authorities.

Despite this harmony of intentions, disagreement has persisted, especially with regard to the best approach to be adopted in initiating joint Community action in the fast reactor field. In short, should co-operation be confined initially to general research and be extended gradually to the industrial sector via parallel agreements between private firms, or should the first step be to set up an industrial consortium of firms from the six Member States to exploit commercially the results of the research, which in this case would be carried out on a co-operative basis?

In order to avoid obstacles and discriminations of any kind, the Commission had previously put forward as a solution the single Joint Enterprise (possibly with subsidiaries) to cover all the work being carried out by the Establishments and by industry, with joint financing and management.[1]

This approach proved abortive. The proposals below attempt to make greater allowances for the points of view that have since been expressed. The procedure to adopt, the most suitable structures and the facilities to be used jointly can be arrived at only within the scope of full-scale negotiations and provided that there is a prior determination to succeed.

3. Proposal for action

3.1 *Justification*

The Commission's aim remains that of promoting the marketing of this reactor type, on a Community basis, as soon and as efficiently as possible and thereby to

[1] Working document ref EUR/C/1482/1/68 dated 1 June 1968, and documents COM/800 (published in the Bulletin of the European Communities, No. 9/10-1968) and COM/801.

encourage lasting industrial groupings of constructors in the Six countries and, also, the co-ordination of investments in the nuclear field.

Having regard to present divisions, the *de facto* autonomy of the three Community programmes and the corresponding special equipment already set up, it is quite plain that these aims of the Commission will only be attainable gradually and that the major difficulty in the way of any Community solution lies in the *initial* acceptance of a certain degree of co-ordination and complementarity. It is essential, moreover, to avoid laborious preliminaries and therefore to commence co-operation in those areas where it is most readily acceptable immediately, postponing its extension to the industrial sector until the future stage of advanced hardware and commercial power plants.

Consequently:

— in the immediate future, the co-ordination of work and the gradual elimination of the duplication of effort due to the present programme overlaps would affect the *R & D programmes of general interest.* These have the advantage of raising relatively few problems regarding industrial property or policy, so that work could be rationalized and a free exchange of information instituted without delay. They account for the lion's share of the manpower and funds devoted to fast reactors, so that any effective rationalization and complementarity would either lead to a beneficial widening of the field of activity or would enable appreciable savings to be made.[1] Furthermore, since they are oriented mainly towards the improvement of present solutions and the development of more advanced designs, they foreshadow the future pattern in this sector. Co-operation started in the R & D field could naturally and steadily extend to the industrial sector via future hardware projects, such as pre-production plants, the first of the second-generation reactors, major supporting facilities etc., thus providing tangible evidence of the progress made under these R & D programmes.

— unlike present-day representative plants, these large-scale future projects still hold out the prospect of effective and lasting Community co-operation in the scientific and industrial fields which may find enormous outlets but, obviously, the first of them will not be built in the very near future. Moreover, the construction of a *single,* Community first-generation pre-production reactor to follow on from the Phénix and SNR prototypes can only be taken as a general aim, for agreement on one single solution could only be reached on the basis of a well-considered common choice in the light of available evidence or as a result of operating experience with the prototypes, on the assumption that one of the designs proves decidedly superior. There will therefore be numerous problems in the future in connection with the selection of the successors to the present prototypes and of the second generation concepts to be adopted and taken up to the commercialization stage or as regards any new test facilities that might be necessary. In order that objective comparisons and well-founded choices may be made, the Commission proposes that a series of *joint conceptual studies and evaluations* be undertaken as soon as possible. These evaluations would call on the specialists both from the nuclear research centres and from the six countries' industrial groups, working in mixed teams. Their conclusions would permit optimum orientation of the R & D programmes and would enable the industrial options to be crystallized. The links thus established between firms should be maintained and strengthened when the corresponding hardware, jointly decided on, comes to be built.

[1] Cf. notes at the foot of page 36.

— regarding the *present representative models — Phénix, SNR and PEC —* the industrial facilities have already been set up, construction has begun or is about to begin and it would be pointless to try to revamp the work schedules drawn up at the cost of so much effort and put them on an entirely Community basis. It is preferable to make the most of the present situation by allowing each prototype to serve as insurance for the other and guaranteeing full and lasting utilization for the irradiation capacity of PEC, which is of use to the Community as a whole.

In view of the probable evolution of the fast reactor family and of its future prospects it is essential not to overestimate the importance of these initial projects or to make them the key to all future developments. They represent only the very first stage and their true function will be rather to put the parties concerned in a position to prove their technical capabilities and to reach agreement regarding subsequent developments on an equal and equitable basis.

3.2 *Proposal*

In detail, therefore, the Commission's proposal relates to the following:

— the R & D programmes of general interest, to be carried out at the JRC and the national centres. The present national programmes would be co-ordinated and rationalized so as to produce a genuine joint programme.

— conceptual studies and evaluations with the aim of improving the orientation of the R & D programmes, preparing future projects and stimulating Community industrial co-operation.

— the connections to be established between the "first generation" representative models and the preceding activities.

The proposal breaks down as follows:

A) Joint Action

a.1) *Work for the Joint Research Centre Establishments*

This consists of supporting work to be performed in the JRC Establishments (The Institute for Transuranium Elements at Karlsruhe and the Ispra Establishment), making use of present staff and not duplicating the work now in progress in the national centres. This work should dovetail logically with the co-ordinated R & D programme of general interest mentioned under B below.

a.1.1) The activities proposed for the Institute for Transuranium Elements are described in Section II.5 and would employ some 200 staff.

a.1.2) The activities proposed for the Ispra Establishment are described in more detail in the appropriate technical annex. A total of 109 staff is required. The selection of the proposed activities was made after consulting the interested quarters. They involve no duplication. The fact that they are carried out by the JRC with unrestricted freedom of access to information would rule out the need for any of the work to be done twice. Certain tasks are already in progress and others rely on knowhow acquired in the design of other reactor types.

The following subjects have been decided upon:

— special thermal problems relating to the use of sodium (boiling and direct contact);

— problems relating to the reprocessing of irradiated fuel (stripping and molten salts);

— problems relating to reactor physics (calculations and codes, integral cross-sections);

— materials problems (plutonium diffusion);

— problems relating to fuel elements (vibration, local velocity).

a.2) *Reactor type collation and evaluation*

This will be a co-ordinating and collating team, numbering about twenty. It would supervise continuously the status and detailed progress of the work being done in the Community. It would be responsible for liaison between the teams and would ensure that all the information that could be communicated was collated and quickly disseminated.

It would assist the Committee responsible for the co-ordinated programme (mentioned under B below), and the teams carrying out conceptual studies and evaluation (a.4. below).

a.3) *Seconded personnel*

The contribution made by the personnel attached to the earlier associations proved to be very valuable, so that it is advisable to retain the principle of this form of Community participation in the various fast reactor programmes. It should also be extended effectually to the Italian, Belgian and Dutch programmes. (These seconded officials would therefore be directly involved in the co-ordinated R & D programme of general interest mentioned under B below). The secondment of officials to the design teams or to the firms concerned might also be desirable. A total of 46 is envisaged.

a.4) *Conceptual studies and evaluation*

These will be evaluations, or comparative studies, relating to the feasibility, potential competitiveness, safety, etc., of the various solutions either contending with each other or proposed as alternatives, but not of detailed draft designs or complete tenders. These studies would be directed along industrial lines and would have to be carried out by mixed teams made up of representatives of the Establishments and of the firms concerned in the six countries. If necessary, several teams could be set to work in competition on the same study in order to leave the firms free to choose their own partners. In the short term these studies would inevitably have to rely on the specialists belonging to the Establishments and the industrial groups building the prototypes and PEC, and the subjects might be, for example, the stretching of the Phénix and SNR designs into a 600 MWE pre-production model, detailed comparison of construction difficulties and the corresponding economic prospects and possibly an attempt to define a common industrial objective for

the "first-generation pre-production model" stage. Subsequently more attention would probably be devoted to the advanced designs: carbide or vented fuels, gas cooling, etc., and possibly the selection and initial investigation of the new test facilities required. More diversified participation by industry could then be feasible and desirable.

These tasks would be carried out in close liaison with those responsible for the co-ordinated R & D programme, particularly the ad hoc Committee. While they were being performed, it would be necessary to safeguard the industrial property rights of any innovators. Subsequent assessment of the documentation submitted could be done jointly by all the interested parties.

B) Co-ordination of the R & D programmes of general interest

At the moment, all the R & D of general relevance to the reactor family is financed by the governments and virtually all of it is carried out in their centres. This state of affairs will continue for a long time since the industrial groups concerned cannot be expected to take over the running here before the type is in wide commercial use.

The co-ordination and subsequent rationalization of the three national R & D programmes of general interest can be carried out within a short time. Implementation of these tasks depends entirely on the political determination of the governments which finance and sponsor the national centres.

The Commission proposes that all the interested parties, and first and foremost the governments, should undertake to facilitate the permanent confrontation of all the programmes both planned and/or in progress in the Member States, to pool *all* the results obtained and to arrange among themselves to institute full and reciprocal facilities for access to all the existing test installations and also appropriate exchanges of personnel.

The merger of the current programmes into one co-ordinated programme implies an objective assessment of them in order to cut out unnecessary duplication of effort and to ensure the optimum use of the available resources. With this in view the Commission proposes the setting-up of a Committee consisting of representatives of the interested parties, each party having voting power proportional to its financial contribution to the co-ordinated programme.

The Committee would be responsible for rationalizing the co-ordinated programme, as regards both its implementation and formulation, and for establishing criteria which would ultimately lead to a common industrial objective at the pre-production model stage mentioned in Chapter 2, Section C. With regard to this last point, the Committee would be closely associated with the definition of the aims of the conceptual studies and evaluations mentioned under a.4 above.

The Committee would be assisted by a permanent secretariat provided by the Commission and would have the additional task of forwarding information and research results promptly to all participants.

On the basis of proposals put forward by the Commission, the Committee would decide where there were cases of unnecessary duplication and would determine the cost of each one.

The Committee would issue recommendations concerning the best use to be made of the savings resulting from programme harmonization and the elimination of duplications, with a view to speeding up or widening the programme.

The Commission reserves the right to make proposals to the Council concerning the use of common funds in order to enhance the effectiveness of its co-ordination work.

C) "First-generation" representative models

In view of the progress made by the work and the structures set up, these representative models — Phénix, SNR and PEC — can no longer be used for a first attempt at regrouping firms within the six Community countries. Nevertheless, co-operation between the teams and firms responsible for their construction and operation can still be entertained as a form of insurance and to facilitate the definition of subsequent joint objectives (a.4 above) deriving from these first major projects.

The Commission therefore recommends that an attempt be made to conclude co-operation and exchange agreements between the promoters of these representative models, with safeguards for industrial property rights, and requests the governments financing them to encourage the conclusion of such agreements.

The undertakings to be entered into might refer specifically to:

— frequent mutual consultations;

— the rapid exchange of all information that can be disclosed, details on the state of progress of work, etc.;

— facilities for joint experimental work, such as irradiations, the use of existing loops and installations, etc.;

— the advantages of diversifying or standardizing solutions, and the possibility of placing block orders or of cross-ordering;

— start-up help, exchange of personnel and comparison of operating results and experience;

— the irradiation in each prototype of typical fuel elements used in the other, as a form of insurance;

— making all information of a general nature available to the co-ordinated R & D programme of general relevance and participation in the evaluations mentioned under a.4 above, etc.

These co-operation agreements should also cover the heavy component testing stations either planned or being built, which provide direct support for the representative models.

Furthermore, the use of PEC as a Community irradiation facility and hence the definition of the test loops to be installed in it, together with the use of Rapsodie and KNK II as irradiation facilities for advanced fuels, should come within the scope of the co-ordinated programme.

The joint enterprise formula could smooth the way for implementation of the undertakings outlined above.

4. Estimate of the Community's financial requirements for the period 1970-74

A — *Joint action*

1. Work by the Joint Research Centre Establishments	
— Ispra (109 employees)	9.5 million u.a.
— for reference only, The Institute for Transuranium Elements, Karlsruhe (Work on plutonium, about 90% of the activity: 200 employees - see Section II,5)	(23 million u.a.)
2. Reactor type collation and evaluation team Total staff: 20	1.40 million u.a.
3. Seconded personnel: an average of 46	3.1 million u.a.
4. Conceptual studies and evaluation (the sum of the costs currently budgeted for in the three programmes)	15 million u.a.
Total	29 million u.a.

B — *Co-ordinated programme* — for reference only

C — *First generation reference models and plant* — not budgeted for

I.2. High-temperature gas reactors

1. Review of the present situation

The new techniques ushered in by the high-temperature gas-cooled reactor, particularly helium technology and coated-particle fuels, supplemented by continuing investigations into graphite, have been successfully tried out in the construction and operation of the Dragon, Peach Bottom and AVR reactors.

Together with the experience gained in the construction of a great many large CO_2-cooled gas/graphite reactors, this enables the interested firms to assess the costs and risks involved in the construction of large HTGR power plants and to put in bids forthwith for the building of such plants.

A 330 MWe prototype reactor is already under construction in the United States and should be completed in 1972. An extensive HTGR programme might follow the AGR generation in the United Kingdom after 1970.

The strong position that the Community has built up for itself in this field through its participation in the Dragon and THTR programmes and the experience acquired in the large gas/graphite power plant field should enable it to enter the industrial stage with the HTGR on an equal footing with the United States and the United Kingdom.

The factors militating in favour of the vigorous development of this reactor type are as follows:

— in the short term: its competitive potential in relation to proven reactors;

— in the medium term: the improvements achieved by the use of a direct cycle (gas turbine) instead of the classic steam cycle; the wide variation in fuel cycles to which it lends itself (plutonium and thorium); and the new possibilities which it opens up for the industrial use of high-temperature heat (iron and steel industry, chemical industry);

— in the longer term: its parallel development alongside sodium-cooled fast reactors and its back-up value in the event of the latter being delayed or running into serious difficulties, this value possibly being enhanced by the development of high-temperature gas-cooled fast reactors.

This fully justifies making every effort to ensure that the Community is not left behind in the commercial exploitation of this reactor type.

It is a familiar fact that the Community's firms are interested in two high-temperature gas reactor designs which are to a large extent based on the same technology. Progress to date with the techniques to be employed in the construction of the first large power plant incorporating these two variants is such that, in the case of prismatic-element reactors, the promoting firms have put in a bid for the construction of a 400 MWe prototype using a low-enriched uranium fuel cycle, while in the case of the pebble-bed reactor the construction of a 300 MWe prototype using a uranium-thorium fuel cycle is planned at present under the German nuclear programme, to be followed, according to the memorandum sent by Germany to the Council in May 1968, by the construction of a 600 MWe plant based on one of the two existing variants.

It has also been decided, as part of the German programme, to build a 22 MWe plant aimed at proving the viability of the high-temperature direct-cycle gas-cooled reactor concept using prismatic fuel elements.

2. Proposals for action

In view of this state of affairs and the need to let Europe's industry exploit the position which it has built up by dint of the Commission's co-ordinated action over the last ten years, the Community must mobilize the resources necessary both to achieve certain specific aims and to pursue the development of the great potential of this reactor type.

With this in view the Commission proposes a number of schemes aimed at strengthening the competitiveness of the firms concerned by fostering large-scale multinational collaboration to carry the development of this reactor type up to full commercialization, when public backing would no longer be necessary.

There are three things involved:

— determining whether it will be possible ultimately to build a single pre-production unit of at least 600 MWe;

— selecting the best time for initiating this venture;

— choosing the variant.

Two factors will determine the solution of these problems:

— the extent to which the firms concerned can combine forces in the future;

— the time factor. Here the Commission feels it desirable to bring the two variants at present competing into closer alignment, so that all the firms engaged on high-temperature reactors are grouped together in one industrial consortium in order to build a single pre-production model of at least 600 MWe. A combination of this kind ought to be brought about soon so that the Community does not fall seriously behind its competitors abroad in the phase in which the techniques developed are demonstrated on an industrial scale.

The Commission proposes that:

— assuming that a satisfactory solution is found to the problems of industrial co-operation in the Community in connection with the carrying-out of the projects before it, the Community should give support to the construction of an initial, steam-cycle plant (joint enterprise, tax exemption, participation in the financial coverage of operating risks);

— other Community countries should take part in the building of the Geesthacht reactor in order to profit from the experience that will be gained from this first direct-cycle plant (joint enterprise, supplies in kind, etc.).

Concurrently, in the research and development field, the Commission proposes the provision of help to ensure that the best use is made of this reactor type:

— by carrying out research at the Joint Research Centre on the subject of fuels, graphite, technology, physics and fuel reprocessing. Detailed programmes have been drawn up following consultations with the main European centres of activity on the HTGR and taking account of a number of proposals from industry (Deutsches Atomforum, Internuclear). These projects are therefore complementary to the national programmes. In this programme emphasis is laid on ever-rising operating temperatures with a view both to improving the steam-cycle HTGR and to helping to solve the problems posed in the use of the direct cycle using helium turbines.

As a result of the great interest shown by the firms in the construction forthwith of large plants of this type the Commission proposes a major extension of the Joint Research Centre's activities in this field. Moreover, the same determination can be seen in the United Kingdom, where the UKAEA has recently decided to undertake a big programme above and beyond its involvement in the Dragon project. Such an increase in the JRC activity is something that can be carried out without delay in view of the manpower and equipment available and by using personnel trained under the Dragon and THTR programmes as the backbone of the JRC's teams as follows:

— by co-ordinating, at Community level, the Community's own projects and the work of common benefit carried out in Member States. In order to back up its projects, the Commission is planning to make a fixed financial contribution to the research programme, which would be co-ordinated by a committee representing the various interested parties;

— by the Community's participating in the Dragon Project for a further three-year period (from April 1970).

It should be possible to take an immediate decision on such an R & D programme benefiting both the variants, without regard to the solutions to be found for the technical, financial and industrial problems relating to the major projects.

3. Resources to be marshalled to implement the schemes proposed

Research and Development Programme

Direct action

Ispra	101 employees
Petten	50 employees
Headquarters	10 employees
Total	161 employees

Total budget for direct action 15.2 million u.a. (including 0.5 million u.a. of new investments)

Indirect action

Participation in national programmes

Estimate in respect of national programmes which are of common benefit: 13-17 million u.a./year

Commission's fixed contribution: 30%

Dragon Agreement

Total budget: £7.2 million for three years, assuming a 40% share to be borne by the Commission (2.3 million u.a./year)

Officials seconded to "indirect action" programmes

24

Total budget for indirect action 30 million u.a.

I.3. Heavy-water reactors

1. Review of the present situation

The main, if not almost the sole, reason for the development of heavy-water reactors both inside and outside the Community is the fact that this reactor family can generate power competitively with a fuel cycle based on natural uranium and thus confers a certain degree of independence in the choice of supply sources.

The position regarding heavy-water reactors in the Community is marked by the dispersal of effort over four variants which are totally distinct apart from a few common features.

Among heavy-water reactors using the natural-uranium fuel cycle, those variants in which heavy water is employed as both the moderator and coolant appear best suited to the use of this type of fuel.

At the industrial level, the recent decision to build a 3 000 MWe plant made up of four 750 MWe units at Douglas Point, thus raising the amount of generating capacity of the CANDU design under construction to about 6 000 MWe, puts this

type of reactor in a favoured position in comparison with the four variants still under development. The competing design, based on moderation and cooling by heavy water in a pressure vessel, development of which has been followed by the construction of a 330 MWe plant in Argentina, should soon benefit from good penetration of the Community market or the export market to give it the same background of industrial experience as the CANDU reactor, this being essential for enabling the Community's industry to keep pace with competition in this sector.

The Community therefore faces the alternative either of carrying on with its policy of the last ten years, namely that of appropriating considerable sums of money, both at the national and at the Community level, for the development of a large number of variants of the heavy water reactor,[1] or of concentrating on the short-term construction of a single power plant in the same class as the one planned for Douglas Point (750 MWe).

In view of the foregoing, time is an essential factor working in favour of the heavy-water moderated and cooled variants, which are at present the only ones to have reached a sufficiently advanced stage of development to offer the guarantees necessary with such a large investment.

2. Proposals for action

In order to achieve this aim, and in the absence of a firm declaration of intent from an electricity producer, the Commission believes that of all the various possible approaches the most suitable appears to be to set up an ad hoc financing company, of a multinational nature, whose funds would be supplied by the participants. It could be given joint enterprise status. At the same time a consortium of electricity producers should be formed which would agree to incorporate the plant in the grid and operate it on terms to be specified later.

The financing company would be responsible for issuing a call for bids to firms in the Community (grouped into one or more multinational consortia in which the industries of the interested countries would be represented) with the aim of obtaining a design proposal for this plant accompanied by a firm bid for its construction, and including the operating guarantees desired by the utilities consortium.

The choice of reactor concept would be left to the firms approached.

If necessary, an agreement for co-operation could be concluded between the group of firms selected and the Canadian Atomic Energy Commission.

In another connection, the building of heavy-water reactors in the Community would pose the problem of the supply of heavy water, the world's production facilities being inadequate for the time being. This problem could be solved at Community level, as regards its own requirements, by building a heavy-water production plant of modest capacity. If this was decided upon, the Commission would be prepared, in so far as it thought it advisable, to contribute towards the construction of such a plant, in particular by granting joint enterprise status.

---

[1] Types of heavy-water-moderated reactor built, under construction or planned in the Community:

— carbon-dioxide-cooled variant: EL-4 (80 MWe, France),
— heavy-water-cooled variant: MZFR (50 MWe, Germany),
— light-water-cooled variant: Cirene (35 MWe, Italy),
— test reactor: ESSOR (45 MWth, Euratom, Ispra).

If the Community were to set its sights on the rapid construction of a pre-production unit, there should be a consequent gradual reduction in the Community's backing for other variants. In particular, the supporting research programmes for these variants could be continued at the JRC on request and against payment as a compensatory gesture.

The development of the heavy-water moderated and cooled reactor variant in the Community will call for a substantial industrial development programme which can receive an effective and vigorous boost from the JRC's major facilities (particularly ESSOR, which has only just become operational) and the experience built up by its staff.

It is worth recalling that the Canadian Atomic Energy Commission keeps its research centres going mainly on its heavy-water reactor development programme.

Pending a decision on the construction project recommended above, the Commission suggests that the JRC development programme be confined to the water-cooled variants. Should a decision to concentrate on the heavy-water variant be reached at an early date, the essential elements in the programme should be revised to suit this objective.

In any event, should variants other than the one adopted as a Community objective happen to be pursued on a national basis, the JRC would be in a position to meet requests for research services which, in this case, would entail payment. Direct action will cover problems of general relevance to the water-cooled variants and the development of the technology of pressure-tube reactor channels:

— physics, shielding studies, dynamics, reactor physics codes and nuclear data;

— fuel element development and testing: mechanical problems, vibration, wear, etc.;

— development of channels and joints (explosion welding, rolled joints, etc.), plugs; techniques for replacing faulty channels (remote shearing and welding of tubes); pressure tube and calandria characteristics; irradiation of channel components;

— zirconium alloys: characterization of their out-of-pile and in-pile mechanical properties (hydriding, in-pile creep, etc.);

— out-of-pile investigations of hydrodynamic instabilities and burn-out in fuel assemblies;

— component development: steam separator, thermal insulation for prestressed concrete pressure vessels, liquid safety rods;

— safety tests: pressure tube ruptures and their effects on the calandria; coolant ejection (dumping); pressure tube cracking, critical length and propagation detection;

— studies on thorium lattices;

— heavy-water production processes; analysis of deuterium sources, evaluation of new production processes and exploratory tests in the laboratory; operation of a pilot plant will form the subject of a request for a supplementary programme if necessary.

The work of co-ordinating the research and technical support programme for the project decided upon will be done by the group of officials already entrusted with this task under the present heavy-water-moderated reactor development programme.

3. Resources required to implement the proposed activities

Direct action:

— 300 officials, including those required to operate the ESSOR complex;

— 165 officials for laboratory research;

— 25 officials for technical management of the programme;

— 35 million u.a. for operation of ESSOR, including staffing costs;

— 4 million u.a. for new loops;

— 13.2 million u.a. for laboratory research;

— 1.7 million u.a. for the management team;

— 2 million u.a. for financing specific work and studies which are of a nature such that they should be carried out by industry or specialist Community bodies.

II. FUEL CYCLE AND ASSOCIATED PROBLEMS

Quite apart from the specific developments in respect of the fuel cycle appropriate to each of the reactor systems referred to in the preceding chapter, those more general fuel-cycle problems which by virtue of their magnitude obviously call for action at Community level are discussed below.

Whatever reactor types may be envisaged, the rapid development of nuclear energy gives rise to a growing demand for fissile materials at competitive prices and to the need for as rational as possible a utilization of these materials and the certain and economic elimination of the fission products.

II.1. Enriched uranium production

1. Review of the present situation

In accordance with the Council's resolution of 8 December 1967, an ad hoc working group from the CCNR drew up a consolidated report on the long-term supply of enriched uranium. This working group came to the conclusion that in order to cover the Community's requirements, which are estimated at 5-8 million units of separative work annually from 1980 onwards, it will be necessary to build a European enrichment plant, since it will no longer be possible for the requirements of the Western world to be met from the existing American and British enrichment facilities.

Parallel with the work of the ad hoc group from the CCNR, two Member States (the Netherlands and Germany) conducted negotiations with a non-member country (Great Britain) with a view to establishing the basis for the construction of enrichment facilities for civil use based on the ultracentrifugation process.

These negotiations now place further activities in this field in a new perspective; it is of the utmost importance that the use of processes based either on ultracentrifugation or on gaseous diffusion should henceforth be studied under such condi-

tions that the decisions relating to the setting up of an industrial-scale plant for the production of enriched uranium can be taken at a Community level without excluding participation by non-member countries.

In order to arrive at such an arrangement, which should extend both to the construction of the installations and to the joint management thereof, it is necessary to take a political decision in principle and to draw up a precise programme for the preparatory work.

2. Proposals for action

To this end the Commission will shortly submit to the Council a number of proposals for action, in continuation of the work of the CCNR ad hoc group.

In particular, the Commission proposes to enter into consultations with the experts of the various countries in order to determine to what extent certain research and development activities on isotope separation could be incorporated into the joint programme.

Above all, it would be advisable to ascertain what can be done to facilitate the technical and economic decisions which are a precondition for a Community project, particularly as regards assessing the performance of the various processes currently in use or being developed in the Community, these being considered both individually and in combination.

II.2. Natural uranium supply

The series of proposals relating to the construction of a European plant for the production of enriched uranium will be supplemented, within the framework of a common supply policy, by proposals for specific action as regards supplies of natural uranium, with a view to determining an overall strategy. Such a strategy is justified by the fact that between now and 1980 the Community's requirements of natural uranium will amount to some 90 000 tons, whereas during the same period availability from the Member States' own resources will be only a few thousand tons.

II.3. Fuel management

1. Review of the present situation

The management of the nuclear fuel in power plants is of direct concern to reactor operators and hence also to fuel-element manufacturers. A system of joint management would make it possible to co-ordinate the individual fuel cycles, to arrive at more economic solutions and to improve security of supplies. In this connection the Commission has found that the industry and certain electricity producers would be glad if the Joint Research Centre could help in the development of various fuel-management models and of suitable computer codes, etc.

Such studies are, moreover, essential to enable the Commission to work out the target programmes provided for in Article 40 of the Euratom Treaty.

2. Proposal for action

The Commission considers that these are activities of legitimate interest to the relevant specialized circles and that they could best be carried out with the support of the computer centre, the programme library and the scientific staff of the Joint Research Centre.

It is of the opinion, however, that they must be regarded as specific services to be performed on request and against payment.

II.4. Reprocessing of irradiated fuels

As far as the availability of reprocessing installations in the Community is concerned, no problems will be encountered before 1975, provided that certain adaptations are carried out at the French plant at Cap de la Hague to enable it to reprocess irradiated fuels from various types of nuclear power station.

On the other hand, the adaptation of aqueous extraction methods and the development of dry routes for the reprocessing of fuels from advanced reactors still call for extensive studies which will benefit the Community. In order to combine all research activities relating to one and the same reactor type into a coherent whole, the proposals for action in this field are included in the development programmes for high-temperature gas-cooled reactors and fast reactors respectively.

II.5. Plutonium and transplutonium elements

1. Scope of the programme

In the Institute for Transuranium Elements, together with a number of similar establishments set up on a purely national basis, the Community has at its disposal a complex of installations equipped for the handling of alpha-emitters, as well as an extremely up-to-date "hot" laboratory. The significance of the work that has so far been done there is reflected in the fruitful collaboration that exists between the Institute's research teams and the various groups working at an industrial or national level. The co-ordination of efforts will be further improved by the setting up of an advisory committee on programmes, which will enable the existing contacts to be organized more efficiently.

The plutonium studies, which make up the essential part of the programme proposed by the Institute for Transuranium Elements, will furnish a contribution to the basic programme on fast reactors. In order that the Institute's activities may be integrated to the fullest possible extent with the research conducted by the specialized industrial and national research centres in the Community, which is directed more particularly towards the technological aspects of the development of plutonium fuels for fast reactors (fabrication processes, fuel behaviour under specific

conditions, etc.), the Commission has slanted the programme for its Karlsruhe Establishment more than in the past towards basic research into the phenomena that occur in nuclear fuels under irradiation.

The aim of this work will be to provide a collection of basic data necessary for the optimization of existing or potential fast-reactor fuels in general (oxides, carbides, nitrides, etc.).

Furthermore, the continuation of the research on the physics and physical chemistry of actinides is being encouraged by the lively interest which numerous quarters are showing in the development of a fundamental programme of this kind within the framework of the Institute.

2. Proposal for action

The study programme will be based on measurements of the basic properties of plutonium compounds, on observations and analyses of irradiated fuels and on irradiations in instrumented capsules. The effort will be concentrated on three specific aspects of fuel behaviour:

(i) thermal properties will be studied with the aid of in-pile conductivity measurements and hot-cell measurements on irradiated fuels. These investigations will be supplemented by fundamental studies on energy-transfer mechanisms, which will be carried out on non-irradiated materials (thermal conductivity, optical properties);

(ii) the chemical effects (segregation and migration of the constituants and fission products) will be studied by point analysis of irradiated fuels. These observations can then be interpreted in the light of fundamental studies on non-irradiated materials (phase diagrams, thermodynamic properties at very high temperatures) and, possibly, simulation experiments;

(iii) swelling will be studied by electron microscopy with a view to obtaining a better insight into the basic mechanism of this phenomenon than is possible with dimensional inspection. These investigations will be backed up by determinations of the local fission-gas concentrations. A study of the chemical state of the solid fission products and their influence on the specific volume of the fuel material will make it possible to assess the part they play in the swelling phenomenon.

For the rest, the scientific supporting activities (production of samples, chemical analysis of plutonium compounds or irradiated fuels) will depend on the basic programme previously defined. Nevertheless, the significance of some of these activities goes beyond this framework: in particular, the determination of the exact burn-ups of fuels irradiated under a fast-neutron flux — a sector which calls for an experimental programme of some magnitude — will provide the neutron physicists with a means of verifying their calculated data. In addition, some of these activities will benefit other services of the Commission or other Community organizations.

Finally, the research programme on transplutonium elements will constitute a continuation of the programme for the study of the basic properties of solid plutonium compounds. Other investigations will relate to methods of recovering the heavy elements present in the scrap produced by the fuel reprocessing plants.

3. Funds necessary for the implementation of the proposed measures

Budget appropriation: 25.3 million u.a.

Personnel: 220 (approximately 10% of this personnel could be seconded to the "Transplutonium Programme").

III. PUBLIC SERVICE ACTIVITIES

III.1. Central bureau for nuclear measurements

1. Justification of Community activity

The setting-up of the Central Bureau for Nuclear Measurements, as laid down in the Treaty, stemmed from the need for the Community to have a centre for nuclear parameter measurements, standards and the production of reference samples.

The activities of this Bureau have expanded to keep pace with the development of more advanced techniques and the increasing number of new requirements.

This type of activity is not carried on anywhere else in the Community with regard to the creation of standards for nuclear commerce, science and industry, existing only to a very limited extent in those spheres of nuclear activity which are chiefly concerned with reactors.

1.1 *Standards bureaux*

Apart from the CBNM there are three "classical" metrological laboratories in the Community, namely the International Bureau for Weights and Measures at Sèvres, the research laboratory at the Conservatoire National des Arts et Métiers, Paris, and the Physikalisch-Technische Bundesanstalt at Braunschweig. The first (a team of 25 persons) is responsible for establishing and preserving basic standards, its main interest being radioactive sources, X-rays and neutron sources. The second (also a fairly small team) operates in collaboration with the first in the last-mentioned field of study, but is chiefly concerned with covering a range of classical magnitudes. The third is a large organization (1 100 persons) dealing with the same magnitudes but concentrating, in the nuclear field, on the dosimetry of neutrons and gamma rays (especially inside reactors). The institute is equipped with a measurement reactor for this purpose. Calibrated sources of radionuclides are also prepared here.

1.2 *Laboratories performing measurements required for reactor calculations*

Those in Karlsruhe, Saclay and Cadarache are the most important. There are others where measurements of this type are carried out occasionally. They are represented, directly or indirectly, on the Euratom Committee for Nuclear Constants,

where projects are co-ordinated to a certain extent, and their progress reports are published in the "Progress Report on Nuclear Data Research in the European Community".

2. Proposal for action

The CBNM's main activities revolve round the definition of nuclear standards and the measurement of neutron physics data. These are to be continued.

Operations in the neutron physics sector, including the use of a Van de Graaff and a linear accelerator, are centred on measurements required for reactor calculations. Requests submitted by reactor constructors for neutron physics data cover the 0-20 MeV energy range. The present accelerators do not cover the 2.3-4.0 and 5.7-15 MeV ranges for scattering measurements and the 6.2-12.6 MeV range for activation measurements.

As the interest of design offices concerned with fast reactor calculations is shifting towards these inaccessible zones, the need for a new accelerator to bridge the gaps is evident.

The main activities in the sphere of radionuclides consist in the standardization, improvement and development of measuring methods and the precise determination of nuclear constants.

A further field of activity concerns the determination of isotopic ratios, which must be known for all stages in the fabrication of reactor fuel elements. In addition, samples required both for the CBNM's own projects and for others are analysed.

In order to meet the internal demand as well as that of the Community's nuclear industries and laboratories, the CBNM has set up a central laboratory specializing in the preparation of highly sophisticated samples.

Logic dictates that the CBNM's further development should now be orientated towards expansion into the non-nuclear sector in conjunction with the creation of the Community Bureau of Standards. Activity in a non-nuclear field could begin with technical back-up for the Commission's own departments and the preparation of reference samples for other parties, using techniques already in existence.

3. Resources required

The action to be taken is of the direct type.

The Community's needs are continually expanding and in order to meet these requirements a normal step would be to provide for the recruitment of more staff, which could then make better use of the investments already made.

It would also be necessary to improve the characteristics of the linear accelerator, to acquire a new accelerator to satisfy the CBNM's need for neutrons with an energy range of 6-12 MeV and to bring about a certain degree of modernization of equipment.

In view of the wide range of the Community's commitments and the various contacts set up with the national authorities of the Member States, it would appear best to limit the proposed measures to a modest increase in manpower to staff the new accelerator.

Proposed staff: 180 on average.

Budget: 24.9 million u.a.

III.2. CETIS

1. Aims and description of activity

CETIS, the scientific data processing centre, has been in existence since the creation of the Ispra Establishment and has proved to be an indispensable instrument in the fulfilment of the latter's tasks. It has been able to satisfy the Commission's specific requirements and to render to numerous public and private organizations in the Member States appreciable assistance with regard to the application of information science in a wide range of activities.

It is proposed that this activity be continued along both lines, as a tool in the hands of the Commission for use in carrying out the research programme and as a public service for other parties, including administration work for the Commission. It is also intended that this latter aspect of CETIS activity should be extended to incorporate the task of setting up a general library of computer programmes covering the scientific fields in which computers are used, which would centralize and disseminate programmes and information relating to their uses.

This activity includes the collection and dissemination of programme descriptions, the translation and adaptation of these to suit different computer types, consultation as to the choice of programme for treating a particular problem, etc.

Finally, there is the proposal to conduct a pilot remote information-processing experiment by connecting up different computers within the Community to form a single network on the model of electricity-generating stations. The result would be an improvement in the average utilization of computer facilities and an increase in the machine capacity available to each user.

2. Incorporation in the Community framework

In the case of the programme library, there is no comparable activity in existence in Europe. The ENEA library installed at the Ispra Establishment is restricted to the field of reactor calculations and is not required to act as a consultation service for users.

Certain projects undertaken in the Community and elsewhere are limited to very specific sectors; hence the active interest shown by numerous research centres, institutes and industrial firms in the creation of a European programme library of this type. It should be emphasized that the PREST group has recognized the front-rank nature of this work, and several delegations from this group have recommended that the library be set up at Ispra. Opinion within the PREST group was also favourable on the question of the pilot remote information-processing network, which, by virtue of its multilateral nature, should be planned on the scale and within the framework of intra-Community collaboration. It is worth noting that experience in this field is virtually non-existent within the Community, apart from the Ispra-Geel and, previously, Ispra-Brussels tie-ups. Several delegations have suggested that Ispra should be the focal point of such an experiment.

3. Resources required

It is considered that this activity requires an average staff of 117 and a corresponding budget of 8.5 million u.a.

In addition, a third-generation computer, with a capacity equivalent to that of an IBM 360/65, should be made available to CETIS. The choice will be in favour of a machine designed and built in Europe. The cost of purchasing such a computer and operating it over a period of five years is estimated at 9 million u.a., of which 80%, i.e. 7.2 million u.a., would be covered by the present programme (the balance being made up from the information-processing project).

It is also intended to install a hybrid computer with capabilities similar to those of the PACE EAI 8800.

The cost of this machine is estimated at 0.7 million u.a., of which 80%, i.e. approximately 0.6 million u.a., would be covered by the present programme (the balance being made up from the information-processing project).

Total cost: about 16.3 million u.a.

III.3. Development of fissile material inspection techniques

1. Nature of the activities

Owing to the marked increase in the amount of fissile materials in circulation, together with the development of power reactors and ancillary installations relating to the fuel cycle, the problem arises of optimization of the inspection techniques now used by the Commission. This is a function laid down by the Treaty and it is essential to reduce its cost to the minimum, since it constitutes a burden for the whole Community.

2. Justification for Community action

The Community's 1969 research programme includes further work on the development of fissile material safeguards and controls. These operations, which are for the most part being carried out by the JRC, and more particularly at Ispra, are closely linked to the research conducted by the Gesellschaft für Kernforschung, Karlsruhe. The activities in this field of CEN, Mol, are being pursued in collaboration with those of the GfK.

The arguments used to justify the inclusion of this point in the 1969 programme warrant the continuation of the work on a Community basis.

3. Proposals for action

The aim is to develop inspection systems which are satisfactory as regards reliability, economy and the guarantees they offer, while avoiding interfering with industrial activities as far as possible.

In this context, the Commission plans to continue for the period 1970/74 with the programme concerning:

— the improvement of fissile material inspection methods. This includes the use of systems analysis for the continuous study of procedures and the development of experimental methods for non-destructive measurements of the fissile material content in characteristic samples taken from different stages of the fuel cycle. This research will be conducted within the JRC, mainly at Ispra;

— the extension of the agreement for co-operation drawn up with the GfK in 1969. As is already known, the programme of this body is centred on demonstrating the validity and conditions of use of a method based on the concept of inspections at pre-determined strategic points. This agreement could be extended to other programmes carried out by certain Member States, with a view to co-ordinating all Community research in this field.

4. Funds required

This is a joint action carried out at Ispra on the one hand and co-ordinated with that of the Member States on the other.

It was suggested previously that this activity should be transferred to the Operating Budget. To avoid the disadvantage of having employees under different statutes of service in the same laboratory, it would seem more convenient for the funds to be paid back into the Research Budget from the Operating Budget.

Number of staff planned:

— Officials engaged on research at Ispra	37
— Officials engaged on the administration and co-ordination of the overall programme	3
	40

The necessary funds break down as follows:

— Direct action:	
— Work carried out at the JRC (staff + cost of minor equipment)	3 million u.a.
— Administration and co-ordination (officials at Headquarters)	0.2 million u.a.
— Indirect action:	
— Co-ordination with national programmes	for reference only
Total:	3.2 million u.a.

III.4. Nuclear plant safety

1. Review of the present situation

In the use of nuclear energy for peaceful purposes an exceptionally high standard has been reached in the prevention of accidents, in the limiting of their consequences and in surveillance techniques. However, the lack of specific knowledge on numerous phenomena has resulted in the adoption of safety margins which are frequently excessive and could have adverse effects on the economy of the plants built. There is no doubt that costs could be cut considerably if better knowledge of the actual dangers and their consequences were available.

Apart from problems common to most or all reactor types, each particular model presents its own special ones. Rivalry between different systems and the speed of technical developments are such that promoters are compelled to concentrate on obtaining construction and operating permits from the appropriate bodies. They therefore only concern themselves with the problems which are peculiar to their particular type and can be solved relatively quickly.

In addition, the disparity of the criteria on which evaluation and legislation in respect of reactor safety are based in the different Community countries is liable to prove a real obstacle to the setting up of a true nuclear common market. It is felt to be necessary to standardize the format of safety reports, on the study and approval of which the granting of construction and operating permits is contingent. This measure should be supplemented by an attempt to bring into alignment methods for the testing, inspection and quality control of equipment for use in nuclear power plants, etc.

Mention should be made in this connection of the use of reliability methods for studying reactor safety. This is based on quantitative concepts of the reliability of structural components (electronic, electromechanical and mechanical) and the likelihood of their failure. The development of this methodology is only in its infancy. Its use should lead to major savings both in capital costs for reactors and in insurance premiums covering nuclear hazards.

2. Proposals for action

Apart from activities aimed at dovetailing methods of assessing nuclear power-plant safety, which could be supplemented by efforts to standardize component acceptance procedures and is dependent on industrial promotion, the programme is concerned with:

— Direct action at Ispra, using the existing personnel. This would deal with problems of general interest, aimed at cutting costs in several or all types of reactors. without affecting the standard of safety hitherto maintained. It would involve the study of the mechanical properties of materials subjected to dynamic stresses, vibration phenomena, the atmospheric dispersion of contaminated gaseous waste, the propagation of pressure waves following accidents, probabilistic systems analysis, etc. This kind of work, which requires highly specialized equipment and techniques and sometimes may bear fruit only in the distant future, is hardly a feasible proposition for any one promoter or reactor constructor.

— The provision of information, especially on the reliability and space dynamics of power reactors. As regards reliability, a system is to be set up for centralizing, listing and classifying reports on accidents and equipment failures, this over the longer haul providing statistical data on power plants.

3. Incorporation in the Community framework

The safety studies planned for the JRC are directed at one specific reactor type or another and have been fitted into the corresponding programme. The activities dealt with in this chapter relate only to problems of general concern. They have been discussed by experts from different countries who have, on the whole, shown interest in these operations.

Finally, if power plant operators in the Member States collaborate in the setting up of a data bank on component failure, this can only speed up the process of obtaining statistical data. Having regard particularly to the CETIS facilities, it is proposed that Ispra should be in charge of the centralization of these operations.

4. Funds required

An average staff of 47 and a corresponding budget of 3.8 million u.a. have been earmarked for this project.

III.5. Biology — Health protection

1. Aim, description of the activities and incorporation in the Community framework

The Commission's proposals for a multiannual nuclear programme in the field of biology and health protection are directed towards the two following objectives:

— study of radiation hazards (Radiological Protection);

— development of nuclear techniques for application to medical and agricultural research (Adaptations).

The development of research and of technological and industrial nuclear applications calls for knowledge of the hazards to man and living organisms from radiations and radioactivity and of the means of reducing them and combating their effects. The Euratom Treaty requires the Commission to draw up basic standards for the Community relating to health protection in the face of radioactive risks. This task cannot be properly discharged without the aid of massive and detailed research, highly specialized equipment and an attendant staff of qualified scientists. Any system of regulations and any policy of harmonization at Community level must be founded on a common scientific basis.

The programme of the radiological protection sector includes the study of the mechanisms of contamination of man and the environment and of the various effects of radiations — hereditary, short-term and long-term, together with the dosimetry of radiations and radioactive substances and the measurement of their direct consequences. This programme implements the general guidelines and conclusions formulated by the ad hoc "Biology - Health Protection" group of the CCNR at its meetings on 14 May and 5 June 1968.

Nuclear techniques have contributed decisively to the progress of the biological sciences, including medicine and agriculture. Now that the production of nuclear energy properly depends increasingly upon large-scale industrial development and that the search for additional benefits is acquiring growing importance alongside the mere immediate need for usable reactors, it is essential to employ the facilities and manpower already available at the nuclear centres, including those of the Community, for the benefit of subjects such as agriculture and medicine, whose social and economic importance is no less than that of energy production. In proposing an "Adaptations" programme, the Commission is endeavouring to use the costly instrument of nuclear research to assist agricultural and medical research

by developing new methods, opening up new avenues and perfecting new products and devices until their value is proven; it hopes also to prevent these activities becoming fragmented.

2. Funds required

An average staff of 63 would be assigned to direct action at Ispra in the field of radiological protection, including the appropriate proportion of the general services; the cost would be five million u.a., plus two million for the construction and operation of a special device (accelerator for the production of monoenergetic neutrons, specially designed for radiobiological research). There would also be a headquarters staff of 15, with a budget of one million u.a. A further staff of 34 and a budget of 30 million u.a. would be required for indirect action.

III.6. Applications of radiations and radioisotopes (Eurisotop Office)

The activities of the Commission in this field include the following:

(i) the promotion and publicizing of industrial applications of radiations and radioisotopes;

(ii) the creation of non-technical conditions (training of personnel, legal, social and psychological aspects) for the introduction of these processes into industry;

(iii) the promotion of the development of application techniques.

These aims will be pursued by the following means:

— loan of the Commission's services, such as technical advice, the creation and publication of technical and economic information media, the organization of conferences and the execution of specialized studies;

— concertation of the efforts of specialized organizations and experts to solve problems requiring Community-level collaboration;

— co-ordination of national activities so as to avoid useless duplication of work and to ensure a balanced development of all techniques.

The activities of the Eurisotop Office, which are directed towards increasing the technical and economic potential of the Community's industry and towards widening and adding to the effectiveness of the national efforts, are receiving the support of industry and of the various national organizations within the Community. Both circles are regularly informed of the progress of its work.

These activities, which are on the borderline between research proper and industrial promotion work, help to facilitate the acquisition and better utilization by industry of the knowledge and techniques resulting from research. Their proper place would no longer appear to be in the joint research programme.

The Commission will therefore ask for nine items on the Research Budget to be transferred to the Operating Budget in order to finance this activity and also for the inclusion of a small sum in the Research and Investment Budget to cover certain studies still required.

III.7. Dissemination of information (CID)

1. Nature of the activities

The CID activities can be divided into three fields, namely publications, libraries and documentation.

These are not research activities in the usual sense of the term, but rather work to back up the Community's scientific and technical activities.

The automation of documentation is becoming more and more important because of the vast increase in the amount of information to be analysed, stored and retrieved in order to satisfy the demand.

2. Justification for Community action

Now that all Community activities are to be concentrated in a single organization, it is logical to consider a similar concentration of all the activities concerned with the dissemination of information. These constitute a permanent project of the Commission which extends beyond the bounds of strictly nuclear activity.

Apart from the obligation laid upon it by the Treaty, the Commission thinks that it would be worth while expanding the present facilities for the dissemination of information and that documentation systems should be automated at the multinational level before this is done at the national level. For this reason it intends to impart some of its technical knowledge to the International Atomic Energy Agency in order to help it to set up the INIS project.

At the same time it should be emphasized that the Agency will not be able to provide the literature search services which the Commission can offer Community scientists.

3. Proposal for action

It is planned to continue the present work of publication and library management. As regards documentation it is proposed:

(i) to continue the work in the nuclear sector;

(ii) to extend it to high-priority non-nuclear sectors in step with the Community's entry in these fields;

(iii) to initiate an information project aimed at sponsoring the use of modern documentation methods within the Community.

4. Funds required

Being of the "direct action" type, the activity could be financed from the Operating Budget.

In view of the extension and diversification of the activities, a slight increase in staff will be necessary, the average figure being raised to 119. The budgetary appropriation is estimated at 12 million u.a.

III.8. Education and training

1. Nature of the activities

In the field of training, the Commission is restricting itself to an activity of supranational scope, consisting essentially in promoting advanced training courses and the preparation of dissertations in centres situated outside the candidate's country of origin, and in furthering the harmonization of nuclear training courses. Lastly, like all scientific institutions, the Community has a duty to improve the training of its scientific and technical staff.

2. Justification for Community action

The Community must create conditions facilitating the free movement of nuclear workers. It is therefore bound to make every effort to enable them to live abroad during and after their training with the minimum of complications.

3. Proposal for action

The Commission intends to continue to provide training courses and grants and to train staff and standardize nuclear education. In the last-mentioned field, it intends to step up and systematize co-operation with training establishments.

A further development might consist in the creation in the JRC establishments of units for specialized training and refresher courses for graduates of universities and institutes of technology; this expansion is a subject which could be discussed apart with the Member States, particularly if the activities were not limited to strictly nuclear fields.

4. Funds required

4.1 Form

The Treaty establishing the EAEC laid down, notably in Article 7, the execution of research and training programmes in the Community. Training programmes, by their very nature, must be classified under direct action. Training courses and grants, regardless of the host organization, and harmonization and training programmes are under the direct control of the Commission's departments.

4.2 Personnel and budget

It is proposed to assign an average staff of nine to this activity with a budget of seven million u.a.

III.9. High flux irradiations

1. Nature of the activities

The development of reactors is mainly dependent upon the behaviour of the fuel elements and structural materials. In order to increase the available knowledge on this subject it is necessary to perform high flux irradiations, since *in situ* exper-

imentation (although essential) takes up too much time and can entail outage risks which are unacceptable to operators. In addition, studies must be carried out on the irradiation properties of the materials which will be used in future reactors (advanced convertors and breeders).

Irradiation properly speaking also involves the development of irradiation devices, dosimetry and analysis in hot laboratories.

2. Justification for Community action

It is understandable that each State should have provided itself with test reactors and associated laboratories aimed specifically at the study of the reactor types developed at the national level. However, the position in the Community with regard to reactors shows that these methods lead to duplication of work.

Once there is agreement on the need for pooling of resources and co-operation between Member States in the power reactor field, it is logical to adopt the same approach in the case of irradiations. However, the positions taken up suggest that such pooling will be difficult to bring about here.

As regards the two high flux reactors of which it is the owner or co-owner, the Commission thinks it expedient to continue to participate in their operation while at the same time trying to ensure the necessary co-ordination. In this field consultations have revealed general agreement as to continuation of the previous activities of the working groups. Meetings of these groups, limited to specialists, have enabled the problems and difficulties encountered to be discussed.

Contacts with national authorities have shown the interest which some of them display in these two reactors, and more particularly in the development of fuels for the high-temperature (HFR) and fast (BR-2) types.

3. Proposal for action

The proposed activities can be divided up as follows:

(i) co-ordination work on irradiation devices, hot laboratories and dosimetry;

(ii) operation of the HFR and BR-2.

The co-ordination activities will be continued in the same form as hitherto.

The performance of the HFR will be improved in accordance with the increase in its power (to be raised to 45 MW following the modifications to the core).

The problem of the future of the HFR is linked to its use for contract work. At Petten a certain potential has been built up around this reactor, which is an instrument for the irradiation of fuel or structural materials, particularly those designed for high temperature reactors. (The HFR temperature range is from 200 to 1 500°C.) There is a wide range of irradiation devices available for this purpose.

As regards the operation of the BR-2, an examination of various possible solutions leads to the following conclusions:

— the maintenance of the association in its existing form does not seem desirable; simple termination of the contract raises delicate problems as regards the assessment of the residual value of the investments (There would be similar problems with other associations.);

— the creation of a joint enterprise will not have the support of the other co-owner. The qualifications of the personnel which the Community has assigned to this association make the maintenance of the association essential to operation. There are two possible solutions as regards what the Community may desire in return — repayment in cash or in services.

In view of the value of this reactor, especially for the irradiation programme of the Institute for Transuranium Elements, the Commission prefers the second formula and would like to obtain irradiation rights, with free neutrons, in accordance with its own participation. An appropriate agreement is now being studied and should be drawn up by the end of 1969.

4. Funds required

4.1 *Form*

The co-ordination work is of the indirect type, while the reactor operation activities come under the heading of direct action, including the BR-2, in view of the manpower provided by the Community.

4.2 *Duration*

Co-ordination is by its very nature a permanent activity, but on the other hand, the Community's direct action in the field of irradiation matters might conceivably be limited in time. In the light of this it is felt advisable, for the next five years, firstly to consider whether the interest in the HFR is likely to be maintained having regard to actual needs and possibilities, and secondly to envisage co-operation on the BR-2, on the understanding that the Community staff would be gradually reabsorbed.

4.3 *Personnel and budget*

The co-ordinating activities come under the Community's Operating Budget.

As regards the HFR reactor, it is proposed to extend the operating contract with the RCN and to maintain a Community staff of 70 for setting up and conducting experiments (including the pro rata proportion of the general services).

A staff of 40 is at present attached to the BR-2. Allowing for a gradual rundown, which should not be commenced until after replacements have been recruited and trained, the average staff for the five-year period is estimated at 20. There is nothing to prevent the other party from recruiting staff from among the Community personnel if conditions are favourable.

The budgets are as follows:

HFR: 19.5 million u.a.

BR 2: 1.4 million u.a.

(less the revenue, which will be set against these sums).

III.10. Contract work against payment

1. Nature of the work

In the last few years nuclear energy has moved progressively from the stage of basic and oriented research to that of industrial development, particularly in the field of reactors and the fuel cycle.

While the first stage must usually be financed entirely by the national and/or Community authorities, it is obvious that private industry should gradually enter the field and bear enough of the risks to justify the subsequent profits.

Since basic research is publicly financed, its results must be available to all taxpayers. On the other hand, when a government, a group of governments, an enterprise or a group of enterprises arrange for certain work to be done by a laboratory, they pay for this work in order to keep the results to themselves, at least in part.

2. Justification for a possible activity of this kind

The Community has spent a considerable amount of money on providing itself with laboratories and staffing them with specialized teams. Both the personnel and the installations are of the highest calibre and capable of contributing to the development of a powerful nuclear industry within the Community. They would enable the Community to avoid useless complications at the level of industrial development.

Industry is gradually becoming aware of the potential which the JRC establishments represent. The Union of Industries of the European Community (UNICE) and the "Atomic Forums" have made known their desire for the JRC to be used for the benefit of their members, and various industrialists have expressed the wish to entrust work to it. The main obstacle to projects of this kind would appear to be the high cost. The Commission thinks that formulae must be found to facilitate such projects and intends to submit a memorandum to the Council during the summer on the question of price scales.

The Member States are, moreover, adopting similar policies at a national level, ranging from the execution of work at reduced prices to the inclusion in research establishment programmes of work likely to promote industry and assist national electricity producers. The fixing of price scales below the overall cost constitutes a form of assistance to the national industry and a protection against competition. An extrapolation to the Community level would be warranted and would, in fact, merely be an application of the common market concept.

3. Examples

a) *Assistance to nuclear power plant operators*

The JRC might provide services in the following sectors in particular, which have been agreed with the operators of power plants in the course of consultations organized by the Commission:

— development of methods and equipment for inspection and maintenance with a view to on-site examination and repair of the strictly nuclear parts of power plants (visual examinations inside the reactor, TV cameras operating under gamma flux, etc.); post-irradiatory examinations (metrology on active materials, in-cell metrology of surface states, in-cell neutron radiography for the non-destructive examination of dense structures such as fuel bundles, etc.);

— training of specialists sent by the power plants;

— studies aimed at the detection of abnormal vibration in components (noise analysis, control of structural weakening, etc.);

— physicochemical behaviour of light-water reactor coolants (fouling, purification);

— fuel-management calculations, for research into optimum operating conditions, particularly with a view to ensuring greater independence of operators with respect to fuel suppliers.

b) *Nuclear marine propulsion*

The proposed activities would be of three types, to be carried out with the Commission's help by a multinational group of organizations interested in nuclear propulsion, and would cover a period of three years.

The Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt (GKSS), the Reactor Centrum Nederland (RCN) and Fiat, who are already active in this field, have said that they are ready to conclude a "multilateral agreement for co-operation" under which they would each undertake to carry out a research and development programme at their own expense. However, the various parties concerned have made it clear that they will sign this agreement only if the direct or indirect activities mentioned below are actually performed. The subjects of the programmes will be agreed on by a co-ordinating group in which the Commission would be represented, and the parties to the agreement would exchange all the results and information deriving from their work. The financial contribution of the Commission to the activities covered by this agreement would be nil.

The activity of the JRC would consist of research and development work in support of these efforts. It would centre on research into reactor physics (burn-up and shielding codes, thermodynamic, hydrodynamic and neutron physics problems, etc.), technology (thermohydraulic and neutron physics problems, mechanical behaviour of structures and components), and materials (burnable poisons, stress corrosion, etc.). These activities form the subject of a specific request from the above-mentioned group and might require a staff of about thirty.

Participation in the operation of the "Otto Hahn" would cost about 0.35 million u.a. per annum.

In return the GKSS would make available to its partners the results of the experimental and research programme to be carried out on board.

A consultative body would be created to co-ordinate the three types of activity, together with sub-committees to study general problems (economic aspects, insurance, entry of ships into ports, etc.).

c) *Development of heat exchangers for the desalination of sea water*

The aim would be to develop heat exchangers with plastic transfer surfaces. The attraction of these exchangers lies in their low cost and their good resistance to corrosion and fouling. Preliminary creep tests on plastic materials for this purpose have already been begun at Ispra.

d) *Development of heat exchangers for using nuclear heat in the iron and steel industry and for the gasification of fossil fuels*

The aim would be to study heat exchangers coupled to a high-temperature gas reactor, with a view to using the nuclear heat for the reduction of iron ores and the production of starting materials for the chemical industry.

e) *Possible contributions in fields of advanced technology*

— Development of impregnated graphites

The Ispra Establishment of the JRC has acquired special knowledge concerning the impregnation of graphite with metal and the preparation of prototypes of semi-products by this process. This knowhow can be put to use in developing prototypes of simple low-cost fuel elements.

— Development of energy sources for oceanographic measuring stations (buoys)

This activity might be undertaken as part of a joint programme, recommended by the PREST "Oceanography" group, for the installation of a network of oceanographic measuring stations.

— Contribution to the development of a sodium magneto-hydrodynamic (MHD) electrical generator

Contributions to the design of a MHD generator, such as that of AEG-Telefunken, can be made in the field of two-phase or alkaline metal flows.

— Contribution to the development of thermionic reactors and radioisotope generators

For the last eight years the Ispra Establishment has been carrying out basic work on the development of thermionic converters and components of thermionic reactors for use in space research.

Limited studies have also been undertaken on the application of radioisotopes to thermo-electric converters.

Below is a list of research subjects suitable for contract work:

— study of the physics of thermionic converters with the aim of improving their electrical behaviour;

— development of metal-ceramic joints for high temperatures;

— irradiation of thermionic converters and suitable nuclear fuels;

— development of radioisotope generators for use in space research;

— development of miniature atomic batteries for use in biomedicine.

— Development of heat pipes

Work on heat pipes in the Community began at the Ispra JRC and has been continued there up to the present.

Help might be given on the following subjects:

— improvement of the methods of designing heat pipes and experimental support;

— development of high-performance heat pipes (high temperatures, intense heat flux, good stability);

— study of the application of heat pipes to space flight.

— Analyses of irradiated fuels

Such analyses are at present being performed at the Institute for Transuranium Elements.

4. Funds required

The types of work to be carried out on request and against remuneration cover a very wide range. It is therefore impossible to set up a permanent team for such work. On the other hand, this activity is useful and has been recommended and even requested by the Council on several occasions.

The need is therefore to create a flexible and efficient machinery both at the operational and at the administrative level to enable a judicious choice to be made between the requests submitted. The first criterion is clearly the material feasibility of carrying out the work with the manpower and facilities available to the JRC.

The Commission should be allowed a certain flexibility (e.g. 5%) in the assignment of staff to the various parts of the programme; it would then be able to allot the minimum necessary personnel to the projects carried out on request. In addition, for projects of major scope and duration the Commission would be free to recruit a limited amount of temporary (unestablished) staff, the cost of which would be borne entirely by the client.

Strictly speaking, such an assignment of staff might be regarded as a programme modification requiring observation of the normal procedures, but the need for an ad hoc Council decision for each request would obviously make the operation almost impossible. The Commission therefore proposes that it should be granted a general authorization (for up to 5% of the staff), on condition that an annual report be submitted to the Council on the projects carried out.

The Commission proposes the creation of a special account for the expenditure and revenue relating to the work done. The balance would be deducted from the contribution of the Member States or used to build up working capital.

From the administrative standpoint, this work would require very close contacts between the client and the group doing the work. In addition, a Consultative Programme Committee comprising representatives of the Member States and multinational trade and industrial bodies would help the Commission to determine any necessary priorities, ensuring a reasonable balance in support to the industries of the various Member States and controlling the correlations between prices and the dissemination of information.

IV. FUNDAMENTAL RESEARCH

IV.1. Fusion and plasma physics

1. Nature of the activities

The ultimate goal is the industrial-scale production of electricity, under conditions of competitivity, by making use of nuclear reactions between light nuclei. Present studies show that this is technically feasible, provided that solutions are found to certain physical problems, and research to this end is being conducted in the laboratories of the main countries of the world. It is essentially a question of bringing about the confinement of the plasma in sufficiently stable configurations. The necessary physical parameters (magnetic field, temperature, plasma density, confinement time) are now fairly well defined and it seems possible to achieve the confinement time even without perfect stabilization.

Research is progressing on several types of configuration. Open configurations do not appear capable of fulfilling the necessary conditions, unless methods of improving their confinement at the extremities are found (use of "high-frequency plugs"). Closed configurations, which are more complex, costly and difficult to produce as regards both the magnetic field and the hot-plasma filling, enable the necessary conditions of prolonged confinement to be met. Another approach, the practical adoption of which calls for substantial technological developments, is the use of very high-density plasma. Possible applications in other areas of science and technology will not be ignored either.

2. Justification for Community action

In accordance with the provisions of the Treaty the Commission has for the last ten years played an important role in the development of this activity at the Community level and intends to continue doing so.

The measure of co-ordination that has so far been attained in the tasks of the associated laboratories — and in this field the Community's effort has been comparable with that of the major powers — must be stepped up further now that the

aims have been defined more precisely. The Commission feels that it is strengthened in this role by the unanimous agreement of the CCNR ad hoc working group and of the various organs of the Council.

The Commission proposes to sustain its part through the personnel seconded to the Associations, through financial participation and through organizational links (Steering Committees, Board of Management, Liaison Group and Working Groups).

3. Proposal for action

The Community programme will embrace the following activities:

— study of the closed-configuration confinement of plasmas whose density and temperature can be varied over wide ranges;

— study of the phenomena which are of a fundamental nature or are relevant to the confinement, with the aid of easily constructed devices, e.g., diffusion through magnetic fields, drift waves, etc.;

— plasma production and heating methods, in particular "plasma—high frequency" interaction, study of the possibility of improving the confinement by means of high-frequency fields, etc.;

— production and study of high- and very-high-density plasmas by laser or magnetic compression;

— improvement of the diagnostic techniques and study of the related problems raised by the research currently in hand or planned.

4. Funds required

Indirect action is concerned here.

The total budget of the Associations for the five-year plan will have to amount to about 150 million u.a. On this basis the Commission's appropriation should be in the region of 45 million u.a.

The personnel should be increased on average to 94. Furthermore, in order to promote international exchanges of personnel between the various Associations, it is necessary to create 10 temporary posts for a period of one or two years or to provide for some other equivalent solution. In view of the general limitation of the number of posts, it seems that this problem could be solved by instituting a system of special allowances.

In accordance with the recommendation of the ad hoc Group, it would also be advisable to set up a reserve to cover any large-scale operation that may become necessary in the next five years. In addition, provision must be made for the possible transfer of a small part of the work on very-high-density plasmas to a nuclear technology centre, should the quantity of neutrons produced give rise to problems of application and shielding.

IV.2. Condensed-state physics and SORA

1. Nature of the activities

That branch of physics which is concerned with the study of the properties of condensed matter (solids and liquids) and the mechanisms of the phenomena that

take place in it has made spectacular progress in recent years, having led to the discovery of new materials, such as the semi-conductors, which have revolutionized numerous fields of technology.

Moreover, it has been found that the inelastic scattering of neutrons can provide the necessary information for a better understanding of matter in the condensed state. The neutron fluxes employed must be very intense and as free as possible from major gamma fluxes.

These requirements led to the concept of pulsed reactors, the advantage of which is that they enable the optimum use to be made of certain measurement techniques. This applies in particular to the "time-of-flight" technique, with which almost "monoenergetic" neutrons can be used. Consequently, the instrumentation associated with pulsed reactors is of a different kind. In addition, these reactors enable extremely high flux peaks to be attained at a very modest power. Pulsed reactors are complementary to steady-state reactors and serve to extend the field of research.

2. Present status of the work

Intensive research is in progress in all the Member States, but particularly at the Jülich, Saclay, Karlsruhe and Grenoble research centres. At Grenoble a high-flux reactor is being built under a Franco-German agreement for co-operation (Max von Laue - Paul Langevin Institute).

In the USSR, a pulsed high-flux reactor in which relatively high-frequency neutron pulses are generated has been operating for over seven years at Dubna. The average power of this unit is now being increased from about 1 to 30 kW. According to information published in January 1969, a more powerful pulsed reactor (average power 4 MW) is currently being designed with a view to possible construction at Dubna.

In the United States, construction work on a very-high-flux reactor at the Argonne National Laboratory has been stopped owing to technical difficulties. This was a reactor with a steady neutron flux. Another pulsed reactor, with an average power of 30 MW, was planned for construction at Brookhaven National Laboratory and was scheduled for start-up in 1979. This project is to be abandoned at the end of June 1969, apparently as a result of the technical difficulties presented by the construction of such a high-powered unit.

3. Justification for Community action

In view of the medium-term advantages to be gained from studies in condensed-state physics and of the necessity to have a pulsed reactor available for these studies, the Commission proposes that Community activity in this sector be continued and that such a reactor be provided, this being the most suitable instrument for modern research methods.

Numerous discussions with the competent officials of the Max von Laue - Paul Langevin Institute in Grenoble have confirmed that the two reactor types are complementary as regards both their inherent characteristics and the experimental techniques planned.

Moreover, since this activity comes within the category of fundamental research necessitating facilities for advanced nuclear technology, it should be carried out at a research centre possessing a sound technological infrastructure. A further requirement is the propinquity of university institutes specializing in solid-state physics. For these reasons the Commission proposes the construction of the SORA reactor at Ispra.

4. Aim and description of the proposed activities

The SORA project has been the subject of detailed studies and of certain experimental tests on which the Council has already been informed. The average power of this reactor would be 1 MW, the pulse frequency of the neutron flux 50 cycles per second and the maximum instantaneous power about 300 MW. The construction of SORA could pave the way to that of a more powerful unit, the need for which is already being stressed by all physicists.

The fact that elsewhere in the world work on other installations intended for similar purposes has been delayed or abandoned, because they were technically over-ambitious, renders the SORA project of particular topical interest. The execution of this project should go hand in hand with an intensification of the work on solid-state physics now being done in the Community. In this spirit, all necessary steps should be taken to make this advanced tool accessible to all physicists in the Member States.

During the construction of SORA the transition will be helped by the continuation of the research already begun, especially in the following sectors:

— defect dynamics, impurities, dislocations and radiation-induced damage;

— liquid dynamics;

— slow molecular movements in solids;

— phase changes;

— thermalization studies.

These investigations, which make up a co-ordinated whole, are being carried out with the aid of the Ispra-1 reactor and the Van de Graaff accelerator, as well as of the techniques and instrumentation already developed at Ispra (neutron physics and magnetic resonance).

5. Funds required

For all these operations it is proposed to assign a staff of 180, including a team who will be responsible for the construction, for supporting studies and for the preparation of the SORA experiments. The corresponding expenditure will amount to 13.6 million u.a. plus the cost of SORA itself, which is estimated at 16.1 million u.a., including the first fuel charge.

V. NON-NUCLEAR SPHERE

Introduction

In the nuclear world the general progress of reactor technology tends to narrow the field of activity of the public research centres, while industry takes on more and more activities. This fact — the logical result of nuclear energy's technical coming-of-age — must sooner or later entail a switching to new activities of that fraction of the existing research potential that can no longer be employed for nuclear purposes. In certain countries, such as Britain and the United States, this switch has already begun. The time has come to apply a similar policy to the Joint Research Centre. The Council has therefore more than once declared itself, in its Resolutions of 8 December 1967, 28 November 1968 and 20 December 1968, in favour of an investigation into non-nuclear activities that might be carried out in the Community research establishments.

With a medium-sized joint centre, however, it is useless to launch into the immense non-nuclear domain without first having decided on a role for the centre, so that it fits in harmoniously alongside various national centres and is assigned tasks of a certain duration which are unquestionably of Community-wide value.

The Commission considers that the Joint Research Centre's role should

— be intimately linked with the essential role of the Economic Community itself;

— rely at the outset on its present specialized technical staff;

— take the proposals of the Working Group on Scientific and Technical Research Policy (PREST) into account.

With these principles before it, the Commission had to make a selection from the numerous fields of action offered in the non-nuclear sphere. It suggests to the Council that the Joint Research Centre's activities should be concentrated on the three following fields:

— research on the abatement of nuisances,

— public service activity in the field of information science,

— the creation of a Community Bureau of Standards.

The reason for this selection is the element of public service which is a feature of all these activities. It must also be pointed out that the first two are likewise covered by proposals from the PREST group and the justification for the third, regarding a Community Bureau of Standards, lies in the contribution it could make towards setting up an economic union.

Let us look more closely at these three fields. It is generally recognized that environmental problems, in their widest sense, will become more and more important in the years ahead. Technological progress is liable to have disastrous consequences if precautions are not taken in good time. Community action in this field is justified by the fact that nuisance problems have not yet been tackled comprehensively and it appears to be necessary to have the whole range of nuisance sources studied in a well-planned manner, not merely from the health standpoint, but also as regards the economic and industrial implications. A further point which should be brought out is the advantage to be gained if these researches culminate in uniform regulations for the whole Community, particularly in view of the industrial and economic implications already mentioned.

As regards information science, there is no longer any need to stress its strategic role in future technological progress. But full use of the opportunities offered by this science presupposes a certain amount of research work which — in the present state of the Community's industry at any rate — can only be done by the public authorities, as well as certain informatory functions which are of a public service nature. In the JRC the Community has an appreciable potential, which could be employed for various public service activities.

The justification for the third field of action proposed lies in the fact that, now that the customs barriers are down, a large part of the obstacles in the way of the Common Market are due to regulations introduced mainly for reasons of safety and protection. It will take a considerable scientific and technological effort to remove these impediments, and their scrutiny must be done on an objective basis accepted by everyone. A Community Bureau of Standards would provide the Community institutions with the technical assistance they need to carry out their tasks, and would at the same time be of immediate value to industries engaging in intra-Community trade and requiring reference samples.

V.1. Abatement of nuisances

1. Analysis of present situation

In recent years both public opinion and the public authorities have become increasingly aware of the dangers that changing techniques, growing industrialization and the use of new substances, combined with the ever greater concentration of populations, represent for man's health and his surroundings.

Such steps as have been taken in Europe so far to protect man and the environment are insufficient; any measures have generally been limited in their approach. If individual countries apply regulations designed to protect health and environment, this is liable to hinder trade and thus make it harder to achieve the aims pursued by the Community. In these disquieting circumstances one must welcome the Community's nuclear health and safety measures, which include the setting of basic standards for the protection of the health of the general public, based on a co-ordinated research programme in which the Joint Research Centre took an active part.

In its report to the Council, the PREST Group recognized the urgency of the battle against pollution, a battle which, though primarily important on the score of health, is not without significant economic effects as well. The Group proposed nine lines of research concerning water pollution, air pollution and acoustic nuisances; these researches, which can be very quickly put in hand, are aimed at discovering more about pollution and the harmful effects of pollutants, with the object of

— defining guide values, quality criteria or thresholds of noxiousness, on the basis of which the competent authority can lay down the standards to be complied with and set up surveillance systems;

— defining and developing efficient technical processes and equipment, as low-priced as possible, to prevent pollution or remedy its effects.

However, the Group, which incidentally proposed three other projects dealing with marine and coastal pollution, stressed the point that these measures are only a first step and that if the nuisance problem is to be solved properly it will have to be tackled in a more methodical and comprehensive manner.

Meanwhile the expert group on "Abatement of Nuisances" had spelt out:

— the importance of all the factors threatening man and his environment, and the need for speedy action on the problems raised by pesticides, drugs, food additives and so on;

— the necessity of treating as a whole the problems of safeguarding man and his environment;

— the fact that permanent European co-ordination of anti-nuisance activities is fundamental to the success of the policy, having regard to the broad range of subjects to be studied and the international nature of air, water and food pollution, the effects of which do not stop at state frontiers.

2. Objective

The Commission considers it necessary to mount a European programme as soon as possible to combat all the factors that threaten the health of man and his environment.

This programme, which should be prepared with due regard to the Euratom Treaty provisions and the experience acquired by the institutions in matters of nuclear health and safety, ought to rest, at European level, on an administrative and technical structure and research facilities in the form of a "European public service" in the health protection field. Acting on lines similar to those of the American FDA in the field of food and drugs, this European public service would work in double harness with the Community Bureau of Standards, proposed below, to provide the foundations for a European-scale complex of harmonized instructions.

The research potential now available in the JRC and capable of contributing to the development of the programme should be reorganized and trained along new lines, with an eye more particularly to the measures proposed by the PREST Group. The proposals for action outlined below were prepared in that context.

3. Proposals for action

(i) The Commission proposes that a nucleus staff be formed in the JRC, thus uniting the means required to carry out research on the protection of man and his environment. This nucleus, consisting of present experts in the field of physics, chemistry, biology and health physics — though not excluding the collaboration of other JRC sections — could form the first scientific unit of the "European Health Protection Service" mentioned above.

(ii) It is proposed that this nucleus be given the task of preparing the ground for and putting into action the following research studies, in line with the measures proposed by the PREST Group;

— establishing computer models (systems analysis) for quantitative evaluation of water pollution at various places as a function of time; similar computer models would be set up for atmospheric pollution;

— development of techniques for detecting and analysing the degree of contamination of various polluted milieux, including biological tests to estimate the overall contamination;

— studies on the dispersion of pollutants in the milieux and of their biological effects, tests on cell cultures and indicator plants, experiments on laboratory animals;

— measurements of parameters that affect the natural cooling of watercourses, and study of heat effects on the aquatic environment;

— study on the catalytic elimination of sulphur compounds in liquid fuels, and on the purifying of gaseous waste;

— in the field of marine pollution, sampling and analysis of certain pollutants in accordance with the PREST proposals, and establishing of computer models for predicting marine pollution and its variation in space and time.

This work would be undertaken in close liaison with the Commission's specialized departments and the national centres concerned, after thorough study of the results already obtained and of programmes in hand, so as to avoid any useless duplication. It would be carried out in keeping with the decisions taken by the Council on implementation of the projects proposed by the PREST Group.

(iii) It is also proposed that the same nucleus be asked to develop the methods and techniques to be used in the inspection and checking of pharmaceutical products and food additives.

In particular, it is proposed that molecular biology methods and techniques be developed for use in detailed research into the effects of drugs and toxic substances on genetic material and on detoxicating mechanisms.

The proposed activities are based on the JRC's work on radiation protection and comprise research on:

— the genetic biochemistry of mammals,

— physicochemical studies on DNA molecule models,

— preparation of synthetic biopolymers,

— standardization of analysis and inspection methods.

4. Resources required

It is proposed to employ an average overall staff of about 103 on these activities, calling for a budget of 8.2 million u.a.

V.2. Information science

1. Purpose and description of activity

The growing importance of this branch of science and technology and its far-reaching effects on modern life are well known. The PREST Group's recommendations give top priority to Europe-wide collaboration.

The Commission considers that the time has come for it to contribute to the Community's effort to advance information science by making use of the potential and staff of the JRC. Such participation may be of two separate kinds:

— development of computer software techniques in order to make fuller use of their powers or to extend their application to new fields of human activity. It should be noted that software requirements are constantly increasing;

— development of advanced materials and components (hardware) for the later computer generations. This is of capital importance to the growth of the computer industry in the Community.

(i) In the software part of this proposed programme, the stress is on measures that accord with general interests and, by their nature and complexity, warrant a multilateral effort. The intention is to develop general-purpose computer codes, numerical computer techniques and programming languages that will facilitate the entry of information science into a number of scientific, technical and management fields.

The computer techniques are essential for converting complex mathematical problems into algebraic problems that can be solved by computers. The work proposed in this sector is aimed at solving certain differential equations with partial derivatives which express numerous problems mathematically.

The programming languages are intended to give easier access to computers. Where analogue machines have to be programmed by means of digital computers, the APACHE language, divised by CETIS, is the only complete and efficient instrument available. There is still nothing for the hybrid computers (combining analogue and digital techniques) and this language needs to be adapted for the purpose.

It is also proposed that CETIS continue its efforts on the mechanization of documentation and of administrative and management procedures.

(ii) The hardware section concerns, firstly, research on the technique of doping of semiconductors by ionic implantation, as applied in the development of electronic devices, and secondly, materials research and the study of optical effects that can be used in information processing.

The great strides made by electronics and its applications in recent years are mainly due to the continual improvements achieved as regards methods of construction and types of semiconductor devices. In particular, new advances in information science are related to the development of devices with high switching speeds which make very compact assemblies possible. The method of "doping" semiconductors by ion bombardment is today regarded as an attractive alternative to the traditional diffusion method used for silicon, and appears to be the only technique for certain compound semiconductors.

As regards the optical processing of information, it is proposed to study storage components based on ferro-electric or magneto-optical compounds; memories of this kind hold out prospects of extremely sophisticated performance. There are also plans for developing the application of electro- and magneto-optical effects in light beam processing; the object of these studies is to try out optical data processing and transmitting systems. The expected advantages of these techniques might revolutionize information processing. The use of such methods in conjunction with semiconductor lasers may prove interesting.

2. Incorporation of the activities in the Community framework

(i) As regards software, it should be remembered that CETIS has acquired particular competence, having created special programming languages and the compiling routines to go with them. It has also developed computer checking systems and since 1964 has been participating in an international project on the evaluation of numerical calculating techniques, in which six other European centres are also taking part. This work resulted in the compiling of a "CETIS Compendium of Numerical Analysis Utility Programs", backed by numerous research centres, universities and industrial firms.

Talks with experts confirmed that all these activities met genuine needs, did not duplicate work performed elsewhere and deserved priority treatment.

(ii) In the case of hardware, it should be mentioned that ion doping of semiconductors has been discussed in preliminary talks with the CEN, Grenoble, in order to dovetail work in this field. Contacts have also been made with various industrial firms (SGS, Siemens, AEG-Telefunken, Philips, etc.), most of whom have expressed interest in this activity.

The Scientific and Technical Committee has likewise supported the proposal. Furthermore, it was adopted on the PREST Group's list of activities deserving a Community effort. In the United Kingdom, the United States and the USSR, the efforts devoted to such research are very substantial.

In the field of optical information processing, research in the Community is on a small scale, more especially as regards the technological aspects of the problem. Here too, the Grenoble CEN is an exception. Approaches to them and to certain industrial firms revealed definite interest.

The talks and approaches will be continued, in order to reach a clearer estimate of the priorities of intended projects. In the United States a number of industrial research centres (IBM, Ford, RCA, GEC, Bell Telephone Co., etc) are actively engaged in this field. The USSR, the United Kingdom and Czechoslovakia have also appointed major research teams for such tasks.

3. Resources required

(i) Software

It is proposed to assign an average of 45 employees to this work. The programme will use up to about 20% of the CETIS digital computer capacity, as well as the hybrid computer, and will bear the utilization charges involved.

(ii) Hardware

An average staff of 600 will be employed on this work.

The appropriation needed for staff and research work amounts to 8.1 million u.a., to which must be added 1.9 million u.a. for the computers (software - digital, 1.8 million u.a.; hybrid, 0.1 million u.a.) and one million u.a. for investments (hardware).

V.3. Community bureau of standards

1. Purpose and nature of work

The removal of all customs barriers within the Community is likely to throw into clearer relief the magnitude of the obstacles to intra-Community trade which are due to disparity in the present legal requirements or regulations concerning industrial technical processes. Recently the Council gave a certain degree of priority to the solving of this problem when it approved a general programme submitted to it in this connection by the Commission.

To succeed in the task of removing the technical impediments to its internal trade, the Community ought to be provided with a technological instrument that would support and help on the efforts to harmonize technical standards in the Member States. For this purpose it appears advisable to set up, step by step, a Community Bureau of Standards (CBS) which could in a sense be compared to the National Bureau of Standards. This Bureau would complement the efforts of the existing national organizations in matters of intra-Community trade.

One of the first tasks of the CBS would be to supply the technical staff to spur on the European effort to harmonize the existing national technical regulations, in its capacity as part of a network of freely associated laboratories.

For this purpose, it would call upon a management committee comprising representatives of:

— the Commission of the European Communities;

— laboratories in member countries which are experienced in the field;

— national standardization bodies.

Working within a definite programme of action, the CBS would collect all the information needed to fulfil the above-mentioned task. In particular, it would draw upon the research findings of the JRC or other Community institutions for the scientific data required for this work. At the same time, unequivocal methods of measurement would be established.

The CBS could also undertake a second task, namely the preparation of standards based either on the already established European norms or on customers' specifications.

Thus the CBS is primarily a technical instrument at the service of the various countries' public and private bodies; its role is not to take initiatives in the way of coercive prescriptions and public inspection measures, but simply to provide the elements on which the desired harmonization can be based.

Briefly, the two chief objectives which warrant the setting up of a CBS are as follows:

— to co-ordinate the efforts of national bodies similar in purpose to the CBS, so as to bring the technical standards and regulations gradually into line;

— to assist industry and research organizations by making samples and reference data available to them and by helping to define standardized measuring methods appropriate to requirements.

The main sectors of activity for the CBS, as a public service, may be:

— Integral nuclear data:

Evaluation and systematic dissemination of the results of integral measurements with a view to standardizing the cross-section sets used in reactor calculations.

— Information on nuclear shielding:

Collection and analysis of data; development of new calculating methods; consultant service.

— Technical materials:

Definition of materials' characteristics and production of standards, pure substances, single crystals, etc.

— Structures and machines:

Definition of technological characteristics of materials; criteria for the selection and interpretation of technical test methods.

— Electronics:

Standardization of electronic equipment and its components. Development of inspection and certification methods.

— Food and drugs:

In addition to the tasks mentioned under the heading of nuisances, the CBS would be instructed to lay down the groundwork for a harmonized set of standards and to elaborate identification and assaying methods concerning products for human consumption.

This brief list shows that the CBS is an indispensable instrument if we wish to try to integrate markets within the Community. Such action is all the more advisable in that it can be started immediately at the JRC, where there is already a nucleus of staff and equipment of the type required for this important work.

2. Incorporation of CBS activities

At present the Community countries have no bodies whose resources and variety of activities can be compared to those of the National Bureau of Standards (NBS).

In the "Europe of the Six" certain institutes, broadly speaking fairly specialized, have a purpose that in some respects is fairly similar to that set out in this proposal. In particular mention may be made of:

— the Bundesanstalt für Materialprüfung (BAM) for Germany,

— the Physikalisch-Technische Bundesanstalt (PTB),

— the Bureau National de Métrologie (BNM) for France,

to which should be added as a footnote the Bureau of Analysed Samples (BAS) in the United Kingdom. Private enterprises producing standards of materials, and independent laboratories of public administrations or trade associations, take part in various capacities in activities of the type proposed by the CBS. Thus technological efforts are fragmented and national or international standardization bodies have difficulty in assembling the technical or scientific data needed for their work and in setting on foot the desired studies.

3. Resources required

In the first place, it must be remembered that the other bodies of this nature employ staffs of the order of several thousand. Even allowing for the existing bodies in member or non-member countries, the tasks that ought to be entrusted to the CBS would still be multiple and complex and the staff requirements would therefore be of much the same order of magnitude.

It appears to be desirable that the Council should take a decision in principle, at the earliest possible date, on the setting up of this body and its management committee.

The Commission attaches great importance to this typically Community project; it proposes that the JRC should place a starting unit at this body's disposal — relatively small in view of its other programmes, but large enough to ensure healthy growth from firm bases and well-proven competence. Development must go forward cautiously, in accordance with gradually acquired experience.

It is proposed to employ a staff of 189 on average during the starting phase, with a corresponding budget of 15.3 million u.a.

CHAPTER 4

Possibilities for future research within the Community framework

INTRODUCTION

A certain number of activities in addition to those mentioned in Chapter 3 have come under review by the Commission. Ties have been established with various scientific and technical circles in the Community countries via the medium of bilateral talks or meetings between experts. The findings which emerged from these contacts have been sifted, as a result of which several research topics, described in this chapter have been put forward. In view of the scope of the Commission's programme, these topics cannot be included with the firm proposals. They could, however, replace those which will tend to decline in importance in the future. Technical annexes similar to those drawn up for the programme activities have therefore been drafted, so that some of these projects could later be included in the Commission's research programme. The allocation of staff and funds, which is not mentioned in the present documents, will then be specified.

It should be noted that the activities indicated below, all of which are of general interest, have barely been touched on in the Member States and could, in the event of encouraging initial findings, constitute the go-ahead for major development work in the scientific, technical and social fields. They could also be carried out under various other arrangements, such as direct action by the JRC, contracts of association or contractual work and against remuneration.

I. NEW APPLICATION FOR NUCLEAR ENERGY

1. Introduction

The heat generated by today's nuclear reactors can compete with that obtained from classical types of fuel in the case of sufficiently large production units. The bulk of the effort to turn this energy to account has been devoted to the problem of electricity production. However, electrical energy only accounts for about 25% of the total power requirements of industrialized societies. The rest is spread over a wide number of uses, which makes it difficult for nuclear energy to penetrate this market. Various sectors have already formed the subject of design or development work with regard to the use of nuclear energy for purposes other than electricity generation. These include sea water desalination, urban heating systems, industrial heating, the reduction of iron ores (iron and steel industry), the production of chemical compounds by radiation, etc.

A possible approach is the conversion of the thermal energy produced by a nuclear reactor into chemical energy in order to obtain an easily distributable product which can be adapted for numerous uses. If its cost could be reduced, hydrogen could well fulfil this function.

At present, the cheapest hydrogen is produced from methane. In Europe the price per calorie needed for this production is twice that of a nuclear calorie.

A small-scale research project carried out at Ispra has revealed a chemical process for breaking water down into hydrogen and oxygen in a series of four reactions which consumes heat at a maximum temperature of only 800°C. This temperature can already be obtained with high temperature gas reactors. The theoretical thermal efficiency of the chemical energy in the hydrogen is about 75% at 800°C.

Taking into account what has been said about the cost of the nuclear calorie and that of a calorie produced by burning methane, it follows that the cost of hydrogen produced by the conversion of nuclear heat could become competitive. There is a big market for the latter in the production of ammonia, the hydrogenation of hydrocarbons and the reduction of iron ores.

This could be considered as a long-term objective with a view to introducing nuclear energy into the power market on a still larger scale.

Another line of approach is that of the synthesis of chemical compounds by radiation. From the economic standpoint, the actual efficiency of the radiochemical processes likely to replace the main industrial ones has not yet proved adequate to warrant the building of chemonuclear reactors. Since the theoretical efficiency of these reactors is very high, a systematic investigation of the influence of the parameters involved and the effect of certain catalysts could lead to an improvement in the actual efficiency.

2. Future outlook.

An effort (on the laboratory scale) would, on the one hand, further the development of a process for producing hydrogen from water and nuclear heat and, on the other hand, enable a systematic study to be carried out of certain chemonuclear reactions.

With regard to the production of hydrogen, this effort could extend to research into other chemical reactions, namely:

— studies on thermodynamics, reaction rates and catalysts;

— material studies with regard to corrosion, hydrogen resistance and creep;

— component technology studies.

In the field of chemonuclear reactions, it would be worth while to undertake a systematic investigation into the effect of the parameters involved, with particular emphasis on temperature rises, wall effects, the presence of rare gases, etc.

These tests would involve the preparation of nitrogen dioxide — a basic constituent of fertilizers — from nitrogen and oxygen, the preparation of carbon monoxide by carbon dioxide cracking and the fixation of nitrogen to carbon for the preparation of amines.

3. Incorporation in the Community framework

There is apparently no investigation of this sort in progress in Community laboratories. The chemical industry and the high temperature reactor constructors have shown some interest and have been duly consulted.

In the field of chemonuclear reactions, possible future lines of approach have been defined through the contacts set up with national research laboratory and industrial experts. The Montedison company and the University of Pavia have offered their co-operation in the form of a special American-made fuel element for fission product synthesis tests and the test reactor Triga Mark III. Belgian, French and Dutch experts have also shown interest.

II. HEAVY ION ACCELERATORS

1. Nature of the activity

The availability of ions of all masses, and in particular very heavy ions accelerated to energies of about 10 MeV per nucleon, should open up new horizons in nuclear and atomic physics, in solid-state physics and perhaps also in chemistry, biology and medicine.

2. Justification for Community action

No machine exists at present which is capable of producing such an acceleration, but there are numerous projects in hand. In the USA there was the OMNITRON project for a circular machine at a total estimated cost of more than 25 million u.a., now superseded by a linear design; within the Community there is the UNILAC project (Heidelberg) and a project at Lyons, both of the linear type. There are also projects based on new concepts, such as the SMOKATRON principle or the use of the systematic ionization difference after stripping in a gas and in a solid. However, meetings of experts have shown that the linear accelerator is the only design which is apparently free from serious problems and risks at the present moment.

The two European linear-type projects mentioned above are fairly similar.

The details of the Heidelberg project are already well-defined, and experiments on components are in progress. Its construction seems at all events to be assured. Work will probably begin in the middle of 1969 and extend over a period of three or four years. The total cost would be about 10 million u.a. or even a little more. The machine would be located at Karlsruhe or in a neighbouring town. The operating costs would be about one or two million u.a. per annum.

No decision seems to have been taken on the Lyons project for the present, moreover, the question arises whether there is any point in pursuing two very similar and costly new projects in the Community at the same time.

For this reason the Commission, which had already proposed action in this field, has welcomed the German government's offer to build and, in particular, to operate the UNILAC machine on a Community basis.

3. Future outlook

In view of the advanced stage of the project, the Community might conclude a contract of association with Germany for the construction and operation of the reactor as now planned; by this participation the Commission would aim to place this programme on a Community basis. In addition, an effort to co-ordinate work on heavy ion accelerators at Community level would be useful.

III. LONG-TERM BIOLOGICAL STUDIES ON THE PROTECTION OF MAN AND HIS ENVIRONMENT

1. Aim and description of the activity and incorporation in the Community framework

(i) A technologically advanced and densely populated Europe, with its manifold and sometimes divergent interests, must be concerned to preserve the basic substance of its civilization: it must keep careful watch to ensure that technological developments do not impair the individual's health and the environment in which he lives. It is therefore not surprising that in line with a decision taken by the Council of Ministers, the problem of "nuisances" should figure among the primary concerns of the PREST group.

One potential nuisance — radioactivity — has been and still is the subject of intensive studies on a Community basis. The same concepts, methods and instruments are eminently suitable for the study of other nuisances. For this reason, and on the model of its work in the field of radiation protection, the Commission proposes that a limited part of the nuisance studies planned by the PREST group, including the biological investigations, should be carried out in its own centres (see Nuisances).

(ii) At the outset, the PREST group selected for immediate study some well-defined topics relating to air and water pollution and noise. But, as the group itself has already recognized, the general problem of the protection of man and his environment is wider and deeper and is of a longer-term nature. The dangers to which man's heritage and his environment are exposed are manifold, insidious and often cumulative. Air, water, foodstuffs and drugs are all vectors of innumerable products introduced deliberately or inadvertently into the biological cycle.

The need for Community regulations on this subject is becoming more and more obvious, and it is thus the Community's first duty to safeguard the general interest. The Commission therefore feels it would be expedient to establish the common scientific basis necessary for the elaboration of effective, standardized and universally acceptable general rules. In order to avoid excessive empiricism, such an activity must be based on the application of the concepts, methods and techniques of molecular biology to a detailed study of the effects of disturbing, noxious or toxic products on genetic material and detoxication mechanisms. Through its nuclear programmes the Commission has gained experience in the preparation of special molecules and in certain biological toxicity tests; this could form the starting point for a long-term in-depth Community project.

IV. OTHER PROJECTS

In the course of contacts with national scientific and technical circles and following suggestions from individual research workers, various other fields for useful Community activity have been proposed and are now being examined.

Some of these activities could, moreover, fairly soon lead to contract work, for example:

— biomedical engineering;

— high-performance materials;

— thermal regeneration fuel cells;

— direct conversion;

— automatic translation;

— automation.

The Commission is also submitting some suggestions for future action in the fields of biological research, population welfare and economic advance, for example:

— the pharmaceutical and biological research industries;

— instrumentation and biomedical information science;

— the physics of the living state;

— co-operation between the Community and Associated States on research and development;

— the Primatology Centre;

— integrated action against harmful insects;

— research on cancerous cells.

Furthermore, it would be of the utmost interest to consider what degree of R & D co-operation could be established between the Community and the Associated States. Such a study is particularly appropriate just now, at a time when the extension of the Yaoundé Convention is being negotiated.

General recapitulative table

A. Appropriations and staff listed under Research Budget

Activities	Personnel			Appropriation (million u.a.)		
	Dir. A.	Ind. A.	Tot.	Dir. A.	Ind. A.	Tot.
I. Contributions to reactor development	780	70	850	97.0	33.1	130.1
II. General fuel cycle problems	220	—	220	25.3	—	25.3
III. Public service activities	558	37	595	84.1	30	114.1
IV. Basic research	180	94	274	29.7	45	74.7
V. Non-nuclear field	397	—	397	34.5	—	34.5
Total	2 135	201	2 336	270.6	108.1	378.7

(*) Less "B" below.

B. Appropriations and staff to be listed under Operating Budget

III. Public service activities (Radioisotope applications, dissemination of information)	128	—	128	12.9	—	12.9

C.

Grand total	2 263	201	2 464	283.5	108.1	391.6

NB. It has been agreed that the staff engaged on the co-ordination and direction of research (96) will come under the General Operating Budget after 1970.

Detail of proposed activities in connection with:

Contributions to reactor development

Activities	Personnel			Appropriation (million u.a.)			Remarks
	Dir. A.	Ind. A.	Tot.	Dir. A.	Ind. A.	Tot.	
Fast reactors	129	46	175	25.9	3.1	29.0	Of which: — project evaluation: 15 million u.a.
High temperature reactors	161	24	185	15.2	30.0	45.2	Irradiations: 1.7 million u.a.
Heavy water reactors	490	—	490	55.9	—	55.9	Of which: — ESSOR operations: 15 million u.a. — new loops: 4 million u.a.
Total	780	70	850	97.0	33.1	130.1	

Detail of proposed activities in connection with:

General fuel cycle problems

Activities	Personnel			Appropriation (million u.a.)			Remarks
	Dir. A.	Ind. A.	Tot.	Dir. A.	Ind. A.	Tot.	
Production of enriched uranium		p.m.			p.m.		Activities connected with industrial policy, and work against remuneration
Supply of natural uranium		p.m.			p.m.		
Fuel management		p.m.			p.m.		
Reprocessing of irradiated fuels		p.m.			p.m.		
Plutonium and transplutonic elements	220	—	220	25.3	—	25.3	Including approx. 10% for transplutonic elements
Total	220	—	220	25.3	—	25.3	

Detail of proposed activities in connection with:

Public service activities

Activities	Personnel			Appropriation (million u.a.)			Remarks
	Dir. A.	Ind. A.	Tot.	Dir. A.	Ind. A.	Tot.	
Central Bureau for Nuclear Measurements	180	—	180	24.9	—	24.9	
CETIS	117	—	117	16.3	—	16.3	
Inspection of fissile materials	37	3	40	3.2	—	3.2	
Safety of nuclear installations	47	—	47	3.8	—	3.8	
Biology — Health Protection	78	34	112	8	30	38	
Education — Training	9	—	9	7	—	7	
High-flux irradiations	90	—	90	20.9	—	20.9	HFR (operation + Euratom staff): 19.5 million u.a. BR-2 (Commission staff): 1.4 million u.a.
Total	558	37	595	84.1	30	114.1	
Radioisotope applications	9	—	9	0.9	—	0.9	Activity to be listed under the Operating Budget
Dissemination of information	119	—	119	12	—	12	

Detail of proposed activities in connection with:

Basic research

Activities	Personnel			Appropriation (million u.a.)			Remarks
	Dir. A.	Ind. A.	Tot.	Dir. A.	Ind. A.	Tot.	
Fusion and plasma physics	—	94	94	—	45	45	
Solid-state physics and SORA	180	—	180	29.7	—	29.7	Including construction of SORA, 16.1 million u.a., and associated equipment
Total	180	94	274	29.7	45	74.7	

Detail of proposed activities in connection with:

Non-nuclear field

Activities	Personnel			Appropriation (million u.a.)			Remarks
	Dir. A.	Ind. A.	Tot.	Dir. A.	Ind. A.	Tot.	
Nuisances	103	—	103	8.2	—	8.2	
Information Science	105	—	105	11.0	—	11.0	
Community Bureau of Standards	189	—	189	15.3	—	15.3	
Total	397	—	397	34.5	—	34.5	

LIST OF ABBREVIATIONS

AEG	Allgemeine Elektrizitäts-Gesellschaft (D)
AGR	Advanced Gas-Cooled Reactor
APACHE	Code facilitating access to electronic computers
AVR	Arbeitsgemeinschaft Versuchs-Reaktor (D)
BAM	Bundesamt für Materialprüfung (D)
BAS	Bureau of Analysed Samples
BN	Belgonucléaire (B)
BNM	Bureau National de Métrologie (F)
BR-2	Belgian Reactor No. 2, Mol (B)
BWR	Boiling Water Reactor
CANDU	Canadian Deuterium Uranium Reactor
CBNM	Central Bureau of Nuclear Measurements
CBS	Community Bureau of Standards
CCNR	Consultative Committee on Nuclear Research
CEA	Commissariat à l'Energie Atomique (F)
CEN	Centre d'Etude de l'Energie Nucléaire (B)
CETIS	European Scientific Information Processing Centre
CID	Centre for Information and Documentation
CIRENE	CISE Reattore a Nebbia (CISE fog-cooled reactor) (I)
CNEN	Comitato Nazionale per l'Energia Nucleare (I)
DFR	Dounreay Fast Reactor (GB)
DRAGON	High temperature gas-cooled reactor
ECO	Experience Critique ORGEL, Ispra
EDF	Electricité de France (F)
EL-4	Heavy-water gas-cooled reactor (F)
ELDO	European Launcher Development Organization
ENEA	European Nuclear Energy Agency
ENI	Ente Nazionale Idrocarburi (I)
ESRO	European Space Research Organization
FDA	Food and Drug Administration
FIAT	Fabbrica Italiana Automobile Torino (I)
GAAA	Groupement Atomique Alsacienne Atlantique (F)

GEC	General Electric Company
GfK	Gesellschaft für Kernforschung (D)
GKSS	Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt
HFR	Hoge Flux Reactor, Petten
HTGR	High Temperature Gas-Cooled Reactor
IBM	International Business Machines Corporation
INIS	International Nuclear Information Service (IAEA, Vienna)
IRI	Istituto Ricostruzione Industriale (I)
ISO	International Standards Organization
JRC	Joint Research Centre
KKN	Kernkraftwerk Niederreichbach (D)
KNK	Kompaktes Natriumgekühltes Kraftwerk (compact sodium-cooled power plant)
LINAC	Linear Accelerator, Geel
MASURCA	Maquette Surgénératrice Cadarache (breeder mock-up)
MWe	Megawatt electric
MWth	Megawatt thermal
MZFR	Mehrzweck-Forschungsreaktor (multipurpose test reactor)
ORGEL	Organic-liquid-cooled, heavy-water-moderated reactor, Ispra
PACE	Type of analogue computer
PEC	Prova di Elementi di Combustibile (fuel-element testing reactor) (I)
PHENIX	Fast reactor protoype project
PREST	Working Group on Scientific and Technical Research Policy
PTB	Physikalisch-Technische Bundesanstalt (D)
PWR	Pressurized Water Reactor
R & D	Research and Development
RAPSODIE	Réacteur RAPide refroidi au SODIum (sodium-cooled fast reactor)
RCA	Radio Corporation of America (USA)
RCN	Reactor Centrum Nederland (N)
SGS	Società Generale Semiconduttori (I)
SNEAK	Schnelle Nullenergie-Anordung Karlsruhe (fast zero-energy assembly)
SNR	Schneller Neutronen-Reaktor (fast neutron reactor)

SORA	Reattore SOrgente RApida (fast source reactor)
STC	Scientific and Technical Committee
THTR	Thorium-Hochtemperatur-Reaktor
TNO	Nederlandse Organisatie voor Toegepaste Natuurwetenschappelijk Onderzoek (Netherlands organization for applied research in natural sciences) (N)
u.a. (EMA)	European Monetary Agreement units of account
UNICE	Union of Industries of the European Community
UNIPEDE	International Union of Producers and Distributors of Electrical Energy

SALES OFFICES

GREAT BRITAIN AND THE COMMONWEALTH

H.M. Stationery Office
P.O. Box 569
London S.E. 1

UNITED STATES OF AMERICA

European Community Information Service
808 Farragut Building
900-17th Street, N.W.
Washington, D.C., 20006

BELGIUM

Moniteur Belge – Belgisch Staatsblad
40, rue de Louvain – Leuvenseweg 40
Bruxelles 1 – Brussel 1
C.C.P. 5080

Agency:
Librairie européenne – Europese Boekhandel
244, rue de la Loi – Wetstraat 244
Bruxelles 4 – Brussel 4

GRAND DUCHY OF LUXEMBOURG

Central Sales Office for Publications of the European Communities
37, rue Glesener
Luxembourg
C.C.P. 191 90

FRANCE

Service de vente en France des publications des Communautés européennes
26, rue Desaix
75 Paris 15e
C.C.P. 2396

GERMANY (FR)

Verlag Bundesanzeiger
5000 Köln 1 – Postfach
Telex: Anzeiger Bonn 08 882 595
Postscheckkonto 834 00 Köln

ITALY

Libreria dello Stato
Piazza G. Verdi 10
00198 Roma
C.C.P. 1/2640

Agencies:
00187 Roma – Via del Tritone 61/A e 61/B
00187 Roma – Via XX Settembre (Palazzo Ministero delle Finanze)
20121 Milano – Galleria Vittorio Emanuele 3
80121 Napoli – Via Chiaia 5
50129 Firenze – Via Cavour 46/r

NETHERLANDS

Staatsdrukkerij- en uitgeverijbedrijf
Christoffel Plantijnstraat
Den Haag
Giro 425300

IRELAND

Stationery Office
Beggar's Bush
Dublin 4

SWITZERLAND

Librairie Payot
6, rue Grenus
1211 Genève
C.C.P. 12236 Genève

SWEDEN

Librairie C. E. Fritze
2, Fredsgatan
Stockholm 16
Post Giro 193, Bank Giro 73/4015

SPAIN

Libreria Mundi-Prensa
Castello, 37
Madrid 1
Bancos de Bilbao, Hispano-Americano
Central y Español de Crédito

OTHER COUNTRIES

Central Sales Office for Publications of the European Communities
37, rue Glesener
Luxembourg
C.C.P.: Luxembourg 191 90

PUBLISHING SERVICES OF THE EUROPEAN COMMUNITIES
4001*/5/1969/5