EUROPEAN ATOMIC ENERGY COMMUNITY

EURATOM

THE COMMISSION

Documentation

attached to

SEVENTH

General Report

on the

Activities of the Community

(March 1963 - February 1964)

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SUMMARY

DOCUMENT No. 1

THE COST PRICE OF NUCLEAR ELECTRICITY

The latest data available to Euratom on the unit cost of nuclear electricity were considered at a symposium held in Venice from 29 to 31 October 1963.

A very thorough discussion took place between representatives of the various Community circles concerned, in both the public and the private sector, and representatives of the Commission, on the present state of technical and economic knowledge and more especially on the capital costs of power plants equipped with proven-type reactors and on the nuclear kWh cost.

The main points on the agenda were:

— methods for calculating the cost price of nuclear power;

— cost of energy produced by nuclear plants constructed or under construction in the Community;

— cost of nuclear electricity at plants coming under the Community participation programme;

— cost of nuclear electricity at other nuclear plants in the Community (EDF and SELNI);

— analysis of the main contracts for power plants under construction in the Community, with special reference to contractual guarantees;

— consumption and production of fissile materials in proven-type reactors;

— outlook and future trends in regard to costs of power generated by plants equipped with proven-type reactors.

I. Methods for calculating the cost price of nuclear power

The discussions brought out the need for establishing a system for calculating the cost of nuclear power which would be as uniform as possible for all Community countries and valid for all proventype strings. To obtain comparable results, it was necessary more particularly to narrow the differences observed in the definition of the factors in the cost of nuclear power.

The Commission accordingly put forward proposals expressing its present attitude and suggested the following breakdown of the factors entering into the cost calculation:

1. Plant costs
2. Charges on fixed assets
3. Fuel cycle cost
4. Operating and maintenance costs
5. Insurance.

1. *Plant costs*

In order to arrive at comparable plant costs for the projects considered, all the cost factors involved must be clearly defined, both direct and indirect costs.

Direct costs are those for equipment (supplies, transport and erection on site) plus customs duties and turnover tax where applicable. Thus under direct costs we have:

a. cost of land and all expenditure on site clearance (whether carried out by the operator or by an outside party on his instructions);

b. civil engineering costs;

c. cost of reactor (including primary circuit and exchangers), with moderator and coolant but not the cost of initial fuel load and reserve fuel;

d. cost of turbo-alternator (including secondary circuit);

e. cost of electrical accessories (i.e. up to and including high tension terminals of power transformer but not including circuit breakers and power offtake line).

Under indirect costs we have:

a. engineering costs;

b. overheads;

c. margin of contingencies;

d. interim interest (up to final commissioning date);

e. increases in costs arising from price changes (estimated until date of commissioning);

f. taxation during period of construction (on own capital and on borrowed funds, together with taxes on return on capital) and customs duties (customs duties paid by the operator direct).

In the present stage of development of nuclear power, the installation costs—expressed in terms of cost per net installed kWe—are obtained from a number of data whose definition varies from one operator to another, which makes proper comparison between two projects impossible. Consequently, it is essential if figures are to be comparable, to analyze very carefully the various factors which determine plant costs.

In the discussions at the Venice Symposium some progress was made towards comparability of installation costs. The participants were able to agree:

— that the reference power shall be the net electrical power;

— that plant costs must include the sum of all direct and indirect costs relating to the construction of the plant up to and including high tension transformer terminals.

It was further agreed that, in spite of the difficulty of determining the incidence of engineering expenditure on items included in direct and indirect costs, this should in fact be included in the total plant costs.

As regards contingencies, there will obviously be differences between one case and the next, between one contract and the next. However, in the light of practical experience, between 7.5 and 10% of direct costs may be taken as a reasonable figure for contingencies.

2. *Charges on fixed assets*

Annual fixed charges are made up of amortization of capital, interest, and taxation relating to capital and to return on capital.

— The calculation of amortization charges presupposes an initial choice as to period over which it is proposed to amortize the installation costs (probable life from the technical aspect or economic life). As a rule, the amortization period will correspond to a cautious estimate of the economic life—normally shorter than the probable technical life—of say 20 to 25 years, except where the amortization period is dictated by tax considerations (Germany and Netherlands). A second choice will concern the method of amortization — on a diminishing scale, by constant amortization or by fixed annual instalments. Since nuclear power plants are normally meant to function at base load throughout their lifetime and reach a more or less constant annual utilization time, it would seem that our preference should be for the system of amortization by fixed annual instalments which has the advantage of giving a constant amortization plus interest charge per year and per unit of output throughout the plant's lifetime.

— Interest charges are a function of the legal structure of the undertaking, of the system of financing and of the characteristics of the money market in which finance for the project has to be sought. These various factors will determine the average rate of interest.

— It is not easy to determine the incidence on annual fixed charges of taxation relating to capital and to return on capital, owing to the complexity of taxation systems and the exemptions which certain undertakings may enjoy.

In working out annual fixed charges per unit produced, account has to be taken of annual utilization time, which will depend, in fact, on the characteristics of the network and the technical availability of the plant. The Commission, for its part, allows in its calculations for an annual utilization time of 7 000 hours so as to get comparable results in this respect at least.

3. *Fuel cycle cost*

The cost of the fuel cycle embraces, on the one hand, a whole series of expenditures relating to the physical operations to which the fuel is subjected (which may range from extraction of the ore to chemical reprocessing after irradiation and radioactive waste disposal), and on the other hand income deriving from the recovery of fissile materials.

A feature peculiar to nuclear fuel cycles is the long timelag between the production of energy and the expenditures or income which accompany the cycle; hence the most meaningful manner of calculating its cost is by actual value method. In this way all fuel expenditure and income, and all energy produced, are referred by means of compound interest, to a common date. But while theoretically this method raises no basic problems apart from that of selecting a correct actual value rate, it is laborious in practice and calls for knowledge of all the technical and economic parameters of the fuel cycle for the operative lifetime of the reactor. For this reason, we are content in practice to calculate the mean cost of a steady-state cycle when such calculations have to be made for plants which are as yet only in the construction stage, as is the case in the Community.

4. *Operating and maintenance costs*

Operating and maintenance costs include costs of personnel, costs of maintaining and installing plant (spare parts, maintenance supplies, moderator and coolant losses) and plant administration costs.

5. *Insurance charges*

These correspond to the sum of annual premiums for insurance covering material risks and nuclear third-party liability hazards.

II. Cost of energy produced by nuclear plants constructed or under construction in the Community

The cost per kWh of these plants, as set out hereunder, is the figure supplied by the operator. It does not permit of direct comparison pure and simple between the costs of energy produced by the several plants, because of the diversity of the construction contracts and the consequent diversity in what is covered by the cost factors. Such a comparison, to be valid, would involve making readjustments the methodology of which is still being worked out.

The following table sums up the main economic data for nuclear power plants either built or under construction in the Community, together with the results of cost calculations affected for the power generated by these plants.

1. *Unit cost of nuclear electricity at plants coming under the Community participation programme*

The Community participation programme covers the construction and operation of five nuclear plants belonging to three different types of proven-type reactors: pressurized-water (SENA), boilingwater (SENN, KRB, SEP), and gas-graphite (SIMEA).

a. *SENA plant*

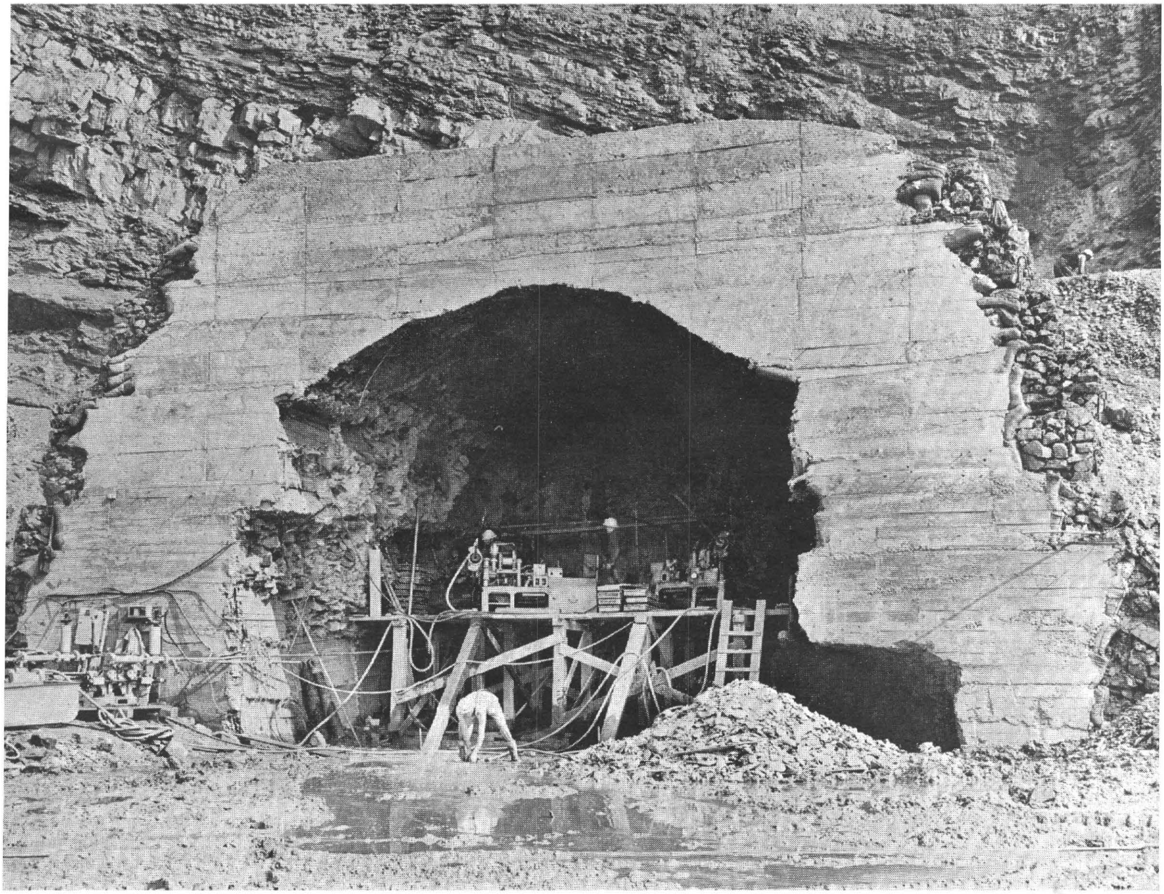
The Société d'Energie nucléaire franco-belge des Ardennes (SENA), a joint undertaking within the meaning of Article 45 of the Euratom Treaty formed by the EDF (France) and the Société Centre et Sud (Belgium), has begun building a 266 MWe plant at Chooz, near Givet, which is scheduled for commissioning at the end of 1966. This project is also included in the Euratom/US Agreement for Cooperation.

Estimated plant costs are 86,635,000 EMA u.a., or a unit cost of 326 u.a. per installed kWh. Fixed charges are calculated on the basis of an annual charge equal to 10% of capital and an annual utilization time of 7,000 hours. In addition, SENA has to meet local taxes of 200,000 u.a. a year. Operating and maintenance costs (including insurance) are estimated at 9.75 u.a./kWe/year.

TABLE SUMMARIZING MAIN ECONOMIC DATA FOR NUCLEAR POWER PLANTS CONSTRUCTED OR UNDER CONSTRUCTION IN THE COMMUNITY

a. *Plants coming under participation programme*

	SENA 266 MWe	SENN 150 MWe	KRB 237 MWe	SEP 47.75 MWe	SIMEA 200 MWe
Commissioning	1966	1963	1966	1967	1963
Charges on fixed assets					
Plant cost (in EMA u.a.)	86,635,000	64,000,000	71,570,000	21,600,000	103,702,000
Cost per kWe	326	427	302	452	518
Use	80 %	80 %	80 %	75 %	80 %
Annual instalments	10 %	10 %	13.17 %	9.31 %	10 %
Fixed charges (including taxes and imposts)	4.76 mills/kWh	6.19 mills/kWh	5.70 mills/kWh	6.41 mills/kWh	7.4 mills/kWh
Cycle cost	3.41 mills/kWh	3.68 mills/kWh	2.40 mills/kWh	2.81 mills/kWh	3.0 mills/kWh
Operating and maintenance costs	1.07 mills/kWh	12.0 mills/kWh	1.05 mills/kWh	1.50 mills/kWh	1.29 mills/kWh
Insurance	0.32 mills/kWh	0.34 mills/kWh	0.42 mills/kWh	0.32 mills/kWh	0.31 mills/kWh
Cost of energy generated	9.56 mills/kWh	11.41 mills/kWh	9.57 mills/kWh	11.04 mills/kWh	12.0 mills/kWh



Construction site of the SENA (Société d'énergie nucléaire franco-belge des Ardennes) power plant. Commissioning of this 266 MWe plant is scheduled for the end of 1966.

b. *Other power plants*

	EDF 3 480 MWe	EDF 4 480 MWe	SELNI 257 MWe
Commissioning	1966	1968	1964
Charges on fixed assets	—	—	—
Plant cost (in EMA u.a.)	—	—	61,400,000
Cost per kWe	260 (*)	234 (*)	239
Use	80 %	80 %	80 %
Annual instalments	8.06 %	8.06 %	10 %
Fixed charges (including taxes and imposts)	3.00 mills/kWh	2.70 mills/kWh	3.42 mills/kWh
Cycle cost	1.74 mills/kWh	1.60 mills/kWh	2.64 mills/kWh
Operating and maintenance costs	0.71 mills/kWh	0.80 mills/kWh	1.55 mills/kWh
Insurance	0.43 mills/kWh	0.43 mills/kWh	
Cost of energy generated	5.88 mills/kWh	5.53 mills/kWh	7.61 mills/kWh

(*) Reference cost based on prices obtaining on 1 January 1963 (excluding added value tax).

On these figures, the cost of energy produced amounts to:

	mills/kWh (1)
— fixed charges	4.76
— fuel cycle cost	3.41
— operation, maintenance and insurance	1.39
	9.56

b. *SENN plant*

This plant, built by the Società Elettronucleare Nazionale (SENN) develops 150 MWe, was the first plant to be included in the US-Euratom Agreement for Cooperation, and went critical in July 1963.

The plant costs were 64,000,000 u.a., giving a unit cost of 427 u.a. per installed KWe.

(1) 1 mill = one thousandth of a unit of account (or US dollar).

Fixed charges are calculated on the basis of an annual charge equal to 10%, and operating and insurance costs are estimated at 10.8 u.a./kWe/yr, own capital being taxed at 0.75%.

For an annual utilization time of 7,000 hours, the cost of energy produced amounts to:

	mills/kWh
— fixed charges	6.19
— fuel cycle cost	3.68
— operation and insurance	1.54
	11.41

c. *KRB plant*

The second joint undertaking within the meaning of the Euratom Treaty, the Kernkraftwerk Rheinisch-Westfälisches Elektrizitätswerk-Bayernwerk, has begun construction of a 237 MWe plant which is likewise covered by the US-Euratom Agreement for Cooperation, and is due to be commissioned in 1966.

Plant costs are estimated at 71,570,000 u.a., giving a unit cost of 302 u.a./kWe. Fixed charges are calculated on the basis of an annual charge equal to 13.17% of capital and an annual utilization time of 7,000 hours. Operating maintenance and insurance costs are estimated at 10.3 u.a./kWe/yr.

On these figures, the cost of energy produced works out at:

	mills/kWh
— fixed charges	5.70
— fuel cycle cost	2.40
— operation, maintenance and insurance	1.47
	9.57

d. *SEP plant*

The Samenwerkende Electriciteits-Productiebedrijven (SEP) has approved the construction of a plant with a capacity of 47.75 MWe. This is the latest project to be included in the Community participation programme, and Community industries will participate very actively in its construction. The planned date of commissioning is 1967.

Plant costs are estimated at 21,600,000 u.a. to give a cost 452 u.a. per installed kWe.

Fixed charges are calculated on the basis of an annual charge equal to 9.31% capital and an annual utilization time of 6,500 hours.
Operating, maintenance and insurance costs are estimated at 11.85 u.a./kWe/yr.

On these figures the prime cost of energy produced can be estimated at:

	mills/kWh
— fixed charges	6.4
— fuel cycle cost	2.8
— operation, maintenance and insurance	1.8
	11.0

e. *SIMEA plant*

The power plant constructed by the Società Italiana Meridionale Energia Atomica (SIMEA) went critical in December 1962 and was connected to the grid in May 1963. This British-designed plant has a capacity of 200 MWe. The plant costs amount to 103,702,000 u.a., corresponding to a unit cost of 518 u.a. per installed kWe.

Fixed charges are calculated on the basis of an annual charge equal to 10% of capital and an annual utilization time of 7,000 hours.

Operating and maintenance costs, including insurance, are estimated at 11.2 u.a./kWe/yr.

The cost of energy produced amounts to :

	mills/kWh
— fixed charges	7.4
— fuel cycle cost	3.0
— operation, maintenance and insurance	1.6
	12.0

2. *Cost of the nuclear kWh at other plants in the Community*

a. *Electricité de France (EDF) plants*

The EDF nuclear power plants have reactors belonging to the gas-graphite string. EDF acts as its own industrial architect and awards and coordinates the contracts.

EDF 3

Initially designed for a generating capacity of 375 MWe, this plant will reach 480 MWe with the second fuel batch. It is scheduled for commissioning in 1966. At 1 January 1963 prices, the estimated unit plant costs exclusive of taxes amount to 260 u.a. This figure includes direct costs exclusive of added value tax, and indirect costs, namely overheads, design studies and interim interest.

Fixed charges are calculated in terms of an annual charge equal to 8.06% of capital (interest rate 7%, amortization 30 years) and an annual utilization time of 6,000 to 7,000 hours.

Operating and maintenance costs are estimated at 5 u.a./kWe/yr. As EDF normally handles its own insurance, for purposes of comparison a sum of 3 u.a./kWe/yr must be added for insurance.

On these figures, the cost of energy produced can be estimated at:

	7,000 h/yr	*6,000 h/yr*
	(mills/kWh)	
— fixed charges	3.00	3.50
— fuel cycle cost	1.74	1.77
— operation, maintenance and insurance	1.14	1.33
	5.88	6.60

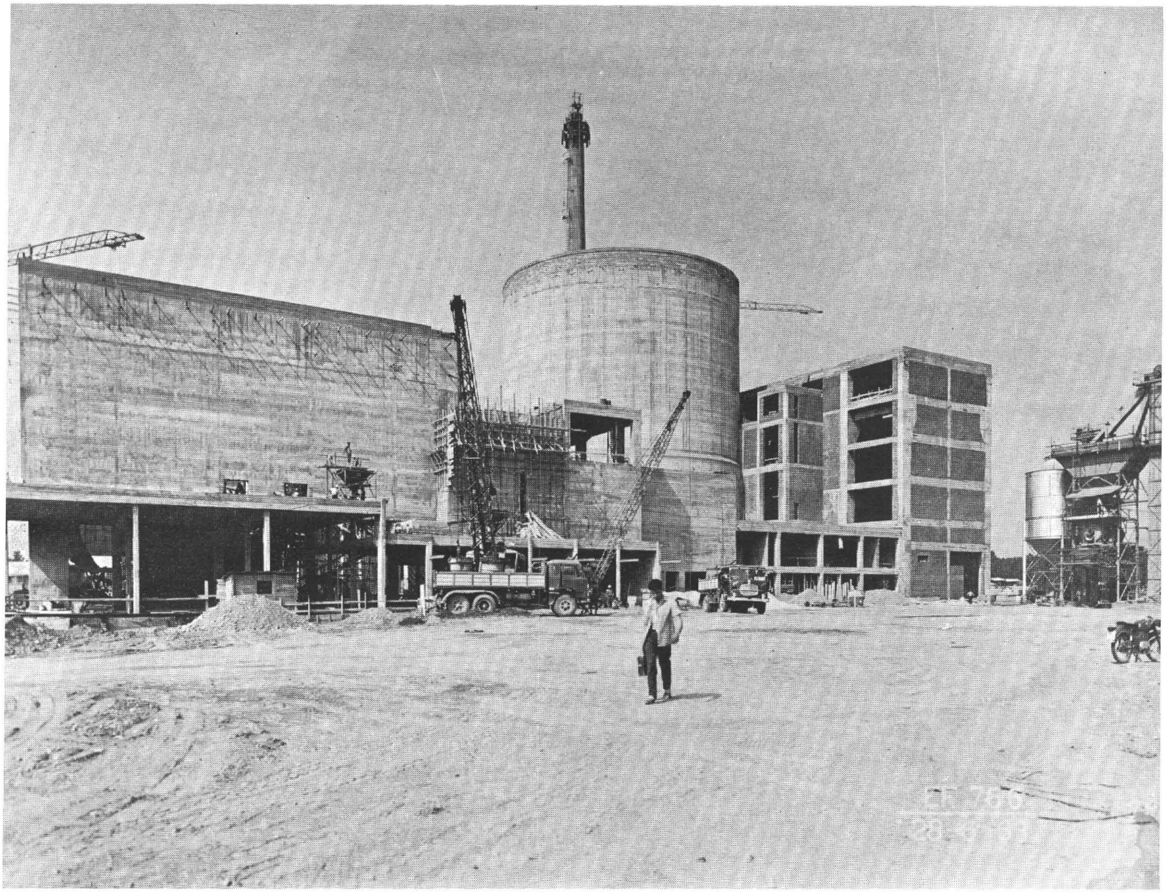
EDF 4

Designed for an installed capacity of 480 MWe, EDF 4 is under construction at Saint Laurent des Eaux (Loir-et-Cher) and is due to be commissioned in 1968.

At 1 January 1963 prices, plant costs are estimated at approximately 234 u.a. per installed kWe. This figure includes direct costs exclusive of added value tax, amounting to 180 u.a., and indirect costs (estimated at 30% of direct costs).

Fixed charges are calculated on the basis of an annual charge equal to 8.06% of capital and an annual utilization time of 6,000 to 7,000 hours.

Operating and maintenance costs are estimated at 5.6 u.a./kWe/yr. (they are higher in this instance because in contradistinction to EDF 3, EDF 4 is assumed to be the only plant on the site). To allow for insurance, a sum of 3 u.a./kWe/yr. has to be added, for purposes of comparison.



Construction site of the SELNI (Società Elettronucleare Italiana) reactor. Commissioning of this 257 MWe plant is scheduled for 1964.

Allowing for large-scale mass production of fuel elements and a reduction in uranate cost, it is reckoned that the cost of the EDF 4 fuel cycle, other things being equal, will show a reduction of 7 to 10% as compared with EDF 3 and be in the region of 1.6 mills/kWh.

The cost of energy produced should amount to:

	7,000 h/yr (*mills/kWh*)	*6,000 h/yr*
— fixed charges	2.70	3.15
— fuel cycle cost	1.60	1.63
— operation, maintenance and insurance	1.25	1.43
	5.53	6.21

b. *SELNI plant*

Initially planned for a generating capacity of 175 MWe, the plant constructed by the Società Elettronucleare Italiana (SELNI) for commissioning in 1964, has had its power stepped up to 257 MWe by the installation of a second turbo-alternator unit.

Plant costs were estimated (including installation of second turbo-alternator) at 61,400,000 u.a., or a unit cost of 239 u.a./kWe.

As the effect of nationalization is as yet unknown, fixed charges are calculated on the basis of an annual charge equal to 10% of capital (like SENN and SIMEA) and an annual utilization time of 7,000 hours. Operating, maintenance and insurance costs are estimated at 10.85 u.a./kWe/yr. On these figures, the cost of energy produced amounts to:

	mills/kWh
— fixed charges	3.42
— fuel cycle cost	2.64
— operation, maintenance and insurance	1.55
	7.61

3. *Analysis of main contracts for construction of nuclear power plants under the Community Participation Programme, with special reference to contractual guarantees*

At the Venice Symposium, the Commission submitted, with comments, the principal contractual provisions relating to guarantees given by contractors, that is to say, provisions contained in contracts and agreements communicated to Euratom pursuant to the Participation Programme.

The purpose of this exposé was to pick out certain aspects of particular value for defining the meeting-point between the opposing parties' requirements and interests, and to give some guidance as to the degree of confidence existing at present in the behaviour and performance of proven-type reactors.

Questions of principle as well as practical aspects of contractual guarantees were discussed, and there emerged a number of useful points for assessing the progress achieved by nuclear technology.

What guarantees are generally found in contracts communicated to the Commission by the contracting parties? These guarantees are broadly two types:

— *warranties* covering plant design, quality and performance of materials, quality of fabrication and assembly;

— *guarantees* proper covering the performance of the plant as a whole or of certain specified equipment.

Warranties comprise two basic features—they specify their term of validity and stipulate the manner in which the constructor must remedy any shortcomings in the performance of his commitments.

Guarantees comprise three basic items:

— the subject of the guarantee: an accurate description of what is guaranteed and on what conditions is of fundamental importance and must be examined in close conjunction with the context of the contract.

— the methods and measures for verifying that guaranteed performances have been fulfilled; this is a highly complex technical item which depends on the type of reactor and is geared to technological progress.

— the penalties and premiums based on results of trials: this item defines the importance attached to each type of guarantee and depends on assessment of the risk of failure.

Examination of the guarantees provided for the SENN, SIMEA, SENA and KRB plants shows that all of them will enjoy guarantees as to:

— net capacity;

— general operational specifications;

— efficiency or heat utilization;

— fuel, or fuel cycle;
— delivery date.

As regards guarantees of availability, these are found only in the SENA and KRB contracts, while guarantees on operating and maintenance costs are specified only in the case of KRB.

It will be seen from the above analysis that guarantees given by constructors tend by and large to express an appreciable growth in confidence in the performance to be expected from nuclear power plants.

4. *Consumption and production of fissile materials in reactors*

The unit cost of nuclear electricity is not in itself a sufficient criterion for proper assessment of the true potentialities of nuclear power in helping to meet the growing demand for electricity. Sooner or later the problem of fissile material supplies is bound to arise. For while the problem hardly exists in the present stage of construction of a handful of prototype power reactors, it assumes fundamental importance as soon as we begin to think in terms of large industrial-scale developments.

For this reason it is essential to consider the characteristics of reactors from the point of view of their consumption and production of fissile material, differentiating between:

— U-235 and natural U requirements;
— characteristics of plutonium production in reactors currently developed in the Community (i.e. light-water reactors using slightly enriched uranium, gas-graphite reactors using natural uranium, and heavy water reactors which, although not yet developed to the same degree, are especially interesting from the point of view of fissile material consumed and produced).

From a study of the specifications of EDF 3 for the gasgraphite reactors, of SENA for the light water reactors, and of EL 4 for the heavy water reactors, we get the following results (1):

(1) These three reactors are chosen because their specifications are now fairly clearly defined and also because nuclear electricity produced from now until 1980 can be expected to be obtained in the main from reactors with similar specifications.

(Figures in brackets indicate the ratio between the values shown in each column, the heavy water string being adopted as the reference).

		column 1	column 2	column 3
Reactor type	Burn-up	Natural U requirements (tons/installed MWe/year	Fissile Pu produced (kg/installed MWe/year)	Fissile Pu produced (kg/ton natural U used)
Gas-graphite (EDF 3)	3,000 MWd/t 4,000 MWd/t	0.37 (3.4) 0.29 (2.7)	0.47 (1.7) 0.40 (1.4)	1.28 (0.5) 1.38 (0.5)
Heavy water (EL 4)	8,000 MWd/t 10,000 MWd/t	0.13 (1.2) 0.11 (1)	0.33 (1.2) 0.28 (1)	2.54 (1) 2.62 (1)
Light water [1] (SENA)	15,000 MWd/t 17,000 MWd/t	0.27 (2.5) 0.35 (3.3) 0.27 (2.5) 0.33 (3.1)	0.35 (1.25) 0.32 (1.15)	1.3 (0.5) 1 (0.4) 1.18 (0.45) 0.97 (0.4)

(1) For contents of enrichment plant waste of 0.25 % and 0.35 % respectively in first and second line.

Whereas the figures in the first column expressing fuel consumption plus immobilization in-pile and out-of-pile show that heavy water reactors are far the most advantageous and permit of substantial savings in uranium, those in the second column point to the value of gas-graphite reactors for producing fissile plutonium when allowance is made for the installed generating capacity.

On the other hand, since the main concern centres on the production of the maximum amount of fissile plutonium per ton of natural uranium, heavy water reactors are seen to be the most advantageous.

5. *Outlook for unit production cost of nuclear electricity*

Plants scheduled for construction cannot come into operation before 1968 at the earliest. This being so, our attention should be focussed on the prospects for nuclear plants to be commissioned around 1968-1970.

a. *Light water reactors*

Plant costs for light water reactors should fluctuate between 175 and 215 u.a./kWh according to whether 500 or 300 MWe units are planned. The fuel cycle cost should be between 2 and 2.2 mills/kWh.

At the same time, it may be assumed that costs of operation, maintenance and insurance will be of the order of 8 u.a./kWe/yr. for a 300 MWe plant and 6 u.a. for a 500 MWe plant.

b. *Gas-graphite reactors*

These reactors are currently being designed for installed capacities in the neighbourhood of 500 MWe, which may rise to 1,000 MWe in the next decade.

It has been demonstrated in trials that burn-ups of 6,000 MWd/t or even more could be obtained, for example by slightly enriching the fuel. A new type of fuel is being developed moreover which will have a specific capacity double that of current fuels.

From this it may be concluded that the future possibilities of the gas-graphite string appear favourable. This type of reactor will probably remain associated subsequently with a mixed programme of thermal reactors and breeder reactors.

c. *Cost outlook*

On data at present available, the cost of nuclear electricity per kWh allowing for annual utilization times of 7,000 or 6,000 hours for the period 1968-1970, can be roughly estimated at the following figures according to the different levels of fixed charges for proven-type reactors:

Cost of nuclear electricity (mills/kWh)					
Annual fixed charges as per cent. of capital investment					
8.1 %		10 %		13 %	
Annual utilization time		Annual utilization time		Annual utilization time	
6,000 h/yr	7,000 h/yr	6,000 h/yr	7,000 h/yr	6,000 h/yr	7,000 h/yr
5.4	4.9	6.0	5.4	7.0	6.3

The competitiveness of nuclear plants at the end of the present decade can be estimated by comparison with a conventional thermal plant as defined below:

— installation costs for plants to be commissioned in 1968-1970 would be 125 u.a./kWe at 1963 prices;

— specific fuel consumption would be approximately 2,100 kcal/kWh or 300 g.c.e. net;

— maintenance and operating costs would be approximately 4 u.a./ kWe/yr.

In these conditions we can estimate the price per t.c.e. at 7,000 kcal/kg delivered at plant, which would enable a coal-fired thermal plant to generate electricity at the same price as the nuclear plants discussed above.

Fuel price for thermal plant to break even with nuclear plant (u.a. per t.c.e. at 7,000 kcal/kg)					
Annual fixed charges as per cent. of capital investment					
8.1 %		10 %		13 %	
Annual utilization time		Annual utilization time		Annual utilization time	
6,000 h/yr	7,000 h/yr	6,000 h/yr	7,000 h/yr	6,000 h/yr	7,000 h/yr
10.1	9.6	10.8	10.2	12.1	11.3

Allowance must of course be made for some margin of error in the above figures but they are nevertheless probable enough. Moreover, they assume no revolutionary technological breakthroughs and have been worked out with all due care.

Accordingly, if we assume a reference price of 12 u.a./tce for fossil fuels, we can see that large-scale nuclear plants will be economically worth while in the Community as a whole in about 1968 or 1970 for utilization times of 6,000 hours per year and upwards.

PROVEN-TYPE REACTORS

I. Light water reactors

This year the light-water-moderated reactor string has taken a decisive step towards competitiveness with conventional installations, at any rate in those parts of the United States where electricity costs are highest. This major target set for the closing years of the present decade will be reached if the performance of 500 MWe plants now under construction in the United States confirms that of earlier reactors such as YANKEE or DRESDEN and if construction costs do not exceed estimates of contract figures.

1. *US/Euratom Joint Programme*

If the cost of the nuclear kWh has gone down, this is because capital costs have themselves been reduced, due more especially to increased plant capacities. This does not mean that the development of light water reactors (boiling or pressurized water type) raises no further problems—as witness the problem of the inadequacy of stainless stell cladding which arose in 1963 and dictated the use of Zircaloy—but it does help to show why the joint Euratom/United States programme is engaged in fairly large-scale activities in this field.

With the completion of the first power reactor (SENN) constructed under the Euratom/United States Cooperation Agreement and the commissioning shortly of several other plants, it has been possible to set a new target for the programme. Henceforward, laboratory studies will be supplemented by experiments carried out during the operation of these plants. These experiments, into the behaviour of the nuclear part or its improvement, will be of the utmost value for design consultants and for the whole of industry in the Community. In this context, a first major research programme to be carried out at the power reactor operated by SENN has just been authorized by the Joint Board for the Agreement.

It is self-evident that large-scale participation by Community engineers is essential if these researches are to realize their full potential, and it is to be hoped that industry will make the effort required to take advantage of this exceptionally valuable source of information. Generally speaking, no improvement has been possible in the participation of Euratom engineers, essential though it is, in current work under contract both in Europe and in the United States, since the last report was submitted.

In 1963 the Joint Board authorized the negotiation of 27 contracts (including 21 renewals) in the Community, the United States contribution being 23 contracts (including 13 renewals).

Total commitments amounting to nearly 40 million EMA u.a., 21.5 in the Community and 18 in the United States, have been entered into during the first five-year period of the US/Euratom Joint Programme. The present imbalance, which reflects a slight lag between the respective time-tables, will gradually be levelled out. The USAEC budget in fact contains an item of 22.5 million EMA u.a. authorized by way of appropriation for the first five-year tranche, which equals the Commission's commitment. Also to be noted as a credit item on the American side is the speedy transmission of information derived from the USAEC's own programmes and the greater contribution of American centres to major objectives of the Joint Programme: plutonium recycling and two-phase flow system studies, for instance.

For the second five-year period of the Agreement, the main objectives laid down by the Commission and the USAEC relate *inter alia* to improvement of power reactors constructed under the Agreement and optimization of their fuel cycle, improvement of cladding materials, plutonium recycling, corrosion, heat transfer and safety studies, and the processing of irradiated fuels and radioactive wastes. A total of about 34 u.a. (Community plus United States) will be earmarked for these tasks.

Abstracts of all results are published in the Joint Research and Development Program Quarterly Digest.

2. *Nuclear fuels and materials*

The bulk of the effort has continued to bear on uranium-oxidebased fuels, which thanks to advances in fabrication techniques can now be obtained as dense powder much purer than the material obtained by the industrial arc-melting process.

At the same time, Euratom has continued its investigation of the properties of pure uranium oxide single crystals and their reaction to certain factors such as the oxygen/uranium ratio and neutron irradiation. An in-pile loop installed in the Melusine swimming-pool reactor (Grenoble), will be used for the study of fission gas diffusion kinetics in fuel samples heated to high temperatures (2,000° C). Also a few uranium oxide rods were subjected to a thermal flux which kept the central zone molten. Despite these severe conditions, one of the rods reached a mean burn-up of 5,000 MWd/t, which proves that uranium oxide can withstand a much higher thermal flux than that generated at present by reactors using this fuel.

Another compound, uranium nitride, was studied in an American laboratory, with the participation of a Euratom engineer. Here the aim is to develop an economic method of making this material and to investigate its neutron irradiation behaviour. While its high reactivity with water rules it out for water-cooled reactors, its excellent compatibility with sodium, along with good behaviour under neutron flux, indicate its advantages for compact reactors and possibly for fast neutron reactors.

Study of the properties of uranium carbide went on as before.

A programme of studies on corrosion of cladding materials and development of zirconium-based alloys carried out both in the United States and in Europe continues to yield important results. Thus a zirconium alloy developed in the Community has been irradiated and results of these tests are expected this year. An American firm has, for its part, succeeded in developing a zirconium-chrome binary alloy highly resistant to hydride formation.

Lastly, mention can be made under this heading of the research contracts signed by the Commission with a number of firms in the Community for developing the industrial fabrication of future loads for power reactors installed in Europe.

3. *Plutonium recycling*

This is one of the leading items in the US/Euratom Joint research programme. Research into the fabrication of plutonium-containing fuels has been continued, along with neutron studies, and the Commission is now in a position to investigate the possibilities of plutonium recycling in several strings.

Several tons of uranium-plutonium alloys of varying composition are being fabricated in the Community. These various fuels, used in the AQUILON (Saclay), MINERVE (Fontenay-aux-Roses) and MARIUS (Marcoule) critical assemblies, are the subject of a series of measurement programmes, the results of which will greatly assist the study of long-term reactivity in heavy-water- or graphite-moderated reactors.

Twelve rods containing a UO_2-PuO_2 mixed fuel were inserted in the BR-3 reactor core in November 1963 for irradiation up to a mean burn-up of 5,000 to 6,000 MWd/t. This experiment will be followed up by the one planned for the SAXTON pressurized water reactor, where a third of the core will be replaced by fuel rods of the same mixed oxide. In this case the fuel will be in pile for several years so as to reach a mean burn-up of 15,000 MWd/t, and thus it will be possible to observe the major nuclear parameter curves in terms of fuel rod burn-up.

Mention must also be made, in this context, of the excellent relations that have developed between the Commission's technical departments and the Hanford centre in America, where a number of personnel from Euratom and its partners have spent long periods very profitably.

4. *Fluid thermodynamics and hydrodynamics*

The thermal flux of a reactor may not exceed a certain critical value, otherwise it will in certain cases cause damage to the fuel cladding. For this reason, a nuclear plant is usually operated at a thermal flux 1.5 times less than this critical value, or even below. This is a serious limitation and explains the cardinal importance of exhaustive study of the problems of heat transfer and hydrodynamics associated with the various water flow systems. Hence the most important laboratories in the Community are participating in a study of these highly complex problems, at times yielding contradictory results. Since they are also included in the Euratom/United States joint programme, it has been possible to coordinate study of these problems with USAEC's own programme. Thus an intensive exchange of technical reports and visits has developed since the beginning of 1963 between specialist laboratories in the Community and the United States. Liaison is maintained through regular working meetings which in turn help to speed progress.

Investigations in this field have already led to one practical application, which is the subject of simultaneous study in several countries (Canada, United States, Great Britain and Sweden), namely, the fog-cooled reactor project which is, in fact, the outcome of research launched in 1959 at CISE (Centro Informazioni Studi ed Esperienze), Milan. These researches relate to the thermodynamics and hydrodynamics of dispersed water-steam mixtures (fog) and to the corrosion resistance of certain nuclear materials (stainless steel, Zircaloy) to this medium.

5. *Miscellaneous researches*

What factors are responsible for the embrittlement of heavygauge steel plate used in reactor vessels, and how can welding and shaping techniques be improved? These, too, are questions which many Community industries are studying, along with some American laboratories.

Finally, other subjects of research covered are light water reactor computer codes, which are handled by industry in cooperation with CETIS and the reactor physics department at Ispra, and development studies on measurement instrumentation or reactor components.

II. Gas-graphite reactors

The Commission has launched an initial series of activities with reference to this reactor string which, bearing in mind the French and British programmes, is assuming an important role in nuclear energy development in Europe. The construction of a sizeable number of large plants (of 500 MWe or thereabouts), in both France and the United Kingdom, provides for industrial development of this string on a scale which holds out hopes of a substantial reduction in the cost per installed kW.

At the beginning of 1964, for the first time in the Community, life-size nuclear power plants supplied current in normal industrial conditions for a prolonged period. This was achieved by the Latina plant and Chinon EDF 1 with gas-graphite reactors.

The work undertaken by the Commission is largely concerned with development of reactor parts such as prestressed concrete pressure vessels and handling gear for fuel loading/unloading in the leaktight containment during operation. The latter study, on which considerable progress has already been achieved, has led to the construction of a mock-up on which remote control fuel handling and maintenance or repair tests will be carried out.

An increase in the specific capacity of gas-graphite reactors is, of course, a cardinal aim. It calls for the development of a particular fuel element geometry and the use of uranium alloys with an improved resistance to swelling. To this end, a study of uranium-molybdenum-X type (e.g. niobium) ternary alloys has been initiated.

Finally, another series of studies deals with in-pile carbon dioxide corrosion of graphite in temperature and neutron flux conditions peculiar to this reactor type. It is planned to follow up these studies by a series of trials on a loop to be installed in a materials testing reactor in the Community.

DOCUMENT No. 3

HEAVY WATER AND ORGANIC REACTORS

I. ORGEL project

1. *Technical and economic features*

In its Fifth Report, the Commission listed the reasons motivating its decision in 1959 to carry out a thorough investigation of the heavy-water-moderated organic-liquid-cooled reactor string and to orient the Ispra establishment's activities along these lines.

The Council of Ministers, when approving the second five-year programme, confirmed this decision of the Commission. This is based, moreover, on the division of labour on an international plane, since the heavy water/heavy water and heavy water/gas variants are being explored simultaneously by other countries such as Canada, France and Germany. The technical and economic considerations set out below suggest that the ORGEL string can, in the medium term, assist effectively in solving the problem of Europe's energy supplies. Indeed:

— in present circumstances only uranium reactors can ensure the Community's independence in respect of fuel supplies;

— the economy of an ORGEL-type reactor would appear to compare favourably with that of other reactors. In particular, the fuel cycle cost is very low and is, moreover, independent of unknowns which may affect the cost of enriched uranium fuel cycles, such as the plutonium buy-back price and the cost of reprocessing;

— capital costs for an ORGEL plant fairly low because with this string proven techniques and fairly cheap structural materials can be used extensively, and also because of the low pressure in the vessel;

— the high outlet temperature of the coolant holds out the hope of good electrical efficiency, provided that a suitable steam circuit is adopted;

— the degree of utilization of both fissile and fertile materials in ORGEL-type reactors is appreciably greater than in other current natural uranium reactors. At the same time the specific output of plutonium is particularly high with these reactors.

2. *Economic study of the ORGEL string*

During 1963 the ORGEL group continued its detailed study of the reference design for the string drawn up by a number of European design consultants. The group concentrated more particularly on the prospects for technical advances, the reactor fuel cycle and ORGEL's fissile and fertile material economy.

Among major technical improvements currently being developed, mention may be made of the improved control methods obtained by substituting more suitable devices for the rods situated in fuel positions, resulting in lower flux perturbations and therefore better all-round efficiency. Another point to be noted is the possibility of raising thermodynamic efficiency by changing the position of the re-superheater circuit in relation to the superheater circuit. Lastly, although the basic feature of an ORGEL reactor continues to be the natural uranium fuel, a slight level of enrichment is envisaged which, by stepping up the fuel depletion rates, will make it possible to improve the economics of the plant.

Another interesting feature of the ORGEL string is that the fuel cycle cost is not bound up with recovery of fissile material in the spent fuel. In fact depletion rates are high, owing to the good neutron economy of the lattice. A large fraction of the Pu produced is already consumed in the pile, and the value of recovering the residue is contingent on the economics of the extraction process. Nevertheless the ORGEL fuel cycle has a very favourable fissile and fertile material economy since consumption is only 0.15 t. Nat.U/MWe/yr. Furthermore, plutonium production is high (3.4 kg/t. U.), which is valuable if reprocessing is assumed.

In short, bearing in mind the very reasonable prospective cost of an ORGEL reactor, the extremely modest fuel cycle cost, the savings in fissile and fertile materials which it makes possible, and its potential value for getting the fast neutron reactor string under way, the ORGEL string is definitely one of the most interesting of those now being developed.

The Ispra establishment of the Joint Centre made, in 1963, a further big contribution to the development of this string in all its aspects. At the same time its collaboration with laboratories in Member States continued, particularly in the form of research contracts.

3. *Research and development programme*

a. *Chemistry*

Study of the behaviour of polyphenyls under the effect of heat and of irradiation was continued. The two in-pile loops mounted in the MELUSINE reactor at the Centre d'Etudes Nucléaires, Grenoble, enabled irradiation of polyphenyl mixtures at temperatures of 200 to 450° to be carried out, the length of the experiments being so selected that at the end of the test 20 to 40% of the substance had decomposed. The results obtained in a series of twenty tests may be interpreted as deriving from two phenomena: firstly, radiolysis, which depends only on the irradiation dose absorbed and will be substantially constant in the temperature range studied; secondly, *radio-pyrolysis,* which is an exponential function of temperature and occurs as heatinduced decomposition accelerated by the effect of irradiation. As far as triphenyls are concerned for instance, this irradiation decomposition seems in fact to take place more rapidly than pyrolysis alone (the ratio varying between 5 and 2 according to temperature). It must be stressed, moreover, that such irradiation of terphenyls at a temperature of 450° C brings with it no additional problems, since it involves only the expected increase in the speed of decomposition. The substances recovered appear not so "heavy" as those which form at lower temperature and are miscible with the initial substances, at any rate up to a concentration of 50%.

In the past it would have been considered over-optimistic to choose a coolant outlet temperature of 400° C. Today we see that this figure can even be exceeded without adverse effects on the organic fluid, provided that it is economically justified and the choice of structural materials permits.

One of the MELUSINE in-pile loops has been equipped with a device for measuring the speed at which the organic decomposes while constant composition is maintained; it will thus be possible to ascertain exactly the organic consumption of a power reactor in various operating conditions. One loop is also to have a prototype electrical heating element installed in its irradiation tank. This device, which simulates a fuel element, will give a thermal flux of up to 100 W/cm^2 and so will make it possible to examine the coolant in the same conditions as in a power reactor. Lastly, one loop is in the process of adaptation to the SILOE pile at Grenoble, and the Ispra Centre, moving in the direction of more basic research, has begun investigating the polyphenyl pyrolysis mechanism and studying their molecular excitation which plays a vital part in the decomposition phenomenon.

In the field of chemical analysis, research has been directed to bettering the methods already developed in laboratories belonging to the Joint Centre or under contract. Both in mineral and in organic analysis, a number of techniques have been applied such as X-ray spectrography, mass spectrometry, thinlayer and vapour-phase chromatography and neutron activation.

Among problems still outstanding are total trace oxygen determination, description of very heavy decomposition products and comparison and standardization of methods.

As to research into new coolants, this has been mainly concerned with determining the principal components in petroleum fractions already investigated but has been slowed down appreciably by lack of funds.

b. *Physical chemistry*

Basic research mentioned in the Sixth General Report has continued at Ispra where work has been performed on improving the ductility of sintered aluminium powder (SAP: a composite aluminium-aluminium oxide material). The behaviour of graphite in an organic medium has been studied but conclusions from this research must await irradiation results. An electrostatic purification apparatus has been perfected and used on laboratory scale with good effect. Considerable effort has been directed to discovering how zirconium and certain of its alloys behave in an organic medium.

c. *Neutron physics*

The experiments referred to in the Sixth General Report demonstrated that neutron theory hat not yet reached a degree of refinement adequate to predict the reactivity balance of a natural uranium ORGEL-type reactor with the necessary accuracy. Investigation of more rigorous theories has therefore begun and two main supporting experiments have been carried out. The first (in the AQUILON reactor) concerns the fine thermal flux structure, the second (in the ISPRA I reactor) the resonance absorption and the conversion factor in an ORGEL-type bundle. Results are now being analyzed.

d. *Heat transfer*

Two heat transfer loops are at present being operated by Euratom contractors ([1]) with the primary purpose of measuring burn-out fluxes. A general law, much more precise than that employed hitherto, has now been formulated which relates critical flux to the velocity and physical properties of the coolant. A systematic study of heat transfer systems from forced convection to burn-out, is in hand together with an analysis of the effects produced by the geometry of test-sections. It should be added that the results set out in the last General Report regarding methods and apparatus for measuring the physical constants of polyphenyls at high temperatures were regarded as adequate for the further development of the project and this research has now been practically finalized.

e. *Fouling*

By its own activities and through contracts under its administration, the Ispra establishment has made a notable contribution to the study of fouling. This

([1]) A third, fully automatic loop, is being used for research into pyrolytic fouling of heating walls.

is a complex phenomenon in which a deposit is sometimes formed, whose main effect is to impair heat transfer in the reactor. Euratom, which had embarked on the study of this phenomenon at Ispra, continued it in 1963. It has succeeded in determining the order of magnitude of certain forces—such as the electric field set up by irradiation—which may enter into its mechanism; it has experimented with heat transfer loops to determine the effect of various thermo-hydraulic parameters and of the composition of the liquid (1) on the fouling rate; and it has brought out the importance of such primary factors as the mineral impurities content and of secondary factors like working pressure which may completely distort measurements if not maintained at a high enough level.

In the related field of organic liquids purification, work has been done on the possible use of solvents. Also, an installation has been prepared for studying filters and absorber beds and a test programme has been worked out with CNEN in the context of that body's researches into organic reactors. Lastly, basic research has started at Ispra on the characteristics of various absorbers.

f. *Technology*

This continues to be a full-time task for the Technology Section at the Ispra Centre, which likewise administers a number of contracts. Installations commissioned in 1962 for testing pumps, valves and measuring apparatus operating in an organic medium at 400° have already yielded numerous results. A Joint Board for exploiting these results has been established with the CNEN (Italian Atomic Energy Commission).

A SAP channel tested out on an out-of-pile loop has provided valuable data: actually, a trial lasting some hundreds of hours on a SAP channel containing a dummy fuel element with organic liquid coolant heated up to 410° C and circulating at 12 m/sec. revealed nothing abnormal. This is the loop which is now being modified to take a prototype channel intended for the ESSOR reactor.

A highly flexible device for exploring the safety features of ESSOR has been constructed, which can later be applied to ORGEL and indeed, more generally, to any other heavy water reactor. Linked with this safety research are methods for measuring stress and pressure fluctuations devised also by the technology service.

(1) These experiments have shown that no fouling occurs in 250 hours at a flow-rate of 3 m/sec., a heating wall temperature of 480° C and a fluid mass temperature of 380° C, where the coolant contains 30% of pyrolytic decomposition products, even if the circuit includes a mild steel section of substantial surface area and up to 30 ppm chlorine.

Among other results achieved in a wide range of studies are those relating to mandrelling, SAP-steel joints and, in particular, thermal insulators (especially flame-sprayed insulators). Finally, work on the thermo-mechanical behaviour of fuel elements is well advanced and shows that present difficulties can be overcome by proper spacing of the rods in the bundle, within the limits of the possibilities afforded by the overall neutron balance.

g. *Metallurgy and fuel elements*

The bulk of this part of the programme is still being carried out at the Ispra establishment where the Metallurgy Section devotes 90% of its energies to it, apart from being responsible for the management of a large number of contracts. The study of sintered aluminium with a view to its use as a cladding and structural material has been continued. Coarse parasitic inclusions have been successfully eliminated (through more stringent quality control of powders); the improvement of ductility at 450° C has been investigated; and the problem of pressure tube fabrication and of the nondestructive examination of smooth tubes have received very thorough attention. For cladding tubes, reject rates are now low enough to make the results economically tenable. Uranium carbide remains the basic ORGEL fuel. Delivery of the 7.5 tons ordered is now in progress and the various problems of composition testing and storage have been resolved.

Under the Euratom/Canada Agreement for Cooperation, SAP-clad 28 mm-diameter solid uranium carbide rods supplied by Euratom were exposed to irradiation for two months in the Canadian NRX reactor. The performance was excellent, to the point of withstanding numerous thermal cycles without damage.

Other points to be noted are:

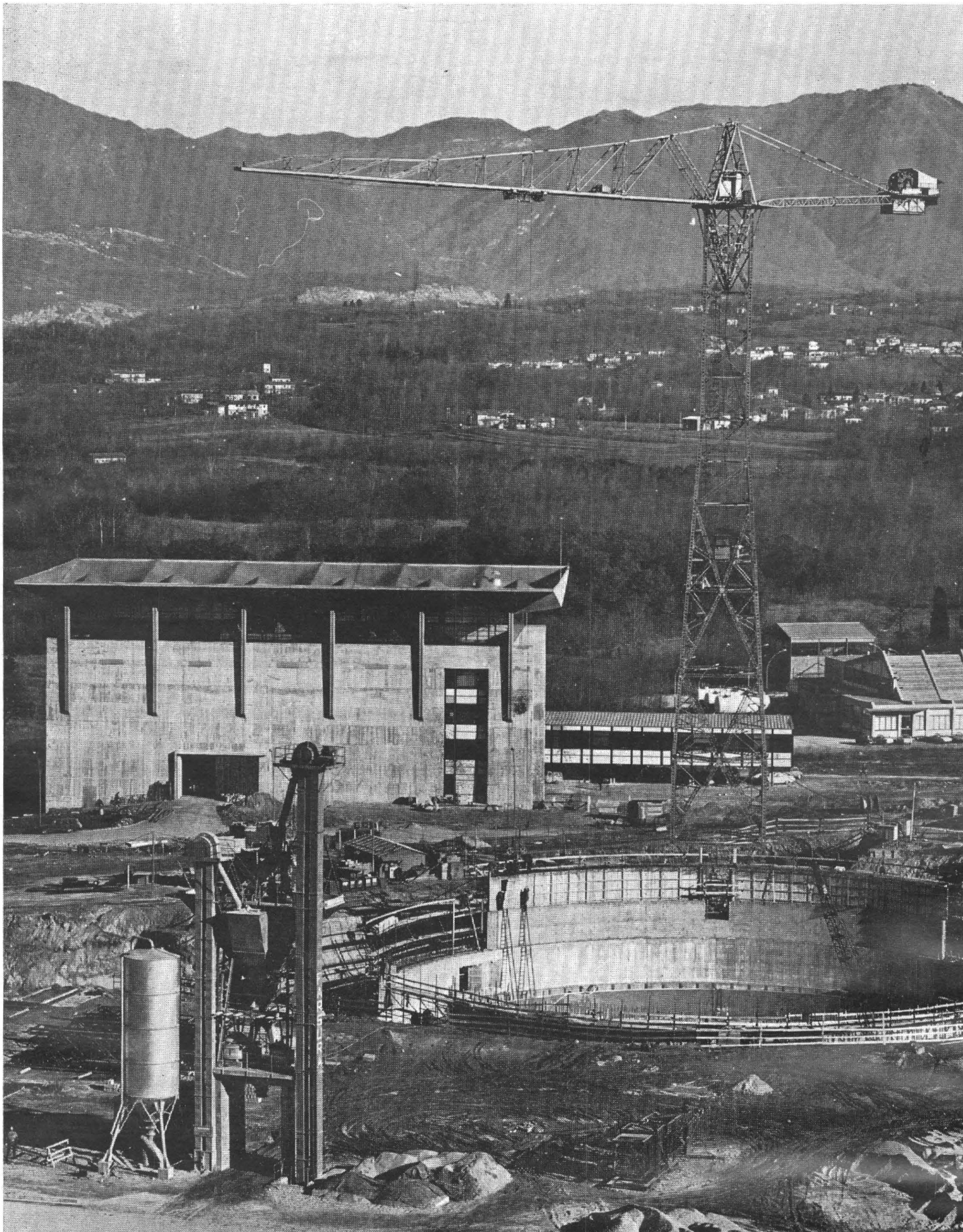
— the publication of a synoptic report on diffusion barriers, the uranium metal method being no longer regarded as having priority where ORGEL is concerned;

— the mounting in the ISPRA 1 reactor of an irradiation device designed for various tests on carbide rods.

4. *Design and construction*

a. *ECO (Expérience Critique ORGEL - ORGEL critical experiment)*

The ECO reactor, the construction of which has been somewhat delayed, is now due for commissioning in April 1964. An extensive programme of lattice studies is scheduled, with the emphasis on carbide utilization which is proving to be the best fuel for an ORGEL reactor running on natural uranium.



Ispra — the ECO reactor and the ESSOR reactor construction site. ECO will go into service immediately, while the ESSOR civil engineering work was begun in June 1963. The reactor foundations and shuttering are already completed, whereas the leaktight containment is still under construction.

b. *ESSOR (ESSai ORgel - ORGEL test reactor)*

Since 10 October 1962 when the Commission approved the construction of ESSOR, a special test reactor for heavy-watermoderated pressure tube reactors, the work has so far proceeded according to schedule and there have been no hold-ups. Site clearance having been completed, the civil engineering contractor was able to take over at end June 1963, and the reactor bed and casing are now completed. The containment shell constructor moved in during December 1963 and the shell is now under construction. As regards the reactor itself, tenders were invited for the main components and the replies are at present being sifted.

Parallel with the above work, studies and tests have continued, with particular reference to the functioning of measuring circuits, valves, pumps and so on, and especially to the feed zone fuel element, by means of experiments at the Mol nuclear research centre.

Lastly, the design of a fuel element for the experimental zone has been initiated. Although not fully representative of an element for an ORGEL power reactor, this element should enable ESSOR to be started up in adequate safety conditions, while providing valuable information on a SAP-clad carbide element.

5. *The Euratom/Canada Agreement and three-way cooperation between Euratom, Canada and the United States*

Cooperation with Canada continued in 1963 but contacts with the Americans were less regular, the USAEC having decided to cease work on the OMR [1] string and to dissolve the Organic Working Group and Standards Committee in order to concentrate on water reactor strings in which the United States has already invested very heavily. The tripartite meeting, held this year in Canada, followed a two-day seminar on essential features of the heavy water/organic string, and confirmed the three participants' interest in the latter. The meeting demonstrated the privileged position occupied by Euratom in this field, thanks to the work of its technical departments.

II. Halden reactor

In 1962 the Commission agreed to a limited extension of the agreement covering the Halden reactor (Norway) so as to complete the experimental

(1) OMR = Organic Moderated Reactor, Idaho Falls (USA).

programme begun there on a uranium oxide fuel element core. A feature of the operation of this reactor in 1963 was the appearance of unexpected spontaneous power fluctuations and an increase in the heavy water leakages previously observed.

The tests were notable for the intensive use of instrumented fuel elements for measuring certain physical parameters *in situ,* which functioned satisfactorily. Analysis and interpretation of the results of the experiments as a whole will take place in 1964, with the help of the large-scale computer and data processing installations acquired by the Halden Project.

III. PRO project

At the end of 1963, negotiations were entered into with the Comitato Nazionale per l'Energia Nucleare for a contract of association to cover research relating to an Italian project for an organic-liquid-moderated and-cooled reactor (PRO Project).

The scheduled programme, to be carried out in the specific conditions of the PRO reactor as to temperature, pressure, coolant composition, etc., will include work on heat exchange, purification and SAP, followed by certain individual irradiation and technological studies.

DOCUMENT No. 4 **HOMOGENEOUS REACTORS**

To arrive at a better assessment of the outlook for a reactor type in which the fuel would be suspended in an aqueous slurry serving both as moderator and coolant, the Commission has since 1959 been engaged in research in association with the N.V. Maatschappij tot Keuring van Electrotechnische Materialen (KEMA) at Arnhem. This research could lead to the construction within the Community of a test reactor, the operation of which would enable present uncertainties as to the homogeneous reactor concept to be dispelled.

It goes without saying that such construction could only be embarked on after detailed study of problems of engineering, hydraulics etc., which in the proposed concept are of particular complexity, and on the basis of a whole range of laboratory experiments. For this reason the research and development studies were further continued by the Euratom/KEMA association in 1963 with special emphasis on the irradiation behaviour of suspended fuels. While it has proved possible, due to advances achieved in the course of the year, to throw more light on the phenomena and mechanisms involved in suspensions subjected to irradiation, results are still inadequate for conclusions to be drawn on suspended fuel behaviour in the conditions obtaining inside a power reactor. Hence the present scope of the trials needs to be extended to cover irradiations at high depletion rates.

The subcritical experiment installed at Arnhem has been in continuous use and has furnished fresh data on problems concerning the neutron and hydraulic stability of suspended fuels in circulation.

Technological and hydraulics studies were continued, dealing in particular with the problems raised by the vessel for the KSTR reactor experiment (KEMA Suspensie Test Reactor) and with the development of certain special equipment such as the hydrocyclone.

On its expiry in April 1963, the Euratom/KEMA association was renewed for a period of three years, the broad lines of the programme remaining unaltered.

DOCUMENT No. 5

FOG-COOLED REACTORS

Work on potential uses of water/steam mixture as reactor coolants was continued under a contract with the Centro Informazioni Studi ed Esperienze (CISE), Milan. Research bore specifically on the operation of a loop installed at Genoa with a view to large-scale flow and heat transfer studies and of a loop for corrosion studies under irradiation assembled in the swimming-pool pile of the SORIN research centre at Saluggia.

The first burn-out measurements taken in the Genoa loop confirmed the results already obtained for simple flow geometries in a smaller loop at Piacenza. Experiments were also carried out on ring geometries, while cluster geometries will be tried early in 1964.

In-pile corrosion tests showed that the corrosion rate of Zircaloy-2 went up by only about 25% following irradiation.

These encouraging results caused the Commission to envisage the design study of a power reactor. A research contract recently concluded with CISE and SORIN will as a first stage enable the basic information to be acquired which is needed for designing a natural uranium heavy-water-moderated fog-cooled power reactor, and to evaluate the economic feasibility of the concept. For a reactor of this type the fuel to be considered may be either uranium oxide clusters or uranium metal in tube form. The first objective is thus to compare the advantages of the two possibilities and discover which is the more promising.

To provide the necessary experimental underpinning, it is planned to conduct critical tests, in Aquilon II at Saclay, with a uranium metal tube lattice. At the same time, the construction of an out-of-pile high-pressure loop should make it possible to simulate the main coolant circuit in the reactor and to investigate the dynamic behaviour of the assembly.

ADVANCED GAS REACTORS

In November 1962 the Commission took part in the extension of the agreement concluded in 1959, under the auspices of OECD, for the construction and operation of a high-temperature reactor experiment at Winfrith Heath (DRAGON project). The aims of the new agreement, which runs until March 1967, henceforward cover, besides construction and operation of the reactor, a large-scale research programme, technical and economic studies and basic plans for a high-temperature power reactor functioning on the same principle as DRAGON and profiting from experience gained with it.

Construction of the experimental reactor, begun in 1960, was practically completed at the end of 1963 and it is expected to go critical towards mid-1964. Full-power operation might start by the end of 1964. This reactor will enable project engineers to try out fuel elements developed for use in future power reactors of this type (pyrolytic-carbon-coated particles of thorium and uranium bicarbide) and to tackle various engineering problems such as the operating behaviour of gas-bearing blowers, the leaktightness of the primary circuit and the purifying plant for helium coolant.

In 1963, prototype fuel elements were tried out in several piles in Europe (Studsvik in Norway, Riso in Denmark and Wurenlingen in Switzerland) and in a high-temperature-helium-cooled loop installed in the BR 2 reactor. The tests were carried out in conditions approximating to those which will obtain inside a power reactor of this type. The results afford grounds for hoping that burn-ups of around 100,000 MWd/t may be achieved in power reactors without fission product elimination and with no risk of undue contamination of the primary circuits.

Certain problems, such as heat exchange in high-temperature systems, have been resolved and the researchers working on them have rejoined their original teams. Progress in other directions, as for instance that of helium purification by low-temperature adsorption, holds out prospects of a solution in the near future.

Mass transfer problems have received careful attention. The test loop installed in the BR 2 reactor has yielded initial results and it is hoped before long to demonstrate that no serious problems will arise in a power reactor. Obviously, everything depends on the leaktight sealing of the heat exchangers.

The physics unit went on with preparations for starting up the reactor equipment and has begun the evaluation and optimization studies, from the neutronics standpoint, for a power reactor based on DRAGON. For the same reactor a preliminary engineering design has been prepared, relating to a 1,250 MWth (535 MWe) installation. This was done in cooperation with an industrial group in the Community to which a design study contract has been awarded at the beginning of 1963. This work corroborated the project conclusions as to the economic value of a high-temperature-gas-cooled thorium power plant.

Negotiations with a view to associating the Community with the German high-temperature thorium reactor project (HTTR project) continued in 1963 but have not yet reached a conclusion.

FAST NEUTRON REACTORS

Almost all the research into fast neutron reactors is being carried out under association arrangements by means of which the Commission coordinates the whole of the present capacity of Community countries.

I. The work at Cadarache and the RAPSODIE reactor

The first of these associations was entered into in June 1962 with the French Atomic Energy Commission (CEA). It has two aims - the construction of an experimental 20 MWth fast neutron reactor RAPSODIE (sodium-cooled fast reactor), and an installation consisting of a critical assembly MASURCA (Cadarache fast breeder mock-up) and a standard neutron source reactor HARMONIE.

This plant will be located at the Cadarache nuclear centre, 35 km from Aix-en-Provence, where the RAPSODIE reactor is under construction and scheduled for start-up in 1966. The purpose is three-fold: firstly, to lay the basis of a sodium-cooled reactor technology which would be directly applicable to future industrial reactors; next to gather physical data and experience on fast plutonium reactors; and lastly to test fuel elements for use in the big fast reactors of the future.

Of the preliminary studies, those relating to the cooling system have taken thousands of hours of experiment on sodium loops one of which, a 10 MW loop, was a replica of one of the two RAPSODIE circuits; other research, on the reactor vessel, is being carried out on a full-scale mock-up. In addition, the fuel specifications have been determined on the basis of experiments conducted on the American critical assembly ZPR III at Arco (Idaho).

The fuel decided on is the mixed oxide UO_2-PuO_2 which proved to be preferable to the U-Pu-Mo alloy originally contemplated. The first 45 kg of plutonium were supplied at the beginning of 1964 by the United Kingdom Atomic Energy Authority, which will also supply the 45 kg still needed. The fuel itself will be fabricated at Cadarache.

By the end of 1963, the conventional buildings and the containment were practically finished and internal civil engineering work was to be undertaken in 1964. The erection of the reactor should thus start at the end of the year and be completed at the beginning of 1966.

HARMONIE and MASURCA

For the RAPSODIE experiments, the nuclear equipment employed will be calibrated by a standard neutron source, HARMONIE, which will also be used for supplying other assemblies and for MASURCA.

HARMONIE is a small reactor based on the American AFSR reactor, Arco, but incorporating improvements which make it a more flexible instrument appropriate for a wider range of uses. In particular, the whole core and blanket assembly can be extracted from the protective concrete shell for special experiments. Design studies are now terminated and construction began at the end of 1963. It is due for completion early in 1965.

MASURCA is a fast neutron plutonium critical mock-up, intended for use in design studies for reactors with cores of up to 5,000 l. volume (i.e. future plants with capacities in the order of 500 MWe). It consists in an assembly of stainless steel tubes in which the volumetric composition of the reactor to be studied will be simulated; the materials are stacked in these tubes in the form of inserts or plates. Once the assembly is critical, it can be used for experiments relating to the reactor project at very low power (maximum 100 W). Construction of this apparatus is about to start; it will probably be completed at the beginning of 1966.

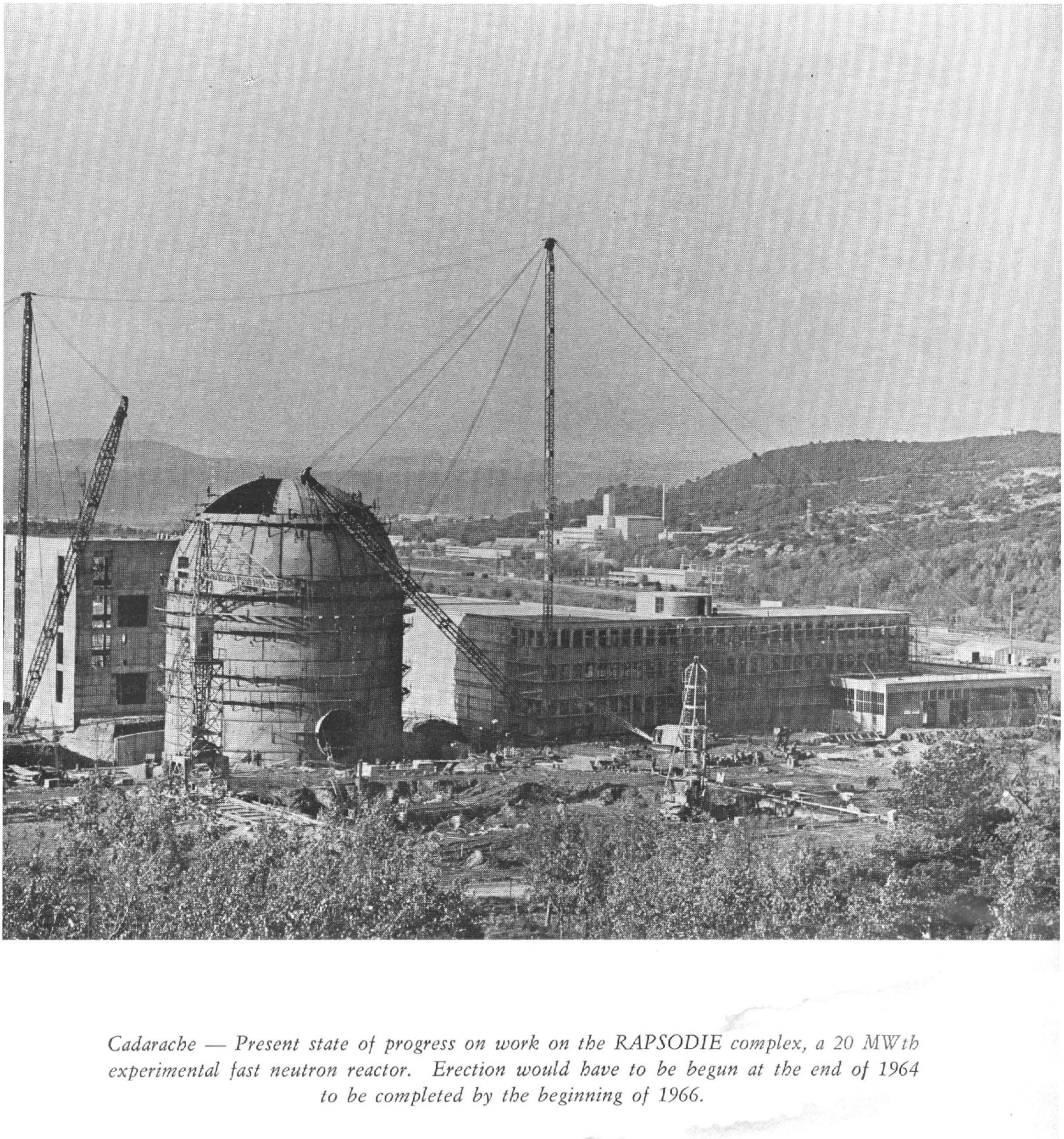
Reactor string research at Cadarache

RAPSODIE is only the first link in the Community's chain of fast reactors. A further stage is considered to be necessary before constructing, around 1975-1980, industrial-scale fast reactors able to compete with established sources of power, either conventional or nuclear, at that time.

This further stage is that of a prototype power reactor of about 100 MWe, in which all the solutions adopted for the industrial reactor will be incorporated.

It will be realized that study of the prototype reactor must depend on the preparation of draft designs for high-capacity industrial power plants and on parallel research in the realm of neutronics as well as thermal, mechanical and fuel studies.

The Cadarache teams will in the first half of 1964 be initiating reactor string studies with assistance from industrial groups in the Community. The Commission will participate in this research under an additional clause to the present association contract, due to be signed shortly.



Cadarache — Present state of progress on work on the RAPSODIE complex, a 20 MWth experimental fast neutron reactor. Erection would have to be begun at the end of 1964 to be completed by the beginning of 1966.

II. Work on fast neutrons at Karlsruhe

In May 1963, a second contract of association was concluded with the German nuclear research centre at Karlsruhe dealing with the fast reactor string. As at Cadarache, its object is the setting up of a prototype reactor but with two important differences. One is that the cooling system is not restricted to sodium—it may use either that substance, or gas, or dry steam; the other is that mixed uranium/plutonium oxide is the fuel proposed, whereas Cadarache intends to cover a range including carbides, nitrides and metal alloys.

It will be the business of Karlsruhe until 1966 to apply and compare the three types of coolant, and from 1967 onwards to concentrate on whichever one moves the best. It is for this that the SNEAK, STARK and SUAK experimental plants have been fitted out.

SNEAK (Schnelle Nullenenergie-Anordnung Karlsruhe) is a fast neutron critical assembly using plutonium like MASURCA but differing from it in two respects—in size (it only permits of the study of reactors with core not exceeding 2,000 l) and in fuel dimensions and composition. The solution thus adopted by Karlsruhe is more especially suited to assessment of the oxide reactors provided for in the programme. Begun in November 1963, SNEAK will probably be completed towards the middle of 1965.

STARK (Schneller thermischer Argonaut-Reaktor Karlsruhe) is simply the ARGONAUT reactor transformed. The latter's central graphite column being replaced by a sub-critical fast neutron core, it is the coupling of this core with the peripheral thermal neutron crown, likewise sub-critical, which brings the whole assembly to criticality. The purpose of STARK is, in the first place, the physical study of this type of coupling. Conversion of ARGONAUT was started in September 1963 and will be finished at the beginning of 1964.

Lastly SUAK (Schnelle unterkritische Anordnung Karlsruhe) is a sub-critical assembly which will be fed from a pulsed fast neutron source. It should enable the neutrons to be subjected to the pulsed technique for which Karlsruhe has established an international reputation in respect of thermal neutrons.

In addition, the Euratom/Karlsruhe association will participate in the establishment of the American experimental reactor SEFOR (at Fayetteville, Arkansas). This 20 MWth pile is designed for studying the Doppler coefficient in fast reactors. Scheduled for commissioning by 1967 it is expected in fast reactors. Scheduled for commissioning by 1967 it is expected to furnish data directly applicable to the large plutonium-oxide fuelled reactors of the future.

III. Italian fast reactor project

A third contract of association was signed at the end of 1963 between Euratom and the Italian CNEN (Comitato Nazionale per l'Energia Nucleare). The original programme has undergone a series of modifications and now needs complete recasting. Discussions are in progress to determine the new programme.

IV. Activities of the Joint Centre in fast reactor research

The Joint Research Centre Establishment at Ispra in 1963 pursued the three lines of enquiry opened up during 1962. In reactor physics, it perfected several advanced codes for fast reactor calculations, along with their application to the Doppler effect. As regards fuel processing, it is investigating an igneous electrolysis process and the reconversion of halides into oxides or carbides.

The start-up of the first sodium-potassium alloy loop has now made possible the study of heat transfer in liquid metals. The second loop should be ready for use early in 1964.

As to the European Transuranium Institute, its activities started with fuel studies as part of the SNEAK programme of the Euratom/Karlsruhe association and of the MASURCA programme, for which it may be entrusted with fuel fabrication.

V. International relations and cooperation

Negotiations for the exchange of personnel and of information on fast reactors continued between the Commission and its associates on the one hand and the United States Atomic Energy Commission on the other hand. Negotiations were also started with the UKAEA on the same subject.

Within Euratom, the recent signature (at the end of the year) of the latest contract of association made it necessary to hold over until 1964 the first meeting of the projected liaison group to coordinate the activities of the Commission and its various associates.

VI. Supply of fissile materials

A substantial problem is raised by fissile materials—how to supply all the fast reactors discussed above. RAPSODIE will require during the second five-year period (1963-1967) some 300 kg of uranium 235 and 180 kg of plutonium; MASURCA and SNEAK, even though practically no fuel will be consumed (since the power will be virtually zero), will need 350 kg of plutonium and approximately a ton of enriched uranium. If the needs of HARMONIE, STARK and other plants or experiments are added, clearly it will be several years before the Community can meet these requirements. Furthermore, when the budget estimates for the five-year programme were drawn up in 1962 it was hoped that plutonium might be obtained on long lease; it was only in 1963/1964 that this turned out to be too optimistic.

It was therefore necessary to enter into negotiations with the USAEC and the UKAEA, these being the only producers in a position to supply the requisite quantities, with a view to solving the problem of fissile material supplies and of financing them within the limits set by the five-year programme budget. In the course of the talks the United States agreed to sell the Community the plutonium required for MASURCA and SNEAK and to lease to the Community until 1968 the whole of the uranium 235 needed. The United Kingdom, for its part, will supply the plutonium which will be used for fabricating the first core for RAPSODIE. A decision will be taken later on the supply of plutonium for the second core (for delivery in 1966/1967).

DOCUMENT No. 8

CONTROLLED THERMONUCLEAR REACTIONS

In contrast to fission, by which energy is extracted from heavy nuclei, fusion could enable it to be obtained from light nuclei. It is only possible in a sufficiently dense, stable plasma raised to a temperature of the order of 100 million degrees. The fundamental problem involved in fusion is precisely to generate and contain, i.e. confine, such a plasma. It is generally held that to solve this problem much more needs to be known about the physical properties of matter in this state, the chief difficulty always being first to produce the plasma and then to hold it. This continued to be the problem during 1963, despite slow progress punctuated occasionally by important successes.

No great changes in policy occurred as far as Euratom was concerned. The Commission's activities were pursued under contracts of association, which remained unaltered in number and in structure. Thus the contracts signed with the Institut für Plasmaphysik (Garching) which was due to expire on 31 December 1963, was prolonged for a year pending the possibility of renewing it, along with the others, for a lengthier period on more standard lines providing better coordination of programmes.

The activities of the laboratories working under contracts of association cannot be isolated from scientific progress in general. However, two notable facts stand out among the year's achievements: one is the discovery of new magnetic field configurations to obtain a stable plasma confinement and the first experimental result on this subject; the other is the application of lasers to the study and possibly the production of plasma. That Community laboratories took part in these two lines of research and made valuable contributions to its advancement is a source of great satisfaction to Euratom. Mention should also be made of the progress achieved in rigging out these laboratories, several large-scale experimental assemblies having been successfully completed, besides exchanges of high-level scientific personnel and participation in international meetings—in particular the one on mirror devices held at Fontenay-aux-Roses by the Euratom/CEA association.

I. Advances in theoretical plasma research

Study of the confinement and stability of plasmas has continued, using conventional magnetic field configurations. Thus work has been pursued on the new toroidal topology stability zones recently discovered at Fontenay-aux-Roses.

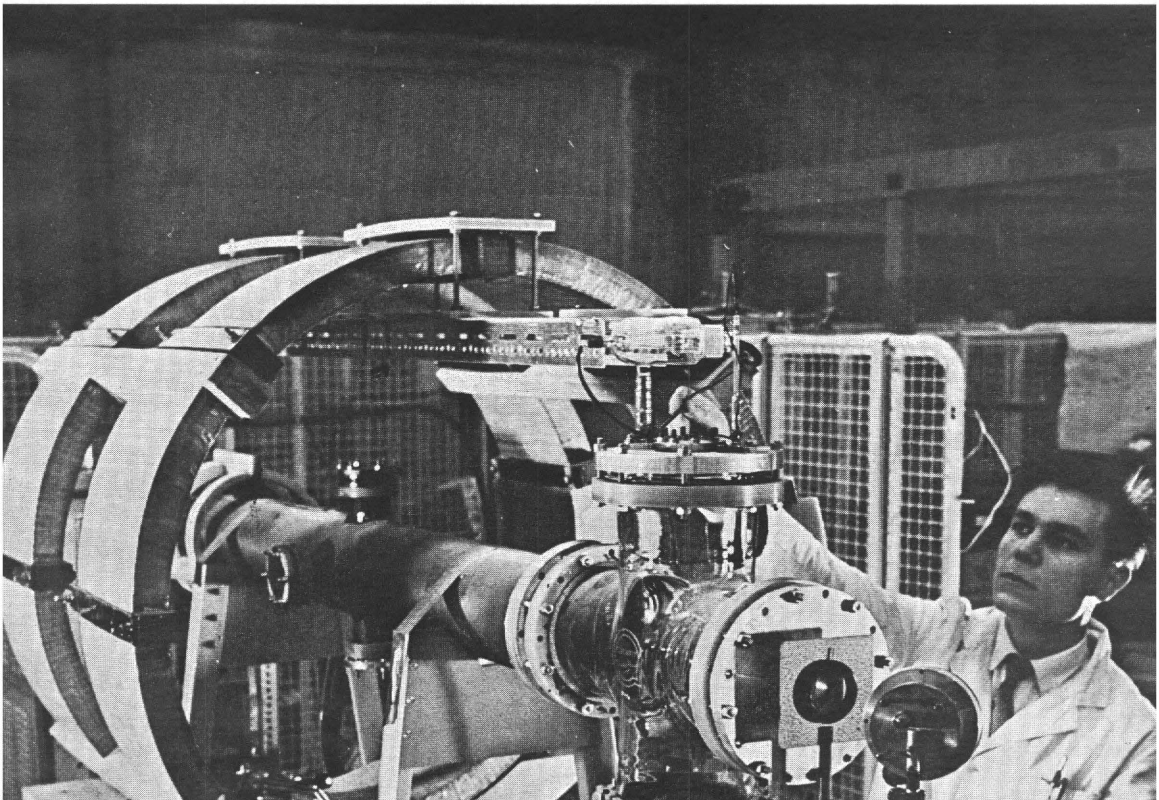
Apart from these conventional configurations, new ones have been discovered at Fontenay-aux-Roses in which the field strength passes through a minimum without reaching a zero value and which appear to be particularly appropriate for ensuring the stable confinement of a hot plasma. Although it is too early yet to say what density can be reached or whether a decisive step has really been made towards a solution of the problem, it seems reasonable to hope that this development will make it easier to hold the hot plasma, so that its study will be considerably facilitated. In the field of plasma dynamics and azimuthal pinch configurations, which are under study at Frascati, Jülich and Garching, particular attention should be drawn to the numerical configurations set up in the last-named laboratory to keep close track of the experimental conditions. Mention should likewise be made of the study being carried out at Garching and Fontenay-aux-Roses of micro-instability, turbulence and diffusion and of the investigation of confinement by radiofrequency undertaken by the Jutphaas and Saclay laboratories. In the field of plasma physics, reference should be made, inter alia, to the work being performed on shock and ionization waves and radiations, as well as the theories covering electrostatic probes and laser application in conjunction with the diagnostic techniques discussed below.

II. Experimental pinch research

Pinch is one of the phenomena by means of which the plasma can be confined, i.e. held away from the walls of the device in which the process is carried out. The pinch effect can be produced by magnetic fields of various configurations, as referred to above. An experiment has also been carried out at Garching on zeta pinch, but the spearhead of the research effort is still directed at tubular and azimuthal (theta) pinch.

Experiments were carried out on the former type of pinch at Fontenay-aux-Roses by means of the EPPE device, which corroborated the stability already observed on a small scale, while the Garching laboratory has been engaged on shock wave studies.

The second type has been explored further at a number of laboratories. This remains the most practical process and is so far the only one yielding a plasma



Fontenay-aux-Roses — DECA experimental magnetic-mirror device for studying controlled thermonuclear reactions.

which is dense (up to 10^{17} particles per cm^3 [1]), hot (of the order of 10 million °K) and which consequently possesses, except for the life-time, thermonuclear characteristics. The life-time of this plasma is only some tens of microseconds, but pending its increase by a factor of at least 1,000, a plasma of this kind can still be used to provide highly useful information. Thus use is most frequently made of the theta-pinch devices to generate this type of plasma. At Garching, for example, various models are used to study plasma dynamics and shock wave propagation as well as to measure their density and radiation emitted. The new 1.5 MJ capacitor bank, which is nearing completion, will make it possible to carry out tests on a larger scale.

The theta-pinch rigs set up at Frascati (CARIDDI experiment) have made it possible to study ionization fronts and instabilities during the initial phase of discharge and of the ignition mechanism. Attempts are now being made at Jülich to produce a hot, dense, pure and reproducible plasma by heating before subjecting it to compression. The small-scale experiments performed so far in this laboratory, which have centred on temperature and density measurements, plasma oscillations, the influence of controlled impurities and plasma end losses, will soon be rounded off by tests on a larger scale, since trials have already been carried out on the 0.6 MJ bank.

The toroidal pinch obtained at Fontenay-aux-Roses on the TA 2,000 machine has been applied to spectroscopy research, while the same laboratory has also initiated the development of the HARMONICA project aimed at confirming the existence of new stability zones. Another toroidal pinch obtained at Jutphaas has been used to study longitudinal pinch, azimuthal pinch and rotating field alternate pinch configurations. After a first rig set up to examine the plasma column in the process of formation, a second is now being constructed which, with a single excited coil, creates a helicoidal pinch which observations have shown to be stable and reproducible.

A further toroidal pinch has been achieved at Garching: on the basis of theoretical calculations, the equilibrium difficulties have been overcome by means of additional windings (M + S torus).

III. Magnetic mirror machines

Plasma can be confined by means of magnetic mirrors in which the particles are reflected inwards into the confinement space. These apparatus, which absorb a considerable proportion of the research effort at Fontenay-aux-Roses, require fields of a more complex configuration involving, however, a greater

(1) 10^{17} = one hundred thousand million million.

risk of instability than that obtaining in the configurations envisaged previously. One of these devices is the ion-injection machine (MMII), the components of which have made it possible to study, before assembly, the injection of deuterium ions and the electric arc to be used to dissociate them.

The same laboratory elaborated the experimental adiabatic compression device (DECA I) in which the plasma was compressed adiabatically by a magnetic field; its successor, DECA II, now used to obtain in certain cases a plasma with an ion energy of 2,000 eV, a probable particle density of the order of $10^{14}/cm^3$ and an estimated life of 100 us. A multipolar field was recently superimposed on the mirror fields in an attempt to improve stability, but it is as yet too early to assess the results.

In addition to this work at Fontenay-aux-Roses, mention should be made of the BILLE-EN-TETE device in which two electrodeless plasma-guns, set up opposite each other, cause head-on plasma jet collisions. In the central region, a high-density plasma in thus formed in which, in a uniform field, the ion collisions transform the kinetic energy of the jets into thermal ion energy. Furthermore, with a view to plasma burst injection, various electrodeless plasmaguns and micropinch guns have been developed.

At Jülich, plasma beams have been accelerated in such guns by means of a progressive magnetic pressure wave, while the rotating plasmas produced in the Jutphaas laboratory have made possible the continued investigation of the basic laws governing conservation of energy and angular momentum.

IV. Production of very high density plasma

Attempts are being made in the Frascati laboratory to offset plasma instability by stepping up the density rather than the duration of confinement. The technique consists in forcing the plasma layer to contract very rapidly down to the smallest possible radius, a process which is carried out in the experiments MIRAPI (1), MAFIN I (2) (contraction by longitudinal pinch) and the MAFIN II experiments (contraction by detonation of explosives). In the first experiment, the plasma, which is produced from aluminium and lithium powder volatilized by an ultraviolet flash with deuterium, is caused to contract round its own axis. In the two others, contraction is effected

(1) Minimum radius pinch.
(2) Magnetic field intensification.

by the implosion of a metallic wall. MAFIN II has proved particularly effective in enabling very powerful magnetic fields to be created (several megagauss).

At Garching, the same objective has been pursued, i.e. the production of dense plasmas by means of a double anode electric arc confined by a field of several tens of thousands of gauss.

V. High-frequency confinement and miscellaneous research

Plasma confinement can also be achieved by the pressure of a high-frequency wave electromagnetic field. In this connection the experiments ICARE I and II set up at Saclay have enabled this effect to be observed for a particle density of about $10^{13}/cm^3$, while at Jutphaas use was made of an arrangement in which the wave's electric field was parallel or perpendicular to the static axial magnetic field.

In the field of general plasma physics, attention should be paid to the substantial activities carried out at the Garching laboratories, where experiments are under way on stationary plasmas of moderate temperature and density but of long duration. The plasmas produced are caesium plasmas, columns of a plasma generated by duoplasmatrons in a longitudinal field, discharge arcs, etc. The studies bear on diffusion (which proved to raise much greater difficulties than anticipated), the transport coefficient interaction with charged particle beams, etc.

In diagnostics, studies have been carried out at Utrecht and Garching to improve the sensitivity of electric and magnetic probes and to reduce their interference on discharge. Likewise at Garching, piezo-electric probes have been employed for the direct measurement of plasma pressure, while for density measurements the Saclay laboratory has developed the microwave system to wavelengths of 0.5 mm.

Finally, attention should again be drawn to the new possibilities opened up by the use of lasers. The Frascati laboratory has employed them for studying microscopic phenomena occurring in plasma, while a laser at a 90° angle has been used at Garching in the observation of plasma diffusion. The Fontenay-aux-Roses laboratory has constructed various types of arc for observation purposes in all the spectroscopic ranges.

VI. Progress of technology

All the advances referred to in the foregoing have gone hand-in-hand with progress on the technical plane. Vacuum techniques have been developed to such a point that values of 10^{-9} - 10^{-10} mm Hg have been attained in appreciable volumes: more symmetrical and intense magnetic fields have been created by means of improved windings (Fontenay-aux-Roses) and better cooling devices (Garching): a solution has been devised to the problem raised by the timing of detonations (Frascati) or spark-gaps (Jülich): more appropriate materials have been selected, and particular attention has been devoted to super-conductor techniques and cryogenics.

DOCUMENT No. 9

STUDIES RELATED TO THE DEVELOPMENT OF REACTOR STRINGS

I. Radioactive waste processing

The past year has been mainly devoted to the study of the problems of processing and storage of radioactive waste which will arise in the Community over the next few years. This survey confirmed the need for concentrating research on medium and high-activity waste on the one hand, and the permanent storage of waste on the other.

As regards storage, work in the Community and in the West has not so far yielded any economic or satisfactory solutions. Interesting prospects are, however, opened up by a number of processes. Studies have been undertaken for instance on the use of derelict salt mines or of pits specially dug in a salt formation for the permanent disposal of radioactive waste. These various possibilities are currently being analyzed and the results will enable priorities to be established for the Commission's research programme activities.

II. Chemical processing of irradiated fuels

Account being taken of the activities pursued by the Member States, the Commission's action has hitherto centred on irradiated fuel processing by volatilization. It will be recalled that the most promising applications of this process appear to be restricted to fuels with a high residual content of fissile material. This applies to fast neutron reactor fuels (e.g. mixed uranium/plutonium oxides) and high-flux pile MTR elements (highly enriched uranium).

Work in progress since 1960 has enabled a start to be made on a small pilot laboratory unit which will make it possible to study the various stages of the process on irradiated fuel. This plant, due for commissioning this year, will be used, at all events primarily, for uranium oxide fluorination studies. It will furnish important data on such points as the decontamination factor, uranium/plutonium separation, chemical reaction control and problems of remote-control equipment maintenance. The advantages of fluorination by chlorine trifluoride have emerged from laboratory research. The method, it seems, permits of complete uranium/plutonium separation; the former is distilled as hexafluoride while the latter, left in the fission products, can be volatilized in turn by fluorine. Research on this reaction scheme, which differs from that investigated in other laboratories (Argonne, CEA) will be continued in the "active" plant.

At the same time, a research group at the Ispra establishment is studying various techniques for the direct conversion of uranium compounds (e.g. halides) into the corresponding carbides. The electro-refining of uranium is likewise being considered. Results to date justify continuance of these researches, which must be regarded as "tail ends" applicable to various techniques for the chemical processing of irradiated fuel. Similarly, another Ispra team is engaged in research on the physico-chemical and thermodynamic properties of various binary systems of molten salts, the formation of solvent/dissolved-ion complexes and the diffusion rate of certain chemical complexes in these media.

The value of this basic research extends both to chemical techniques for processing irradiated fuel making use of a dissolution separation step in a molten salt bath, and to the homogeneous reactor developed at Oak Ridge (molten salt reactor).

DOCUMENT No. 10

REPROCESSING AND TRANSPORTATION OF IRRADIATED FUELS

I. Reprocessing of highly enriched fuels and fuel element refabrication possibilities

As stated in the last General Report, the reprocessing requirements for MTR-type fuels highly enriched with U 235 are becoming increasingly urgent in the Community, mainly owing to the saturation of storage capacity for irradiated fuel elements at experimental and research reactors (MTR and swimming-pool type).

Hence the Commission pursued its investigations into the relative advantages of the possibilities open to it for the reprocessing of this type of fuel. Following an economic survey of comparative reprocessing and transport costs based on firm offers, the Commission entered into negotiations with the United Kingdom Atomic Energy Authority for the reprocessing in Great Britain (Dounreay) of MTR fuels from the BR 2 and HFR reactors during the transitional period in which reprocessing plants are not available within the Community. It is possible that the solutions to be adopted for reprocessing irradiated fuels from HFR and BR 2 may be applied to other experimental or research reactors in the Community for the administration of which Euratom is neither wholly nor partly responsible.

In connection with these negotiations, the Commission is canvassing, in conjunction with test reactor operators and nuclear fuel manufacturers, the possibilities available for the re-use of the fissile materials recovered from reprocessing, e.g. by re-enrichment employing fresh material and the subsequent fabrication of new fuel elements. The Commission has also begun negotiations with the Italian Atomic Energy Commission (CNEN) with a view to possible participation in the projected EUREX plant for the reprocessing of highly enriched fuels. It is to be noted that this plant, which would be able to handle 31 kg of uranium-aluminium alloy a day, may come into operation around 1966. At the same time the Commission is making detailed studies on the technical and economic aspects of the EUREX project as also on the methods employed and operating conditions at the plant.

II. Reprocessing of natural uranium or slightly enriched fuels

The Commission has remained in touch with the activities of the Société Eurochemic; it has been associated in particular with studies carried out within various committees to determine the financial implications of launching and operating the Eurochemic enterprise within the framework of the reprocessing programmes contemplated.

III. Transportation

Bearing in mind the priority to be given to the chemical reprocessing of MTR-type irradiated fuels, the Commission has been giving special attention to problems involved in the carriage of these fuels, with particular reference to:

— containers to be used for such consignments
— contracts for the transportation of consignments
— insurance cover for third-party liability.

1. *Containers*

A major difficulty in the design of suitable containers for the carriage of irradiated fuels is that there are no recognized international standards governing the safety criteria with which such containers should comply. Although the question is under active study by the International Atomic Energy Agency in Vienna, the fact remains that until such time as appropriate international regulations enter into force those persons whose business it is to design containers and draw up plans for their construction are working in conditions of some difficulty, since it is impossible for them to know precisely what yardstick will be applied by the competent authorities when they come to grant their approval to the use of such containers for transportation purposes.

As things stand at present, only the US Atomic Energy Commission has drafted a regulation, the final text of which has still to be worked out in the light of results from, and experience with, this draft regulation in the future. Taking into account the disparity in the requirements which thus emerge, the Euratom Commission is particularly interested in the development of IAEA's work on the establishment of regulations to govern the transport of irradiated fuels and of radioactive substances in general with a view to bringing about the worldwide coordination which is vital in this field.

The Commission has likewise been concerned to promote a contribution to the study of all these problems; thus the Community's second five-year research and training programme provides funds which can be used to finance specific studies aimed at arriving at a more precise idea of the technical solutions to be devised in drafting blueprints for the construction of containers and packings.

As regards more especially the containers needed for the carriage of fuels unloaded from the HFR (Petten), BR 2 (Mol) and ISPRA 1 reactors in carrying out the respective design studies, account has been taken of the period when the containers are to be used and their destination. Since ISPRA 1 presents the most urgent problem and the irradiated fuels are to be dispatched for storage at EUREX (Saluggia), an 8.8 t container capable of holding 9 fuel elements has been chosen. This type of container proved to be the most advanced at the present time. As to the HFR reactor, studies to date have led to the design of a 16-element container weighing approximately 17 tons, while similar studies in respect of the BR 2 reactor have resulted in the design of another 17-ton container but with a capacity of only 13 elements, allowing for the higher U 235 content.

2. *Transportation of consignments*

In order to obviate the adoption of piecemeal solutions to all the problems relating to the transport of irradiated fuels unloaded from research reactors belonging to the MTR stable in the Community, the Commission sent out, along with the call for bids issued early in 1963 for the carriage of consignments from BR 2 (Mol), HFR (Petten) and ISPRA 1, two simultaneous questionnaires concerning consignments of the same nature from French and German reactors respectively.

From an analysis of the response received by the Commission to the call for bids and the replies to the questionnaires, it was possible to start out by comparing the average transport costs relating to each of the possible destinations considered, namely:

— Idaho Falls, USA
— Dounreay, Great Britain
— Eurochemic, Mol
— EUREX, Saluggia.

From these average costs it was possible to draw up a first general balance-sheet covering also the cost of chemical reprocessing, so as to make a comparison from the commercial angle between the various solutions that may be envisaged as to the choice of reprocessing plant.

As regards ISPRA 1, the immediate need to arrange for the evacuation of fuels in excess of that reactor's storage capacity dictated an initial decision to transport them to the EUREX reception swimming-pool at Saluggia where they will be stored pending arrangements for actual reprocessing within the general framework of the overall problem of chemical reprocessing of MTR-type fuels.

It was decided to put the carriage of these consignments in the hands of the Borghi concern established at Bologna (Italy), whose tender had been adjudged the most favourable.

As to carriage of consignments from the HFR and BR 2 reactors following examination of the proposals received in reply to the call for bids, the Commission selected those submitted by the Société Transnucléaire (Paris) and the NUKEM (Hanau)/Haeger & Schmidt (Bremen) Group respectively, and entered into joint negotiations with those proposers.

Contractual agreements resulting from these negotiations will take particular account of the choice of destination for these consignments within the context of the general decisions concerning the chemical reprocessing of MTR-type fuels used in the Community.

3. *Insurance cover in respect of third-party liability*

In submitting their tenders, transportation enterprises attached firm proposals from insurers for third-party cover in the event of accidents of nuclear origin. The Commission has received, firstly, a policy drawn up by the Syndicat belge d'assurances nucléaires as spokesman for the Community nuclear insurance pools and a policy emanating from the London insurance market, and secondly, the premium schedules relating to those policies.

As regards carriage of irradiated fuels from the ISPRA 1 reactor to the EUREX chemical reprocessing plant at Saluggia to be effected exclusively by land, only the Community pools' proposal could be considered, since the proposal from the English insurance market was only valid for carriage partly by sea. Accordingly negotiations are in progress with the transportation firm selected and the Italian pool. The situation regarding this purely Italian carriage arrangement is quite clear since atomic legislation is in force in Italy by which third-party liability with a ceiling of 3.150 million lire is channelled either to the operator or to the carrier. The operator or carrier must take out insurance or other financial guarantees to this amount. Damage in excess of that figure entails the financial intervention of the Italian State.

For the transportation of irradiated fuels from the HFR reactor at Petten and the BR 2 reactor at Mol, the situation is far more complicated. In the first place it has not yet been decided to which chemical reprocessing plant these irradiated fuels are to be consigned. In the second place, no atomic legislation so far exists in the Netherlands in respect of third-party liability, and Belgian legislation on the subject applies only to the CEN. Consequently, account must be taken on the one hand of unlimited liability on the part of the carrier and the operator, and on the other hand of the limited financial capacity of the insurance market. The possibility of sea shipments likewise raised specific problems in view of the very extensive guarantees which shipping firms will demand. The problems relating to transport within the territory of the United States and Great Britain alone appear to be solved, owing to their respective atomic legislation. Final negotiations can only be undertaken with insurers after the destination of the fuels is decided.

Speedy ratification of the Paris Convention and the Supplementary Convention on third-party nuclear liability could, it must be stressed, considerably simplify the problem of cover for risks relating to the carriage of nuclear substances.

DOCUMENT No. 11

MARKED MOLECULES AND RADIOISOTOPES

I. Marked Molecule Research

The first noteworthy example of the use of isotope-marked organic compounds is provided by the work of R. Schoenheimer and D. Rittenberg, who in 1936 established what has been the basic concept for the most important biological discoveries of the last fifteen years.

During this time, the applications of marked molecules have expanded considerably. While industry has as yet employed such molecules to only a limited extent, the investigations which they have opened up on the molecular scale have made them an important instrument fo research in biology, medicine and agriculture. With the aid of marked molecules, it is possible, in infra-red spectrometry, to pinpoint the correlation between the structure of organic compounds and their properties; in chemical analysis, to determine a constituent of a mixture without having to isolate it quantitatively; and also to study the physico-chemical mechanisms involved in adsorption and catalysis phenomena and in the action of ionizing radiations. These are just a few of the uses of marked molecules; their field of application is at present undergoing a rapid expansion.

Moreover, this range could be widened much further were production, which is in many cases inhibited by high costs, able to keep pace with demand. While it is true that industry supplies some 3,000 products, this figure falls far short of the amount which could be synthesized and also of the needs of potential users. It is precisely the wide variety of requirements that in the case of most marked molecules dictates limited demand, which can scarcely serve as a basis for regular production.

In the light of these conditions, Euratom's activity is directed to three aims.

The first is to build up a collection of marked compounds not yet in commercial production but which some day may be used on a substantial scale. This operation is backed up by a continuous survey of present or future users in order to assess both their requirements and the possible benefit to be derived from the industrial-scale production of certain compounds in the near future. As a result of this activity, it has already been possible to launch new production lines in several fields.

In the second place, Euratom plans to promote research into new fabrication processes, the improvement of methods for purifying compounds and the increase of their storage life. With a view to concentration of effort, the accent has been laid on generally applicable production methods. A number of research projects are accordingly being carried out in laboratories working under contract to Euratom; they relate in particular to:

— the preparation of ^{14}C-marked cholesterol compounds for use in studies on tumour growth inhibition;
— the marking of gibberellic acid, with a view to determining the rôle of this substance in plant growth;
— the preparation of tritiated amino-acids and the study of methods of storing them;
— the development of a highly sensitive method for measuring the surface radioactivity of solids by determining certain marked radicals which adhere to such solids by adsorption;
— the synthesis of certain organo-metallic compounds by the use of fission-fragment recoil energy.

The third aim concerns the question of information. In order to develop the use of marked compounds, put the research effort on a more efficient footing and adjust production to needs during a period of persistent uncertainty as to the market trend, it is necessary to arouse interest, arrange discussions on methods of synthesis and the market outlook and foster the pooling of experience in all fields. This purpose is served by the dissemination of reports and the organization of technical meetings. In this connection, special mention should be made of the first international conference on methods of preparing and storing marked molecules, held in November 1963. At this conference, which was sponsored by the Commission and attended by 180 experts from all countries, 63 original papers were read, including 16 arising out of work performed by holders of Euratom contracts.

II. Radioisotope Research

Activity in this field has been carried out along three main lines—improvement of production methods, recovery of fission products and development of new applications.

From a series of surveys carried out at the beginning of the year, it was possible to gauge users' needs, the improvements they considered should be made to the currently marketed substances and the producers' requirements as regards enriched elements for isotope fabrication. These findings have been supplemented by documentary material and the compilation of experimental data on current production in the Community.

Another enquiry is in progress, this time on high-intensity-source production capacities in the Community during the coming years.

As regards methods, a radioisotope-preparation technique which is more selective and less costly than those at present in use has been developed and CNMB (Central Nuclear Measurements Bureau) and in various laboratories in the Community to determine the spheres in which it can be applied. Another laboratory has been commissioned to investigate the improvement of tritium targets for the production of neutrons in accelerators. Finally, negotiations are in progress for the conclusion of a contract for the study of portable shortlived radioisotope generators.

Research into radioisotope recovery from concentrated fission-product solutions has been continued by a French and a Belgian team working in association with the Community. Whereas the CEN is endeavouring to develop a method which is generally applicable to solutions of various origins, the CEA is conducting research along conventional lines (Marcoule-type fission-product solution), into very-high-activity solutions. As a result of the efficiently coordinated work of these two bodies, a method of recovering caesium-137 has been brought as far as the pilot stage.

With regard to new applications, activity is being directed towards the study of matter exposed to intense radiation. Experiments have been launched under contract, in particular on catalytic reactions. In addition, with a view to opening up the way for possible action by Euratom, a thorough-going enquiry has been carried out to ascertain the work which has been completed or is in hand and the material and skilled manpower resources available.

An investigation conducted by French experts has shown that analysis by radioactive techniques is still far from widespread except in biological and medical laboratories, this being attributable to the fact that these techniques have not yet evolved to the point at which they can be generally employed outside research centres. The Commission is accordingly studying several analysis processes, i.e. by neutron activation (in particular, with monoenergetic neutrons), charged-particle activation, radiometry, etc. The studies in progress for more than two years on the development of targets necessary for the production of neutrons in accelerators have been continued.

An original method for using large-cross-section tracers has been elaborated and the extent of its potential uses is being determined in the laboratory. The originality of this technique consists in the fact that detection is effected during the operation itself and not subsequently as in the processes hitherto employed.

DOCUMENT No. 12

Bureau Eurisotop

INDUSTRIAL APPLICATIONS OF RADIOISOTOPES AND RADIATIONS

The "Bureau Eurisotop" was set up by the Commission at the end of 1961 for the purpose of promoting and publicizing the use of isotopes and radiations. With the assistance of a Consultative Committee consisting of independent experts selected from the Community countries, the Bureau seeks to reinforce and coordinate activities relating to information and promotion within the Community. Its main concerns are the following:

I. Developments of methods and apparatus

In collaboration with national laboratories and with industry, the Bureau is evolving methods and apparatus for isotope applications by means of development contracts.

Activities launched in 1962 led to the signature in 1963 of fifteen contracts covering development work with particular reference to mining, the iron and steel industry, the glass industry and civil engineering.

Under the 1963 programme, the Bureau studied some thirty proposed new contracts bearing on new spheres of application, including the machine industry, the chemical and textile industries, and telecommunications techniques.

At the same time, the programme embraces more general industrial applications such as radiochemical analysis, activation analysis, radiosterilization and the utilization of radiation energy.

II. Information and documentation

In the field of information the general aim of the Bureau is to interest industry in the uses of radioisotopes and radiations.

An information and advisory service is at the disposal of all organizations, firms and persons in the Community. Many enquiries are addressed to this service, which has a growing fund of documentary sources to draw on, including *inter alia:*

— a specialist library dealing with isotope techniques and the uses of radioisotopes and radiations
— a large bibliographical card index on isotopes and related techniques
— industrial documentation containing data on services and supplies of an industrial nature relating to the use of radioisotopes and radiations
— a picture library and a catalogue of films dealing with industrial applications of isotope techniques.

This heading also covers the Bureau's part in organizing conferences on the technical and economic aspects of the industrial application of radioisotopes and radiations.

A documentary film on the industrial applications of radioisotopes and radiations has been filmed under contract.

Furthermore, in collaboration with experts from Community countries, the Bureau is preparing information booklets aimed at publicizing the range of isotope techniques and uses. The following are in course of preparation:

— isotope techniques in the textile industry
— special techniques of activation analysis
— flow rate measurement in industry by means of radioisotopes.

Information leaflets are also issued, dealing with the Bureau's other activities and work.

III. Coordination within the Community

The third year of the "Bureau Eurisotop" was especially notable for the strengthening of the close links already established with the producers, users, and experts concerned with industrial application of radioisotopes and radiations. Its work of coordination mainly took the form of organizing seminars on specific themes.

An initial scheme led to a pooling of experience among organizations concerned with radioactive methods for tracing leaks damaged in underground town gas mains. Meetings were arranged at Saclay, Lyons, Saluggia and Saligno to demonstrate measuring instruments and methods employed and to show how the techniques adopted meet practical requirements.

A seminar on the use of radioactive tracers for determining the movement of solids in water was organized from 2 to 4 October 1963. The majority of the fifty participants represented organizations specializing in hydraulic and nuclear techniques. Sixty-five reports were submitted by the participants, covering the thirteen items on the agenda and providing a basis for consideration of isotope techniques from the most varied angles.

The above-mentioned studies demonstrated and emphasized the importance of isotope techniques in plans for preventing silting up and sand-bar formation in rivers, ports and lakes, for improving dredging techniques and methods of residual and industrial effluent purification, and for coast protection. The work of coordination and promotion begun at this first seminar will be continued by small expert groups working on detailed items.

A seminar on the applications of activation analysis was held in Brussels on 21 and 22 November 1963, at which the various working groups in the Community met representatives from the industrial sector with a view to promoting an exchange of views and closer collaboration. From reports presented by the numerous participants it was possible to draw up an inventory of existing irradiation and measurement methods in Community centres and laboratories. It was clear from the very fruitful discussions that the devices and methods employed leave room for improvement, to the benefit of all concerned. And it was agreed that, from several points of view, the technique of activation analysis would develop on more rational lines if work were coordinated. Ten small standing sub-committies were set up to study the most important of the problems raised during this meeting.

Another initiative in the field of coordination and promotion is directed especially to the application of radioisotopes and radiations in the textile industry. At two meetings between representatives of the textile industry and specialists in isotope techniques, details of organization were considered. A programme of activities has been worked out in cooperation with the European Community Textile Industry Coordinating Committee (COMITEXTIL), under which experts on isotope techniques will be sent to study the situation at first hand in various branches of the textile industry and to explore the hitherto untapped opportunities for using radioisotopes and radiations in the textile industry. The survey reports drawn up by these experts will constitute the working papers for meetings to be held in 1964. Thirty-three experts have so far confirmed that they will be taking part in this survey and the management committee for this project held its first meeting on 5 February 1964 in Brussels.

IV. Legal and economic questions

As stated in the Sixth General Report, the Bureau is examining legal and economic problems with a view to assisting in the creation within the European Community of an administrative and juridical organization appropriate to the needs of industrial application of radioisotopes and radiations.

To this end, a statistical report dealing with isotope production and utilization has been prepared.

In this same context a systematic analytical survey is in progress on the technical, economic and social structure of requirements concerning the industrial applications of isotope techniques.

NUCLEAR MARINE PROPULSION

I. Contract of association with Reactor Centrum Nederland

The aim of this association, which was concluded in December 1961, is to draw up construction plans and sufficiently detailed data to assess the possibility of developing a prototype pressurizedwater reactor for marine propulsion purposes. The programme comprises theoretical and experimental work, the results of which will be used to set up the reactor project.

Theoretical work

In 1963, numerous operations were carried out which covered most aspects of the project. Particular mention should be made of the theoretical studies on the incorporation in the fuel of a consumable neutron poison and on the dynamics of the heat exchanger and reactor assembly, as well as of the calculations to be used in determining the heat-transfer surface of the heat exchanger.

Experimental work

This work calls for a range of special installations, several of which were commissioned in the course of the year and have already been employed for some experiments.

A critical assembly, KRITO, has been constructed at Petten. In consequence, it will be possible to assemble and measure a core with an enrichment of 3.1% and subsequently 3.8%, and then a core having two zones with enrichments of 3.1% and 3.8% respectively.

Tests have been carried out on the incorporation of consumable poisons in uranium oxide. In the corrosion field, research has been combined with non-destructive examinations and also tests on Zircaloy-2 behaviour in stringent pressure and temperature conditions.

Other tests have been concerned with the welding of Zircaloy plugs on to piping of the same material.

Considerable efforts have been devoted to the experimental studies on thermohydrodynamic problems.

For certain tests, the installations are still in course of preparation. Noteworthy among these are an installation for subcritical experiments, a high-pressure irradiation loop (to be mounted in the HFR reactor at Petten), a steam-generator test assembly and a high-pressure corrosion study loop for testing fuel-element mock-ups. In addition, a contract has been concluded with an industrial firm for analyses and calculations of stresses in the steam-generator tube plate. Finally, a measurement programme is to be carried out with a pressurizer test plant.

II. Contract of association with Fiat-Ansaldo

The initial aim of the Euratom/Fiat-Ansaldo association programme which is supported by the Italian Atomic Energy Commission (CNEN), was achieved in the spring of 1963. This concerned the choice of the most suitable reactor from among the various strings under study since the start of the programme. It will be recalled that the reactors in question were for a 23,500 shp reference tanker of about 50,000 tons.

The comparative study of the various reactors was subdivided into four parts, i.e.:

- design of a forced-circulation pressurized water reactor with optimization of the basic parameters and the main components;
- practicability of the construction of a natural-circulation pressurized water reactor;
- main technical problems arising out of the possible use in the reference vessel of different types of boiling water reactor, namely:
  a) direct cycle, natural or forced circulation
  b) indirect cycle
- comparative analysis on a technical and economic basis of the reactors studied.

Forced-circulation pressurized water reactor

As a result of the study, the choice fell on a forced-circulation pressurized-water reactor, as this offers numerous possibilities of improvement, the most significant of which are partial control of the reactor by chemical shim, elimination of the steam and more compact construction by using a reactor vessel with built-in heat exchanger. As yet, however, it is scarcely possible to say which of these improvements will be adapted in the future reactor.

Natural-circulation pressurized water reactor

This may be said to be an original reactor design study, particularly in view of the layout of the various systems and the preliminary design of its components. Some of its features, i.e. the absence of circulation pumps, make for an extremely safe installation. However, experimental work should be carried out and a prototype built before any construction is started. As this presupposes heavy development costs and a long-term programme—two items for which it is difficult to make preliminary estimates—this reactor has not been adopted.

Natural-circulation direct-cycle boiling water reactor

The possibility of using this reactor on board the reference vessel was explored by means of a thorough analysis from which, despite the absence of previous experience, certain conclusions were able to be drawn.

The many problems raised by this reactor type (in particular stability at sea, maintenance and accessibility of the turbines and the auxiliaries), would entail protracted development operations, the outcome of which, moreover, would be uncertain.

Forced-circulation direct-cycle boiling water reactor

Adoption of forced circulation would to a large extent simplify the problem of stability in boiling water reactors. This principle was accordingly considered and analyzed as an alternative to natural circulation, but did not result in the establishment of a complete design. Dynamic trials on a "rolling test assembly" would be necessary and the research programme would have to deal with the same problems as those enumerated in the case of the natural-circulation direct-cycle type.

Indirect-cycle boiling water reactor

As the object is to assess the advisability of further development, studies have not been carried as far as the detailed design stage. They have, however, borne out the fact that this type, like other boiling water reactors, has all the uncertainty factors inherent in two-phase circulation, including its effect on the core circulation stability.

To sum up, it may be said that the forced-circulation pressurized water reactor is the obvious choice as far as the further development prospects are concerned. It was in this light that negotiations were started with Fiat and Ansaldo in 1963 for speeding up the projected research by means of a broader-based contract.

III. Collision tests (Fiat-Ansaldo contract of association)

In October 1963, Ansaldo commenced a series of collision tests on scale 1:15 models in order to try out some anti-collisionstructure solutions. As Ansaldo's programme is not geared to the development of basic theories, the experiments are being interpreted in accordance with known theories such as the laws of similarity applied to explosions. The tests are being conducted with a test rig in which a truck with the bows of the striking vessel runs along a ramp and hits the anti-collision-barrier model of the rammed vessel.

The first experiment would appear to corroborate the importance of the thickness of the plating in relation to the other components of the anti-collision structure—a point which had already been brought out by Japanese studies. This experiment is at variance with the studies carried out in the United States, in which the internal elements were found to be the most effective components. A careful check is therefore needed.

As other research in this field is being conducted at Naples and Hamburg, the Commission has organized exchanges of views and information, encouraged closer cooperation and endeavoured to coordinate certain programmes.

IV. Shielding tests (contract of association with the Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt mbH-GKSS)

The shielding tests initiated under the association with Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt mbH have been continued.

In 1963 two experimental set-ups were available for these test—a collimated-beam shielding test device (ESTAKOS) and a large-plate device (ESTAGROP I) for shielding tests in a pool of the Geesthacht research reactor. A large irradiation channel (ESTAGROP II) has been developed and will be used for the first tests in 1964.

The introduction of a second core into the Geesthacht research reactor pool has made it possible to measure simultaneously the efficiency of the various shielding geometries in ESTAKOS and ESTAGROP I.

Shielding tests in the Geesthacht research reactor

The ESTAKOS experimental assembly was constructed in order to provide, by relatively simple means, an overall view of the radiation-proof characteristics of various types of screens and to use the results obtained for shielding optimization.

Special tests with larger plates (ESTAGROP I) are aimed at determining the limits of the method of assessment and at studying measurement result variations.

The results of the first series of tests, which were carried out in 1962, have been used as a basis for other tests aimed at measuring the radiation transparency of various combinations of materials.

These tests have been paralleled by theoretical research aimed at devising combinations of various materials having a high radiation-blackness.

In 1963 a second core was assembled in a pool of the Geesthacht research reactor, thus permitting an extension of the programme.

With the aid of a pair spectrometer, the gamma spectrum was measured at various distances from a reactor core. These measurements yielded in the 1.5-8 MeV range a continuous spectrum from which only the 7.7 MeV aluminium absorption line (the fuel elements are Al-clad) and the 2.23 MeV hydrogen absorption line emerge.

Other measurements have been concerned with the influence on the gamma spectrum of an iron layer set at various distances from the reactor.

In order to study the possible uses of new detectors, the gamma doses were measured with ionization chambers and the results compared with those obtained in the same measuring positions with glass dosimeters.

Theoretical study of shielding problems

The GKSS group of theorists has developed from theoretical models a series of calculation programmes which have been used to check the experimental data.

Development and testing of measuring instruments and methods

The measurement electronics necessary for testing were continually improved in 1963 and the development of new measuring methods proceeded further. A case in point was the testing of a semi-conductor neutron spectrometer which had been devised by GKSS.

The calibration of the spectrometer with monoenergetic neutrons was in satisfactory agreement with the calculations. The linearity of the spectrometer when tested proved excellent.

V. Description of the Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt mbH (GKSS), Hamburg vessel

Negotiations are being conducted with the Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt mbH-GKSS, for Euratom participation in the construction of the nuclear part and also in the operation of the vessel now on the stocks.

1. *The hull*

Designed as it is for experimental purposes, this vessel should enable technical trials to be carried out with nuclear installations in conditions liable to obtain on board ship. Apart from this main task, it should be able to be used as a bulk carrier in normal operating conditions when the experiments have been completed.

The design is based on the Germanischer Lloyd and Bureau Veritas classification rules.

The vessel has a nominal draught (9.2 m) displacement of 25,950 tons in sea water and will develop a 10,000 to 11,000 shp. With a deadweight capacity of 15,030 tons it will have a test speed of 15 3/4 knots.

2. *The reactor*

The propulsion plant consists of a light-water-cooled and moderated reactor of the advanced pressurized water type. The whole of the primary system will be housed in the pressure vessel and will operate at a relatively low pressure (64.5 atm. abs.) and with a low void coefficient in the core. The lower part of the pressure vessel will contain the core along with the central riser. The steam generator will be above the core, the purpose of this arrangement being to ensure that in the event of failure of the circulation pumps the primary coolant has sufficient natural circulation for partial-load operation.

The steam cushion in the upper part of the pressure vessel keeps the pressure in the primary system quasi-constant during fluctuations in the temperature and the primary water volume.

The pressure vessel, the primary shielding and some auxiliary circuits will be surrounded by a leaktight containment shell which will be accessible for limited periods.

The reactor core, designed for a power of 35 MWth in normal operating conditions, will consist of 16 stainless-steelclad enriched uranium oxide fuel elements.

VI. Mechanical tests on marine reactor parts (contract of association with the Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt mbH (GKSS) - Hamburg)

At Geesthacht, a "rolling-test assembly" has been constructed with which to test the mechanical strength of reactor parts in conditions similar to those prevailing in operation at sea.

It can support parts weighing up to 2.2 tons and generate 3 g accelerations. Since vertical accelerations can be produced combined with rotary motions, it is possible with this assembly to simulate rolling, pitching and heaving. Some defects observed at the start-up of this installation, which is the only one of its kind in Europe, have been eliminated, so that trouble-free functioning is now ensured even during continuous operation. Special emphasis has been laid on accurate and rapid control of accelerations.

Tests were carried out in 1963 on a control-rod drive device and on several graphite reflector models for a gas-cooled marine reactor.

The working programme for the rolling-test assembly is laid down each year by the Commission and the GKSS. It is the responsibility of the industries concerned to perform tests with this device and to supply at their own expense the marine-reactor parts or the models for testing. The task of making available the assembly and the operating personnel devolves upon the Euratom/GKSS association.

MATERIALS TESTING REACTORS

I. BR 2 test reactor

The BR 2 materials testing reactor at Mol operated jointly by Euratom and the Belgian Nuclear Study Centre (CEN) had, at the end of 1962, reached half its rated specific power. This first phase of power run-up, although no irradiation experiments were performed in this period, afforded the international team running the reactor the opportunity of familiarizing themselves with it and enabled the Commission to pronounce it suitable for operation.

In January 1963 the first core of 14 elements was replaced by a second 18-element core and nine operating cycles were carried out at half the rated specific power. Irradiations were carried out for the French Atomic Energy Commission (CEA), the CEN, Euratom, the DRAGON project, the United Kingdom Atomic Energy Authority and various users in the Community; they were concerned more especially with a loop developed by the DRAGON project for studying corrosion of graphite by impurities in helium, with instrumented capsules used for the study of graphite, beryllium oxide, terphenyls and plutonium oxide and with the production of radioisotopes such as cobalt-60 and iridium-192.

A dismantling cell constructed by a Community firm and brought into operation in 1963 has already made it possible to extract 3,600 curies of iridium-192 with the very high specific activity of 450 g from the reactor.

The third phase of the tests, from September to November 1963, covered the run-up to full power and plant operational safety trials.

On 24 September, over a period of 14 hours, the specific power was gradually raised to 1.5 times the figure for which the unit was designed; maximum heat flux at the surface of the fuel elements reached 600 W/cm^2, maximum thermal neutron flux 10^{15} n/cm^2, and fast neutron flux 3.10^{14} in identical conditions. These values are among the highest ever reached in a reactor.

Operational trials were carried out in extreme conditions involving the emergency cut-out of the cooling system. Despite this quite abnormal situation—which could only arise as the result of a serious accident involving, for instance, the failure of the primary cooling circuit—no damage was observed. It was thus ensured that any error or accident which might interrupt the cooling process would have no disastrous effects on the plant.

Since November 1963, the reactor has been operating at rated power, which corresponds to a maximum heat exchange of 400 W/cm^2 and experimentation is proceeding according to plan. The experiments, which are aimed at studying the behaviour of materials or components used in nuclear reactors, can be carried out on behalf of bodies in the Community or in other countries. The design, construction and inspection of the experiments before in-pile insertion are performed by the technology laboratory and sometimes by industry, coordination between the users and the various departments at the BR 2 reactor being effected by a group of project engineers.

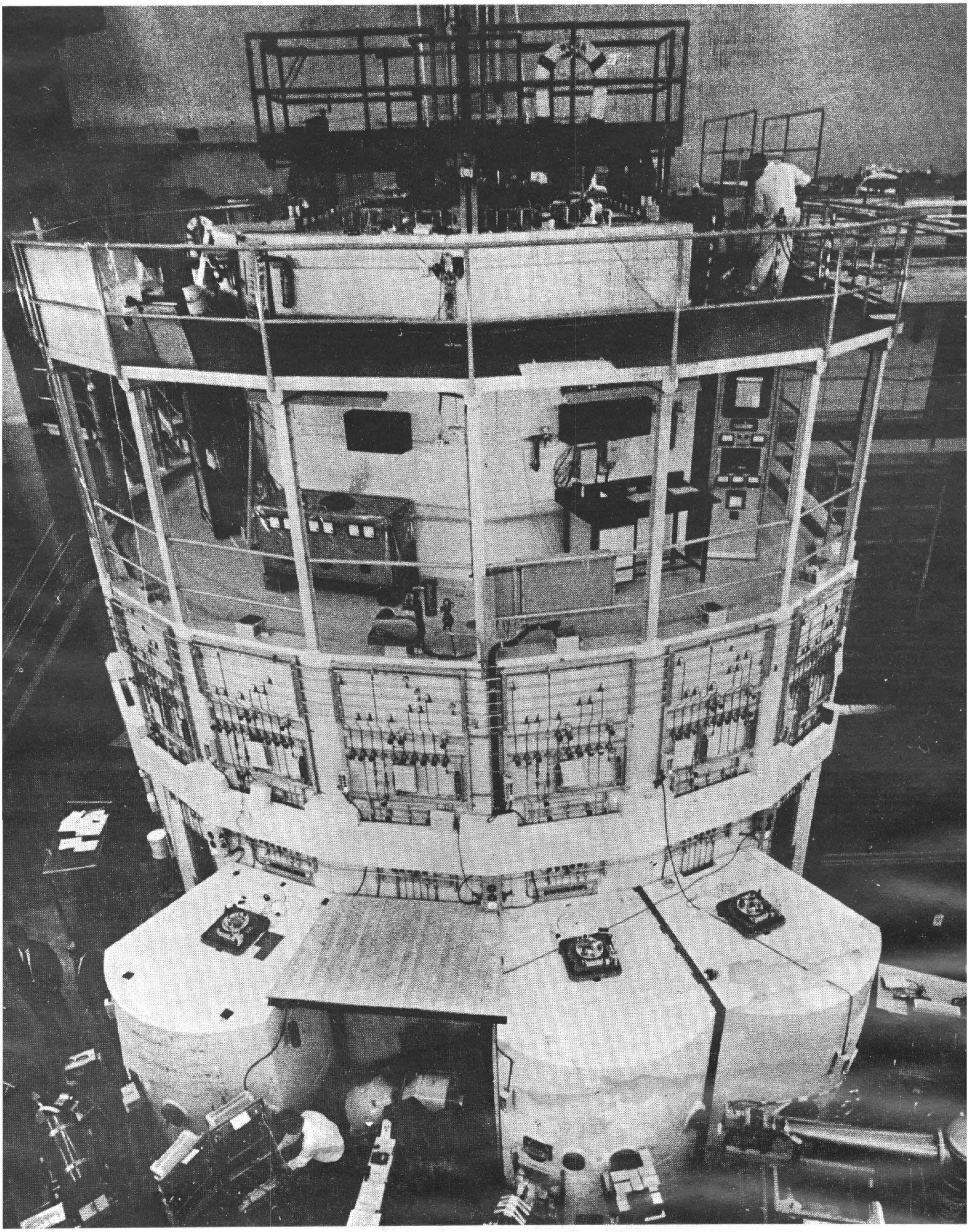
Fabrication of lead cells is in hand for the medium activity laboratory, while work has been completed on the design of a very high activity laboratory which could be built in the course of the third five-year plan.

II. Petten HFR reactor

The high flux reactor set up at Petten by Reactor Centrum Nederland (RCN) and transferred to the Community on 1 November 1962 was brought into operation at the end of 1962 after acceptance and safety trials.

Throughout 1963 it operated normally without incident and enabled ten complete cycles to be carried out with an average duration of 20 days. Experiments performed during the year include an initial irradiation of graphite samples carried out on behalf of the DRAGON project at successive temperatures of 600, 900 and 1200° C in the same device. Other experiments were concerned with nucleargrade graphites for EDF-type gas-cooled reactors, with special graphites, beryllium oxide and zirconium hydride. In addition, small quantities of iridium were activated with a view to producing radio-iridium. These various activities were undertaken in some cases on behalf of users in the Community, in others under arrangements for joint action with national nuclear centres. A number of experiments carried out by Euratom scientific departments and by the RCN were designed to arrive at a more thorough understanding of the basic characteristics of the HFR reactor. In this respect special mention may be made of gamma-heating test measurements using several different methods for purposes of cross-checking.

Considerable effort was devoted to the development and finalization of irradiation devices for use in high flux reactors and specifically in the Petten HFR. In the initial phase of this research a number of thermocouples were irradiated, together with irradiation capsules intended for experiments at temperatures between 150 and 1000° C. In particular it was possible through close



Petten — General view of the HFR high flux reactor built by the Reactor Centrum Nederland (RCN) and handed over to the Community on 1 November 1962. After the final acceptance and safety trials the reactor went into operation at the end of 1962.

collaboration with the Centre d'Etudes nucléaires at Grenoble to develop irradiation devices for temperatures ranging from 600 tot 1000° C, some of which were inserted in the pile. Work on developing a very high temperature irradiation device (around 1500° C) was carried to a successfull conclusion; this device will probably be inserted in the pile in the course of the year.

It will be remembered that, pursuant to the Euratom/Netherlands Agreement, priority is given to experiments under the Dutch programme during a transitional period of four years dating from the commissioning of the reactor. It is not surprising therefore that part of the reactor's capacity has been employed by RCN researchers whose irradiation programmes covered samples of steel and UO_2 at low temperature. The Joint Management Committee provided for in the Euratom/Netherlands Agreement was set up and has started work. The RCN is responsible for the technical management of the reactor in accordance with the same agreement under which it was to fulfil these functions for a period of four years.

As far as construction is concerned, the plans for two laboratories—for low and medium activity respectively—have been completed; a start will be made on the two buildings before July. A dismantling cell is nearing completion in the factory and will shortly be installed at one of the HFR swimming-pools.

DOCUMENT No. 15

PLUTONIUM AND TRANSPLUTONIUM ELEMENTS

I. Plutonium

As in previous years, the Commission's work was again centred on the study of plutonium recycling in thermal reactors. A description of this work will be found in Document No. 2 on proven-type reactors.

Pending completion of the buildings under construction at Karlsruhe, the European Transuranium Institute, with as yet only a small staff, continued to develop its programme along the lines set out in the last annual report. These studies, it will be remembered, will be devoted primarily to problems of both basic and applied research raised by the use of plutonium in nuclear reactors in technically and economically feasible conditions.

But if again this year no research project has been completed at Karlsruhe, the training of future teams has nevertheless proceeded. Save for a few engineers engaged on planning, the scientific personnel recruited for Karlsruhe has been retained on temporary assignments to various research centres in the United States and in Europe so as to gain further experience in plutonium handling techniques or in scientific or industrial disciplines connected with the Karlsruhe programmes.

II. Transplutonium elements

Cooperation between the Commission and national research centres has this year enabled fresh progress to be made with the European transplutonium elements programme.

At Saclay, a research team working under a Euratom contract has, for the first time in the Community, succeeded in isolating and purifying ponderable amounts of transplutonium elements from a plutonium sample irradiated for two years in the EL 3 reactor.

The Mol team (Centre belge d'Etude de l'Energie nucléaire), for its part, received from the United States, at the end of the year, the first samples (3 g of americium 241) destined for regular production of transplutonium elements by irradiation in the BR 2 reactor. Construction and assembly of the equipment needed for this production (special 1000-curie cell, in particular) is well under way, so that the first processing of a large quantity of highly-irradiated americium can be carried out at the beginning of the year. This will make possible the isolation of californium 252 in ponderable quantities, of the order of 10 microgrammes.

Research into the production of transplutonium elements and study of their chemical properties has been continued by all Euratom contractors—CEA, CEN, RCN and Liège University—and some new publications have appeared describing the results obtained. At the beginning of 1964 a fresh contract was signed with the Jülich Nuclear Centre for determining the distribution coefficients of plutonium, americium, curium and rare earths in a liquid-liquid extraction system.

Relations with countries outside the Community have likewise developed satisfactorily so that the optimum conditions for effective cooperation will all be present when the requisite material facilities become available to Euratom. Special mention should be made of the collaboration with American laboratories and the USAEC, through which valuable samples have been made available to the Commission, and which has been reinforced by a series of exchange visits and by participation of American research workers in Euratom programmes.

NUCLEAR MEASUREMENTS

The construction of nuclear reactors and the multifarious applications of nuclear techniques necessitate knowledge of a great many physical data. Determination of such data is the aim of the work performed at the Central Nuclear Measurements Bureau in collaboration with the national and international bodies and laboratories concerned. This work embraces the measurement of neutron parameters, the manufacture of standards for fissile and stable isotopes and radioisotopes and the basic research inherent in these activities. In addition, the CNMB prepares and analyzes numerous samples required for the measurement of nuclear constants as well as for use in Community and, in some cases, extra-Community laboratories. The Bureau also carries out a large number of measurements, particularly in the field of isotope composition, for account of other parties.

I. Neutron Paıameter Measurements

This programme is based almost entirely on the high-priority demands of reactor constructors. It is discussed at regular intervals by the European-American Nuclear Data Committee and the corresponding committee of experts of the Community.

The final Pu-239 effective fission cross-section measurements for thermal and epithermal neutrons were made at Saclay in cooperation with CEA (French Atomic Energy Commission) physicists. Analysis of the results has virtually been completed.

After final acceptance, in November 1963, and energy-calibration of the Van de Graaff accelerator, the following measurements were immediately carried out:

- effective elastic and inelastic scattering cross-sections of iron and sodium, similar measurements on zirconium being envisaged;
- effective cross-sections of eight threshold reactions, which are of importance in the spectrometry and dosimetry of fast neutrons in reactors.

Simultaneously, work on the critical compendia of known data on reactions of this type was continued and a further collection was published.

In addition, the study of the following questions was initiated:

— measurement of the total effective cross-sections in the 2-10 keV interval, in particular that of uranium-238;
— stabilization of the Van de Graaff energy and utilization of the device when thus improved for more accurate measurement of thresbold reactions in connection with accelerator-energy calibration;
— contribution to the establishment of a neutron-flux standard in 1-100 keV interval.

The works trials on the linear accelerator which were carried out for each of its characteristics individually, yielded satisfactory results. Full-capacity tests will only be able to be carried out after the installation of the accelerator at Geel, which is scheduled to start in April 1964. Preparations are being made for the following measurements in the resonance field:

a. total effective cross-sections (notably that of plutonium-240);
b. effective fission cross-sections (notably that of plutonium-239);
c. effective capture cross-sections;
d. effective scattering cross-sections.

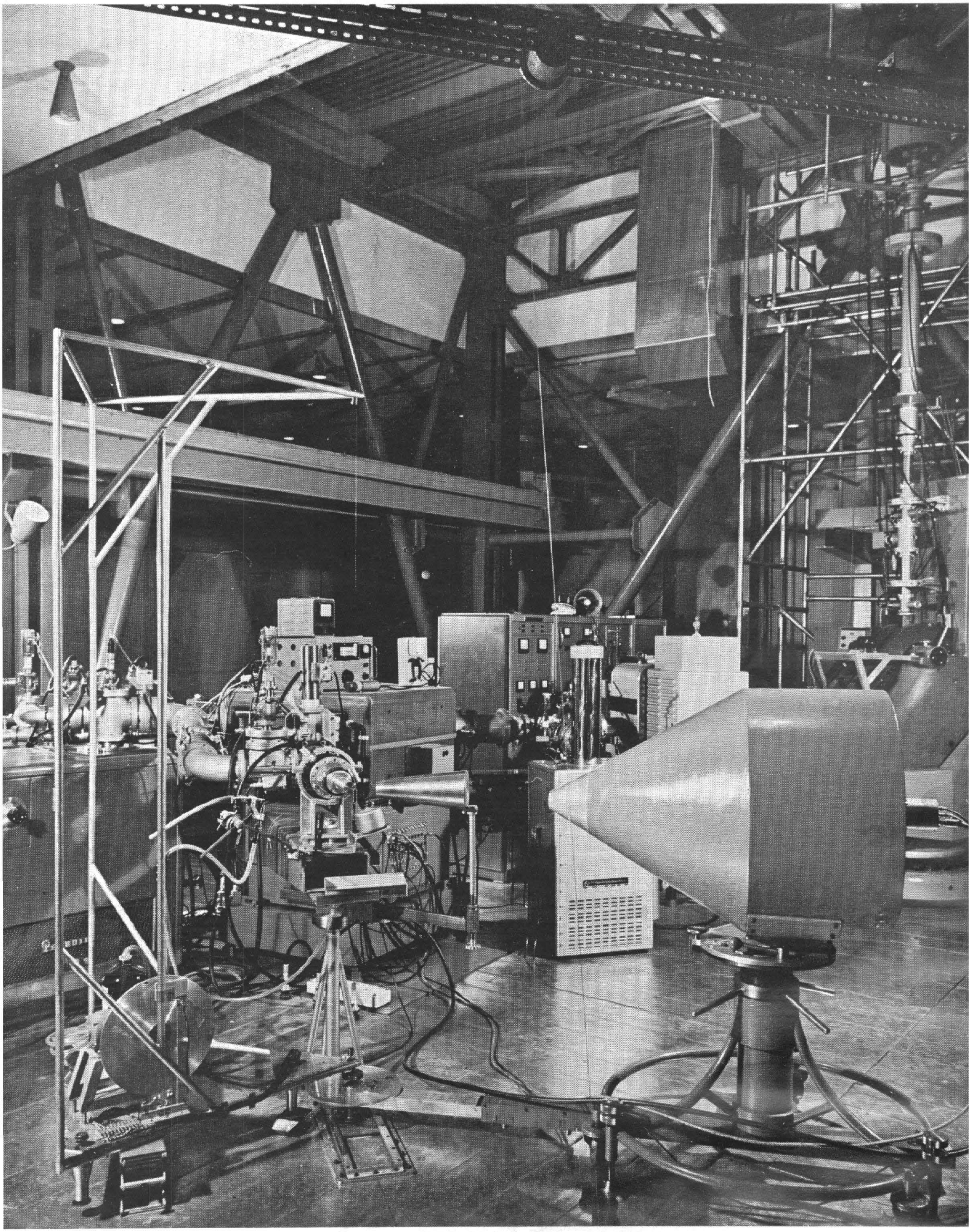
It is planned to carry out some of these measurements in collaboration with physicists of the Belgian Nuclear Study Centre (CEN). Working groups of the CEA (Saclay) also contemplate using time-of-flight positions during part of the year.

I. Comparison of Stable and Long-Lived Isotopes

The investment and development programme was pursued, and in particular orders were placed for a tandem mass spectrometer for accurate measurement of very low isotopic concentrations in solids and for a mass spectrometer for measuring deuterium in heavy water.

The study and manufacture of isotope standards has already produced results. On the basis of the comparison of existing standard boron stocks carried out by the CNMB, the UK Centre at Harwell was prompted to renew its own inventory, while the United States has announced its intention of employing two—for that matter equivalent—standards, namely that of the National Bureau of Standards (Washington) and that of the CNMB.

Thus the references for a large number of neutron parameter measurements have been standardized in the countries participating in the work of the European-American Nuclear Data Committee (EANDC). A project is also under way for the manufacture of depleted uranium standards and is concerned in particular with the study of fuel consumption (natural uranium) in



Geel — Central Nuclear Measurements Bureau (CNMB). Test hall of the Van de Graaff accelerator put into service at the end of 1963.

reactors. Furthermore, as isotopic analyses of plutonium have now become a matter of routine, a start may be made with the fabrication of standards for this element. The necessary samples are available. A theoretical and experimental study has been made of the errors in the isotopic dilution analysis method, and thus it is now possible to carry out accurate quantitative measurements of very small amounts of a solid element (downwards of 10^{-6} g). Finally, cooperation with centres outside the Community has been set up for the comparison of heavy-water samples.

III. Absolute Radioisotope Counting

Progress has been accomplished in alpha counting with lowgeometry counters, as well as in the standardization of cobalt-58. The liquid scintillator method has been applied to caesium-137 with an accuracy of a few tenths of a per cent. The systematic study of factors which influence the accuracy of absolute countings has been continued. The CNMB's neutron standard source has been compared with Canada's standard source.

Precise measurement of the effective cross-section of cobalt-59 for thermal neutrons is now in hand.

The CNMB has continued to participate in international comparisons of absolute radioisotope countings. It has proceeded further with the accurate study of nuclear data which are of importance for counting precision, such as the americium-241 decay scheme and the conversion coefficient and L/K ratio measurements.

IV. Sample Preparation Laboratory

Measurement of nuclear data is only possible provided accurately determined samples are available. The laboratory has determined and prepared more than two thousand such samples, which are earmarked for national centres (Karlsruhe, Mol, Saclay and Aldermaston), Joint Research Centre Establishments (Ispra, Geel) and universities in the Community.

These samples differ considerably on account of the basic material used (e.g. isotopes of uranium, plutonium, boron, lithium, carbon, etc.), the form in which they have been prepared (plates, cylinders, solutions, etc.) and the specifications required (e.g. chemical and isotopic purity, homogeneity, total mass accuracy, etc.). In each case, therefore, special operations are required as regards fabrication, chemical and isotopic analyses and metrological definitions. With the CNMB's present limited resources—especially in manpower—it is not possible to deliver these samples within the desired and desirable time-limits. The development programme is accordingly confined to the improvement of the existing fabrication methods (vacuum evaporation, electrospraying, electrolysis, electrophoresis, rolling, etc.).

During a meeting held at Geel, there was an interchange of technical experience in sample preparation between the CNMB and American and British experts.

V. Contacts with National and International Institutions

Contacts with standards bureaux in the Community and elsewhere have been continued, as well as those with nuclear centres. They have resulted in exchanges of samples and the coordination of the activities of several sectors.

The CNMB continues its collaboration with the International Bureau of Weights and Measures, as manifested in particular by its participation in the work of the latter's Consultative Committee on Ionizing Radiations.

The Euratom Nuclear Data Committee has been broadened and now includes reactor physicists. This expansion was carried out in connection with the setting-up of a European-American Reactor Physics Committee (EARPC). In this way, fruitful discussions have been arranged between measurement experts and reactor experts. The same Committee is continuing to coordinate measurement programmes in the Community and to prepare the ground for the work of the European-American Nuclear Data Committee. It also performs the preparatory work for the meetings of the EARPC.

The EANDC has now succeeded in launching important programmes relating to Pu-239 irradiation, and also to electromagnetic separation for the large-scale production of ultra-high-quality higher isotopes of this metal. Another of its noteworthy preoccupations is with the critical compilation and assessment of the ever-increasing mass of available neutron data.

An observer from Euratom has taken part in meetings of a working group set up by the International Atomic Energy Agency in Vienna for the purpose of forming a world nuclear data committee.

REACTOR PHYSICS

This general activity of the Ispra Centre embraces, in addition to neutron and radiation physics, reactor calculation and reactor shielding.

I. The SORA Source Reactor

Every nuclear research establishment requires a versatile high-intensity neutron source. Accordingly, the Reactor Physics Department has formulated for Ispra the fast-neutron source reactor project known as SORA (SOurce RApide), in which the fast neutrons can be slowed down and transformed into thermal neutrons as desired and the reactor can operate on a continuous or a pulsed basis.

The critical mass has been calculated for various core compositions, and the reactivity studies on the pulsation system have been carried out for a spherical or cylindrical geometry. The active part of this core has to be cooled by liquid metal, and the reflector by helium. The average thermal power is planned to reach 250 kW, and the impulse frequency 100 cycles/sec. with a pulse duration of 50 us. Thus a range between 10^{-3} (1/1000) and 20,000 eV is available for neutron physics experiments using the time-of-flight method.

II. Neutron Physics

The study of the interaction of neutrons with matter is not only a *sine qua non* for the power reactor development, but also of fundamental importance in present-day physics. But knowledge of the laws on this interaction is still very fragmentary, as even the basic physical data are not always obtainable with a sufficient degree of accuracy. For this reason, a theoretical and experimental programme has been drawn up and launched in the field of neutron physics.

Thus with the ISPRA 1 reactor it has been possible to measure the inelastic scattering of slow neutrons using various substances and to carry out experiments on a beam of high-intensity polarized neutrons. The total cross-section of the organic liquids has been assessed and the effective resonance integral values have been obtained for the metallic fuel elements. In addition, the AQUILON reactor at Saclay has been used to determine the fine structure of the thermal flux in a beam of ECO-type elements.

As regards the theoretical aspect of the neutrons-matter interaction, scattering models have been analyzed at Ispra, the cross-section calculation methods have been improved or refined, methods for solving stationary and non-stationary transport problems have been developed and, finally, calculation processes which can be used for several reactor types have been devised.

III. Reactor shielding and safety

Ispra's activity in this field has followed three main directions, i.e. calculation of shielding designs for various reactors including SORA, development of new calculation methods for the more precise evaluation of radiation doses, and experimental study of neutron propagation. The accelerator belonging to the Padua Institute of Physics has been employed for this last-named project.

With regard to safety in particular, Ispra has worked out for the Garigliano power plant calculation methods applicable to boiling water reactors. Some studies have also been carried out on the design of an excursion reactor.

With the same safety considerations in mind, the Technology Department has conducted research into rapid pressure fluctuations in reactor vessels.

IV. Fuel cycle

The aim of the research recently undertaken at Ispra in this field is to enable Euratom to advise other nuclear establishments on fuel costs. This research is concerned in particular with the influence of plutonium on the neutron balance and forms the subject of theoretical work to be backed up by an experimental programme in which use will be made of the ECO reactor. Ispra has also started on a fuel cycle analysis involving the testing of the various burn-up codes for adaptation to computers.

SCIENTIFIC DATA PROCESSING

The structure and equipment of the Scientific Data Processing Centre (CETIS) are designed primarily to meet the computation and documentation needs of Euratom and the other Communities. The facilities, however, are to an increasing extent being made available to other users (universities, national research centres, etc.) inside and outside the Community. CETIS activities comprise:

— Analog and digital hybrid computing. The Computer Centre carries out work requested by Euratom and other scientific bodies in the Community or elsewhere, and further undertakes mathematical research and programming system research;
— Non-numerical data processing, in particular by using the big electronic computers for documentation.

The work carried out at Ispra is supplemented, moreover, by research contracts in several fields.

I. Computation

The digital computers have been in constantly increasing demand. They were in regular two-shift operation in 1963 (cf. Table I below) which, in view of the limited number of operators, gave rise to certain difficulties.

The analog computers, on the other hand, were operated at something below maximum capacity. This, it is true, was partly due to use of the APACHE code which enables the computer time to be cut to less than half of what would be needed for the conventional method currently employed in the biggest scientific and industrial centres in Europe and America.

Table II shows the utilization time for the various computers on each type of work.

CETIS carried on with the elaboration of nuclear codes and circulated to users a manual explaining their use. It prepared several new codes which, together with those already compiled, will be placed at the disposal of the European nuclear programme catalogue which the OECD's Nuclear Energy Agency recently decided to set up at Ispra in view of the experience already gained in this field by the CETIS team.

The Centre's computation activity also comprised analytical and programming work for Euratom departments and the European Communities' Joint Statistics Office.

Table 1

COMPUTER USE-TYPE OF WORK (per cent)

January-December 1963

A. — CLOSED SHOP work (1)	7090	1401/1	1401/2	231R/1	231R/2	231R/3
1) *Computer operation and maintenance* (input-output, training, start-up, demonstrations, engineering changes, upkeep, etc.)	16.17	56.20	22.83	22.92	15.70	10.92
2) *Operation of Programme Catalogue and testing of programming systems*	7.05	4.02	2.97	—	—	—
3) *Computation services*						
a) for Euratom scientific departments and Euratom contracts	10.59	2.49	0.77	26.85	61.90	79.65
b) for the European Communities Statistics Office	11.16	8.28	10.09	—	—	—
c) for general departments of the Ispra Centre	0.69	2.96	27.33	—	—	—
d) for general departments of Euratom, Brussels (October-November)	—	—	4.39	—	—	—
4) *Research proper*						
a) automatic documentation and translation	2.90	4.33	26.40	—	—	—
b) other research (APACHE project, System Programming, numerical analysis, nuclear code elaboration, mathematical statistics, special research into analog techniques)	13.28	7.08	5.49	50.23	22.40	9.43

(1) By CLOSED SHOP is meant computer work carried out by CETIS to solve problems referred to it by third parties or arising from research covered by its own programme. The latter items are grouped under point 4.

B. — OPEN SHOP work (1)	7090	1401/1	1401/2	231R/1	231R/2	231R/3
1) *Work for Euratom account*						
a) Reactor Physics Department (use of library codes)	9.92	2.63	0.07	—	—	—
Reactor Physics Department (other question)	12.07	1.78	0.26	—	—	—
b) Chemistry Department, Engineering Department, etc.	1.29	0.37	0.01	—	—	—
c) ORGEL	1.29	1.15	0.41	—	—	—
2) *Work for outside account* (Universities, nuclear research centres, scientific institutions, EURATOM contractors, etc.)	13.51	8.50	2.23	—	—	—

(1) By OPEN SHOP is meant computer work carried out by third parties themselves, only the computer time and operation being provided by CETIS. About half this work involves solely the use of standard codes.

Table 2

COMPUTER TYPES

Total time employed (hours)
(1 January - 30 November)

DIGITAL				ANALOG		
7090	1401/1	1401/2	1620	231R/1	231R/2	231R/3
3,742	3,274	2,055	770	710	918	1,085

From the technical angle, the analog computers were equipped with a semi-automatic visual indicator panel designed and patented by CETIS, and the analog processing of the SORA dynamics was supplemented by a repetition calculation system.

II. Non-numerical data

The bulk of the work in this sector was carried out at the request of the Euratom Information and Documentation Centre (CID) and for account of the EEC Terminology Bureau. This work consisted in the study of an information retrieval system and its programming on an IBM 1401.

Furthermore, CETIS has helped to improve and to devise a method for the more rational use of the Russian-English automatic translation programme elaborated under a research contract by a team at the University of Georgetown.

OTHER RESEARCH

I. Solid State Physics

Research on the physical properties of uranium carbide has continued at Ispra. Measurements carried out with direct current from liquid nitrogen temperature to room temperature demonstrated a linear variation in electrical resistance which is characteristic of metallic solids. At the same time, reflectance measurements showed at optical frequencies, conductivity and polarizability variations similar to those of uranium metal. Thus the electronic structure of the carbide appears to be akin to that of uranium metal, although the effect of the U-C bond is to modify the electron density, bringing about a shift from the highest levels of the valence bands towards the vacant levels of the conduction band.

Further measurements of ion conductivity in polar solids were made, with the object of obtaining data on lattice imperfections caused by mechanical deformation. The activation energies for the shifting of excess imperfections induced by plastic creep were found to be low and it would appear that the interstitial atoms rather than the vacancies contribute, during plastic deformation, to the appreciable increase in conductivity.

X-rays of various intensities were measured after diffraction through thick silicon and germanium crystals under alpha irradiation and through boron-treated silicon crystals. Irradiation had no effect on the abnormal transmission of X-rays. On the other hand, an appreciable increase was observed in the intensity of the rays reflected by the surface of the irradiated crystals or diffracted through thin silicon crystals. The number of atoms displaced by elastic particle collisions was calculated. A semi-conventional study of the photoelectric absorption phenomenon as a function of scattering angle and of wave-length was carried out on silicon, zinc and germanium for X-ray frequencies far removed from the characteristic atomic frequencies. The angular dependence of the absorption coefficient proved to be far below that calculated on the basis of the conventional damped harmonic oscillator formula.

II. Magnetic resonance

A detailed study of free radical solutions has been initiated at Ispra by means of magnetic proton relaxation. The proton spinlattice and spin-spin relaxation times in a solvent (benzene and toluene) were measured using the spin echo method. Information was obtained on the nucleus—interaction between free radicals—based on the thermal dependence of the respective relaxation times and it was possible to deduce from the ratio between the relaxation times that the relaxation mechanism was governed mainly by the dipole-dipole interaction. From the frequency dependence of the spin-lattice relaxation time it was possible to infer that, for an organic radical dissolved in toluene, relaxation was not governed by one single correlation time.

III. Direct conversion

Research continued on methods for the direct conversion of heat of nuclear origin into electricity, as far as the resources allocated to this work permitted.

At Ispra, two irradiation tests were carried out on nuclear-heated thermionic converters. Both cells operated with a molybdenum electron emitter heated by the radiation from a mixture of highly enriched uranium carbide and zirconium carbide. In one of the tests, some 40 W(e) were obtained during a period of two days, with a thermal efficiency of more than 10%. Measurements were also carried out to determine the effect produced on work function by atoms absorbed on the emitting surface.

Research conducted under contract on magnetohydrodynamic generators made it possible to measure the rise in the thermal conductivity of an argon/potassium mixture brought about by heating (1500° Kelvin) and to determine that the increase results from superheating induced by shock waves. A helium shock-wave tube has been constructed and the first shock wave velocity measurements have been carried out.

IV. Low-energy nuclear phenomena

In 1960 the Commission signed a contract of association with the Italian Atomic Energy Commission (CNEN) for work on low-energy nuclear phenomena. Researches covered by this contract which, it will be recalled, are split up among the groups belonging to the Istituto Nazionale Fisica Nucleare (INFN), are being actively pursued.

In the field of nuclear reactions, the Ericson effect, which since its discovery in 1960 had been purely a matter of theory has for the first time been experimentally observed, studied and extended. Reactions produced by protons, deutons and photons have been studied, while a comprehensive programme of effective cross-section measurements has been carried out. In nuclear spectroscopy, INFN research workers have *inter alia,* made studies of nuclear configurations, carried out inner "bremsstrahlung" and angle correlation measurements, and conducted experiments on the inner Compton effect. Research has been undertaken into the inelastic scattering of neutrons on helium nuclei; and experiments with the ISPRA 1 reactor have made it possible to expand the range within which maintenance of parity in strong interactions may be affirmed.

It goes without saying that this contract is fundamentally aimed at gaining fresh insights into the nuclear physical processes of the low-energy range, but in point of fact, one of the reasons motivating this action on the part of Euratom was that it afforded an opportunity for consolidating and coordinating the efforts exerted by several research groups of proven quality which had been prevented by the limited nature of the means at their disposal from working with the degree of efficiency required. After three years of joint labours, the Commission's experiment can be confidently stated to have been justified and to have helped in giving a fresh boost to Italian research into low-energy nuclear physics.

It was with this general climate in mind, in addition to the results obtained, that the Commission decided in 1963 to renew this contract of association, making the new programme a prolongation and extension of the earlier one.

DOCUMENT No. 20

POWER REACTOR PARTICIPATION CONTRACTS

I. SENN Garigliano Power Plant

1. *Status of power plant work and commissioning*

During the period form 1 January to 5 June 1963, the assembly work was completed and the pre-commissioning trials carried out, while from February to April 1963 the initial-load fuel elements were transported by air and road from San Jose, California, to the site.

On 5 June 1963, the reactor went critical for the first time with seven elements in the Zircaloy channels.

The first power trials proceeded smoothly up to 30 July 1963, when a serious defect occurred in the stator winding of the 200 MVA alternator. As a result of this incident, the power tests had to be suspended and the period of waiting entailed was employed to carry out a general overhaul of the plant.

In mid-November 1963, the power tests were resumed, albeit without using the turbogenerator group; thus on 23 November the reactor attained its full power by means of an ordinary steam circuit, without feed water pre-heating.

In the last month of the year, the reactor was operated for a brief period at full power for the purpose of gammascanning of the fuel elements and preparing for combined power tests with the use of the turbogenerator group.

On 23 January 1964, the plant supplied the grid with nuclear current for the first time.

2. *Implementation of the contract*

a. *Secondment of personnel*

During 1963, the following personnel were assigned to the plant:

	Total 1963	Man/months 1963	Average attendance figure
Euratom employees : *a.* permanently seconded *b.* temporarily seconded	 3 3	 36 4.5	 3 0.4
Engineers seconded by enterprises or organizations in the Community countries	26	63	5.2
Trainees	4	5	0.4
Total	36	108.5	9

The 26 engineers seconded by Community enterprises or organizations were from the following Member States:

Belgium	1
Germany	5
France	13
Italy	5
Netherlands	2

Of the trainees, one was from Germany and three from France.

b. *Acquisition of information*

As a result of the assignments and training courses, 46 papers, reports or studies were produced in 1963.

II. SIMEA Latina Power Plant

1. *Status of power plant work and commissioning*

After the reactor had gone critical for the first time on 27 December 1962, the tests and measurements carried out on it at very low pressure in air took four months. The power run-up started in April and the first nuclear kilowatt-hour was supplied to the grid on 12 May. By the beginning of August, a power level equal to 80 % of the rated power had been reached, but the plant soon had to be shut down as a consequence of damage to the coolant-liquid circulation blowers. After a stoppage of two-and-a-half months, power operation was resumed on 3 November 1963, but at partial load because of mechanical difficulties with the turbogenerator groups, full load (200 MW) being reached for the first time on 16 December. The Latina power plant supplied 293,500,000 kWh to the grid in 1963. It has been operating at full power since the beginning of 1964.

2. *Implementation of the contract*

a. *Secondment of personnel*

During 1963, the following personnel were assigned to the plant:

	Total 1963	Man/months 1963	Average attendance figure
Euratom employees : *a.* permanently seconded *b.* temporarily seconded	 1 6	 12 5	 1 0.4
Engineers seconded by enterprises or organizations in the Community countries	31	30	2.5
Trainees	2	2	0.2
Total	40	49	4.1

The 31 engineers seconded by Community enterprises or organizations were from the following Member States:

Germany	4
France	23
Italy	4

The two trainees were from France.

b. *Acquisition of information*

As a result of the assignments and training courses, 55 papers, reports or studies were produced in 1963.

III. SENA Chooz Power Plant

1. *Status of the work*

The civil engineering contract was signed in January 1962, and the on-site work started at about the same time. The first operation was the site preparation on the right bank of the Meuse. The cutting of the galleries was delayed, on the one hand, by landslides above the entrance and, on the other hand, by falls of rubble during excavation. It proved necessary to concrete the entrance and prop up the galleries. Bolts were placed in the vault of the galleries and caverns in order to limit rockfalls. The cutting of the galleries has now been completed and that of the caverns is continuing.

The work on the control buildings, the turbine hall and the other outside work is proceeding normally. Installation of the mechanical and electrical parts should start about mid-1964 to permit power run-up by the end of 1966.

In April 1963, SENA concluded a supplementary contract with the suppliers group aimed at achieving a net electric power of 266 MWe. The supplier undertook to design the first core in the light of the technical advances made up to the completion of the construction work.

2. *Implementation of the contract*

a. *Secondment of personnel*

During 1963, the following personnel were assigned to the plant:

	Total 1963	Man/months 1963	Average attendance figure
Permanently seconded Euratom employees	2	24	2

b. *Acquisition of information*

As a result of these assignments, 13 papers or reports were produced in 1963.

IV. KRB Gundremmingen Power Plant

1. *Status of the work*

The Société Kernkraftwerk RWE-Bayernwerk GmbH, which was incorporated as to 75% by RWE and as to 25% by Bayernwerk, is building a 237 MWe net boiling-water reactor at Gundremmingen. The suppliers are Allgemeine Elektrizitätsgesellschaft (AEG), International General Electric Operations Ltd. (IGEOSA) and Hochtief AG for the civil engineering work.

General view of the 237 MWe KRB (Kernkraftwerk Rheinisch - Westfälisches Elektrizitätswerk-Bayernwerk reactor now under construction. Commissioning is scheduled for 1966.

The power plant's three supply contracts were signed in November 1962, i.e. about a month after the start of the on-site work. The severe winter of 1962-63 caused a delay of approximately six weeks in the construction of the reactor building, but it is likely that this delay can be offset by changes in the construction schedule. The contracts for the leaktight reactor building, the pressure vessel, the circulation pumps, the heat-exchangers and the main transformer have been awarded. These reactor parts are now under construction.

Commissioning of the plant is scheduled for the end of 1966. The civil engineering and the manufacture of the equipment are proceeding normally.

Assembly of the reactor containment shell has now been completed and the pressure testing has started. During 1963, it was suggested to KRB that the core design be modified on the basis of the results obtained with the fuel elements of the VBWR and DRESDEN reactors. After a detailed study of possible variants, the solution involving the use of Zircaloy-clad fuel elements was adopted. This has necessitated clearing up the technical and financial questions raised by the core-design modification.

2. *Implementation of the contract*

a. *Secondment of personnel*

During 1963, the following personnel were assigned to the plant:

	Total 1963	Manmonths 1963	Average attendance figure
Permanently seconded Euratom employees	2	12	1

b. *Acquisition of information*

As a result of these assignments, two reports were produced in 1963.

V. SEP Power Plant

1. *Status of the work*

The project consists of three phases. At the end of each phase, a decision is taken as to whether or not to continue with the next.

The first phase, involving the preliminary design study, has already been completed. During the second phase, which is at present in course of implementation, a detailed design study will be set up for the power plant, while the third phase will be the actual construction of the plant.

Following signature of the contracts with General Electric and Euratom, SEP has tackled the technical problems to be solved during the second phase. These problems concern, for instance:

— the fuel-element cladding;
— reactor vessel;
— steam-separation and drying devices;
— the loading and unloading device;
— the shielding;
— the design of the plant buildings.

At the time of writing, a team of SEP engineers is working with the General Electric engineers at San Jose, California, on the development of the nuclear part. Another location where important activities are in progress is the SEP/KEMA head office at Arnhem, where the studies are coordinated and the plans for the conventional components and the civil engineering are drawn up.

2. *Implementation of the contract*

a. *Secondment of personnel*

During 1963, the following personnel were assigned to the plant:

	Total 1963	Man/months 1963	Average attendance figure
Permanently seconded Euratom employees	1	6	0.5

b. *Acquisition of information*

As a result of these assignments, two papers or reports were produced in 1963.

VI. Information supplied by the contractors

In return for its participation, the contractors are required to convey to the Commission the information obtained in performing the contract on the design, construction and operation of the power plant. This information is supplied in the form of documents and reports such as:

— design and construction plans;
— measures taken to operate and equip the plant;
— safety reports;
— operating data.

The reports relate to the technical, economic and safety data on the plant. Some of them are compiled periodically (annually or quarterly); others supply overall data (completion of the work, fulfilment of the contract after four year's operation); while yet others contain special data concerning, e.g. health and safety, fuel-element transportation and operating accidents and incidents.

In practice, the contractors have supplied the required reports and documents in due form; copies may be sent to industries and organizations in the Community and may be consulted at Euratom headquarters. There are now more than 10,000 pages of text and plans available. The material received during 1963 may be summarized as follows:

Information received	SENN	SIMEA	SENA	KRB	SEP	TOTAL
First reports	2	1	7	2	1	13
Annual reports	2	1	2	—	—	5
Quarterly reports	10	4	8	—	—	22
Special reports	6	20	13	—	—	39
Safety reports	9	1	—	—	—	10
Plans, specifications etc.	11	9	2	—	3	25
Contract documents	8	1	5	3	2	19
Total	48	37	37	5	6	133

VII. Dissemination of information

The information furnished in document and report form by the contractors or obtained at first hand by engineers on detachment is disseminated in two different ways, i.e.:

1. *Dissemination of documents*

The documents to be distributed are of three types, namely:

— *reports of engineers detached by the Commission*

These reports are brought to the attention of about 150 Community industries and organizations concerned through six national correspondents;

— *reports of firms' engineers*
— *contractors' documentation*

A list of these reports is circulated by the national correspondents. Industries and organizations concerned may obtain microfilms of these reports simply on request or may consult them at the Commission's head office.

During 1963, the Commission received applications for microfilms totalling about 20,000 pages, corresponding to the numbers of the following reports:

Country	Organ. firms	SENN	SIMEA	SENA	KRB	SEP	TOTAL
Belgium	2	12	—	—	—	—	12
Germany	4	53	15	18	1	—	87
France	—	—	—	—	—	—	—
Italy	9	86	111	14	—	—	211
Luxembourg	—	—	—	—	—	—	—
Netherlands	3	34	—	4	—	—	38
Total	18	185	126	36	1	—	348

In the course of the same year, the documents were consulted at Euratom headquarters by 184 persons, the breakdown being as follows:

Belgium	: 29	organizations	and	firms	sent 48	persons
Germany	: 14	»	»	»	» 27	»
France	: 24	»	»	»	» 59	»
Italy	: 16	»	»	»	» 34	»
Netherlands	: 14	»	»	»	» 16	»
Total	: 97				184	

2. *Information meetings*

During 1963, the third information meeting was held, being attended by 169 delegates from 104 organizations and enterprises in the six Community countries. Under the working programme for the two-day meeting, the following questions came up for examination:

— the implementation of contracts of participation;
— the work and the results of the tests carried out in the three power plants with which contracts had been signed up to 1962;
— the terms of the two contracts concluded in 1963 (KRB and SEP).

At this meeting, a number of technical problems in connection with the SENN and SIMEA final acceptance tests were given a thorough airing. Of particular importance were the contributions of the engineers from Community enterprises and organizations who had been seconded to the plants in question and who were able to report in detail on the studies which had been carried out and to describe their active participation in the construction work on the various power plants.

DOCUMENT No. 21

INTERNATIONAL CONVENTIONS ON NUCLEAR THIRD-PARTY LIABILITY

I. Conventions on the liability for damage caused by land-based nuclear installations

1. As was indicated in the previous general report, thirteen out of the sixteen States who signed the Paris Convention of 29 July 1960 on third-party liability in the field of nuclear energy, signed a supplementary convention on 31 January 1963, four years after negotiations began, based on a draft submitted by the Commission to the Member States of the Community. These two conventions should provide Western Europe with a unified system of nuclear third-party liability and coverage for nuclear damage, mainly by calling for concerted action on the part of the signatory States.

At present, however, no ratification procedures can be initiated owing to the negotiation of a world-wide convention on third-party liability for nuclear damage within the IAEA. This convention was signed on 19 May 1963, as a result of the IAEA-sponsored diplomatic conference in Vienna at which the Commission was represented by observers. Neither the signatory States of the Paris Convention and the Supplementary Convention, nor the United States or the USSR, were among the signatory States to this Convention.

To enable the former to become parties to the Vienna Convention the text of the Paris Convention had to be modified, a process which also gave rise to changes of detail in the Supplementary Convention. As the "European" Conventions had already been signed, the necessary adjustements were made in the form of two additional protocols, which however only concern technical points, the Vienna Convention being based on the same principle as that of Paris.

The signatory States and, in particular, the Member States, have decided to ratify the Paris Convention and the Supplementary Convention in the near future, taking into consideration on the one hand the prospects for the ratification of the Vienna Convention, and on the other the fact that the Convention makes no provision for a system of allocation of public funds for the compensation of damage in excess of the sum insured. However, the Commission wishes to emphasize the advantage of having a world-wide system set up to govern nuclear third-party liability. This is an important feature in the development of nuclear energy and particularly in the expansion of European atomic industry exports.

2. As the Paris Convention and the Supplementary Convention may be expected to come into effect shortly, the Commission is from now on bringing its attention to bear on the problems bound up with their implementation. Some Member States have already adopted national laws, thereby enforcing, on a unilateral basis, rules which spring largely from the international conventions now being prepared, while the others are drafting implementary legislation. In fact, the Conventions leave the decision on many points to national legislators or establish rules which they have the right to waive.

A wide degree of uniformity between the national laws is desirable if full practical scope is to be given to the advantages afforded to industry by a unified system in Western Europe as a whole. Points exist where appreciable differences in these laws may engender disparities from one country to another as to the weight and distribution of the financial burden resulting from third-party liability. Apart from impeding the creation of equal conditions for the development of nuclear industries, such disparities could from obstacles to the conclusion of nuclear hazard insurance contracts which Member States are obliged to facilitate under the terms of Article 98 of the Treaty. The Commission is at present considering the question of the harmonization of the methods by which the Paris Convention and Supplementary Convention are to be applied.

II. Brussels Convention of 25 May 1962 on the liability of operators of nuclear-powered ships

Certain States, for the most part non-European, have stated that they are only provisionally prepared to adopt various rules of this Convention which applies, in the maritime sector, solutions derived from the principles of the Paris Convention. Therefore, after having adopted the Convention—no nuclear maritime power appeared among the signatories—the diplomatic conference on maritime law held in Brussels appointed a group of experts responsible for the examination of problems bound up with:

— the establishment of an international judicial body solely competent in matters of litigation arising out of the convention;

— the creation of an international system of joint financial responsibility to cover the liability of the operators of nuclear vessels, fixed at 100 million US dollars and which the States issuing the operating licence of the vessels involved in a nuclear accident are obliged to cover over and above the sum guaranteed by private insurance;

— the accession to the Convention of intergovernmental institutions in their capacity as authorities empowered, in the same way as States, to issue licences for the operation of nuclear vessels under their flag.

The Supplementary Convention to the Paris Convention has had a considerable influence on the Committee's discussions on the second point. The Commission was represented by observers at the meetings held by this Committee which is due to make its report to the Belgian Government by 25 May 1964.

In the absence of a suitable international system the United States Government is seeking by means of bilateral ad hoc agreements to devise a solution to the problems of third-party liability and coverage which will arise when the mixed cargo vessel, the NS "Savannah", docks in the harbours of various countries, including several Community States.

DOCUMENT No. 22

PRACTICAL PROBLEMS INVOLVED IN THE INSURANCE OF NUCLEAR RISKS

In accordance with the task laid on the Community by Article 98 of the Treaty, namely that of facilitating the conclusion of insurance contracts, the Commission has, as in previous years, given its attention to the practical problems involved in the coverage of nuclear risks through the insurance market. This work was carried out by a group of insurance experts set up at the end of 1961.

I. Insurance of land-based nuclear installations

With a view to working out a policy for covering nuclear hazards affecting the Joint Research Centre installations and also to finding solutions as regards the coverage of such hazards in the Community as a whole, the Commission, with the cooperation of nuclear insurers, is engaged in gathering more information on the insurance market. At present, both inside and outside the Community, this market is extremely narrow, mainly owing to the limited number of nuclear installations and to the fact that by no means all the operators avail themselves of insurance. In every Member State except Federal Germany public atomic research bodies are insured against third-party liability. Things are different in the United States and the United Kingdom. However, power reactor operators in all these countries generally take out third-party liability insurance. As for the installations themselves, to all intents and purposes they are only insured against damage in Italy and the Netherlands. The market for such insurance is thus even smaller than that for third-party coverage.

In the light of these facts, and on the basis of a comparative analysis of the policies of nuclear insurance pools in the Community carried out under a study contract, the Commission has made a systematic examination of the problems relating to the insurance of fixed nuclear installations. These problems are bound up with the state of development of the relevant insurance market, the lack of sufficiently long experience of the hazard and the burden involved in insurance coverage for nuclear risks, particularly in the context of the current economic data on nuclear energy production.

II. Insurance of risks connected with the use of radioisotopes

These risks are already widespread and will gradually extend to most fields of activity through the expansion of the use of radioisotopes in industry and agriculture as well as in scientific research or medicine. Adequate coverage of these risks, that is, not only for injury to staff and damage to property of the insured caused by the radioisotopes he is using, but also for any damage inflicted on other persons, is a major condition of this expansion.

Danger resulting from the use of radioisotopes appears to be limited, as any possibility of chain fission reaction is ruled out. Nor does the Paris Convention apply to liability for damage caused to third parties in the use of radioisotopes. In view of their limited extent, insurance of such risks involves no serious coverage problem and in all Member States, with the exception of France, is effected through the ordinary market, i.e. companies acting independently but with the assistance, apart from one Member State, of a consultative committee of experts—a system which, with reinsurance, results in uniformity of practice in the various countries. Radioisotope hazards represent an aggravation of a conventional risk which as a rule is already insured, although it should be stressed that the use of radioisotopes in certain cases makes for greater safety in the establishment using them. Radioisotope risks are not well enough known to be included in existing conventional policies. Such inclusion, which is desirable for the sake of simplification, can only be envisaged after many years of experience comprising a large number of cases. The overriding concern of the group has been to aim at the greatest possible simplicity in the formalities required of the insured, and on various points it has consulted users of radioisotopes. It is with this aim in view that for third-party liability in the carriage of radioisotopes it has established a standard policy covering a series of consignments over a given period. This policy covers every person who may incur liability for damage caused to a third party by such operations. This automatic concentration of the responsibility for compensation in one person is calculated to afford insurers appreciable savings.

III. Insurance of nuclear fuel carriage

Attention should be drawn to the importance of the invitation sent out in February 1963 for tenders in respect of the carriage of irradiated fuels discharged from various research reactors operated in the Community. The carriers who replied forwarded insurance proposals from nuclear insurance pools in the Community as well as from British insurers. The experience gained with regard to the risks involved in, and the insurance of, such operations, will be of great value to both carriers and insurers.

DOCUMENT No. 23 **MANAGEMENT OF INDUSTRIAL PROPERTY**

The number of patents filed in the Community has increased steadily. The Commission has followed up the contract-research patent system which it laid down in 1961 with two new statements to the Council, the one dealing with the system governing non-patentable information and the other bearing on the procedure with regard to "basic patents". The Commission has also outlined to the Council its attitude to the granting of licences, in respect of its patents, to non-member countries and to persons or firms outside the Community.

I. Communication of patent applications (Article 16)

Notifications of patent applications as provided for in Article 16 of the Treaty were submitted in a regular manner and within the time-limits laid down. By 31 December 1963 the Commission had received details of 9,961 patent applications, 1,176 were notified in 1963. The number of inventions covered by patent applications conveyed to the Commission in the form either of accounts of content or simple notifications is 7,368.

II. Filing of patents by the Community oι holders of its contracts

At the end of 1963 the Commission's Patent Office had dealt with 387 inventions stemming from the research programme. Of this number 139 had been examined in 1963, as against 128 in the previous year. Between the date of the Treaty's entry into force and the end of 1963, these inventions had been the subject of 302 premiers dépôts filed on behalf of either the Community or the holders of its contracts, 101 of them being filed in 1963. The total number of requests for the extension of patent rights to other countries had reached 969 by the end of last year. A total of 29 of the patent applications submitted in countries where a preliminary examination is required have already been granded, non having been rejected.

The inventions for which patents had been filed up to the end of 1963 break down as follows:

	1963	*Previous years*
ORGEL, ECO and ESSOR	24	49
Controlled thermonuclear fusion	12	23
BR 2 reactor	2	18
DRAGON project	14	54
Miscellaneous	52	51

They split up by origin as follows:

	1963	*Total for previous years*
Joint Research Centre establishments	34	57
Contracts of association	33	50
Other contracts	22	32
Dragon project	13	54
Miscellaneous	2	2

A list of the patent applications filed during the period from 1 March 1963 to 31 December 1963 is given in Document 34 attached to the present General Report.

In addition, the periodical "Euratom Information" publishes the administrative data relating to the patents granted and their principal claims.

III. Working of patents held in portfolio

The JRC establishments are already utilizing a number of patented inventions on a laboratory scale. Some of them were employed in the construction of ECO or are to be applied in the construction of ESSOR. Several inventions deriving from research contracts are being worked by the contract holders. Cases in point are the semi-industrial-scale utilization—in particular for supplies ordered by the Commission—of SAP (Sintered Aluminium Powder, a cladding material) patents. Many patents for equipment which have arisen out of contracts of association in the field of fusion have served as a basis for the manufacture of research apparatus. The BR 2 and DRAGON inventions have for the most part been developed within these two projects. In the case of the DRAGON project, mention should be made of the special importance of the patents relating to coated particles and to thermocouples. A new invention developed by the Ispra establishment, a new chromatographic process, has formed the subject-matter of a licence contract.

IV. System governing information and patents in research contracts

1. *Non-patentable information*

At its meeting on 1 and 2 April 1963, the Council was notified by the Commission of the rules that the latter contemplates applying to non-patentable information resulting from research contracts. No objections were raised by the Council to these rules, which also met with the approval of the sectors concerned.

The main underlying principles are as follows:

a. The Commission has the right to communicate to Member States and to persons and enterprises in the Community, in accordance with Article 13 of the Treaty, any information arising from the execution of the programme as laid down in the technical annex to the contract.

b. When any such knowledge cannot be put to any use in the nuclear field, its dissemination is subject to the agreement of the contract-holder, unless the information in question forms one of the specific subjects of the contract.

c. The contract-holder may not prevent communication of the results obtained from the contract to Member States, or to persons or enterprises in the Community as required by the Treaty. The contract-holder may, however, oppose wider dissemination in the form of publication, stating his reasons for so doing.

d. Under its obligations and as part of its policy of exchanges with non-Member States, the Commission may communicate the information referred to in (a) to non-Member States or to persons or enterprises outside the Community.

The contract-holder, however, is entitled:

— to be informed, at the time the contract is signed, about these obligations and this policy and in this case no modification of these obligations or this policy can be invoked against him;

— to put forward any reasons why the information should not be communicated, the Commission being obliged to refrain from transmitting the information if it considers these reasons compatible with the interests of the Community;

— to be allowed to participate in the exchange of information if this is likely to result in industrial application outside the Community.

e. The know-how required for the practical utilization of the information referred to in (a) remains the property of the contractor who has the right to draw up agreements with third parties—e.g. for technical assistance—on this point but on condition that he allows the Member

States and persons and enterprises in the Community to have priority as regards the benefits of such information. If, on the other hand, it is the acquisition of the know-how which forms the subjects of the contract, it is subject to the rules on information as set out in (a) to (d) above.

2. *Basic patents*

The Commission also informed the Council, meeting on 30 and 31 May 1963, of its proposed solution for the problems raised by the existence of "basic" patents in connection with the research results obtained under contract. This solution elicited no comments from the Council and was also approved by the sectors concerned.

The problem was to prevent the contract-holder from invalidating the rights which he had accorded the Community concerning information and patents arising from the contract, by invoking a patent (basic patent) acquired outside the contract and upon which utilization of the information and patents originating from the contract is conditional.

If, for example, the contractor holds a patent for a novel organic liquid and the purpose of the contract is to adapt this liquid to use as a moderator in a reactor, possession of the basic contract would enable the contract-holder to prohibit the Commission and third parties from availing themselves of the results of the Community-financed research.

It is henceforth laid down that the Commission and the contract-holder shall determine, prior to signing the contract, whether basic patents relating to a technical field which has been defined or has been designated by name require undertakings to be given by the contract-holder.

These undertakings will include an obligation to supply, and if called for an obligation to grant, licences on commercial conditions. The utilization of knowledge and patents arising from the contract will therefore no longer encounter any bar arising from the basic patents.

V. Granting of licences in respect of Community-owned patents

At the Council's meeting on 1 and 2 April 1963, the Commission outlined its attitude to the granting of licences to non-member countries or to persons or enterprises outside the Community.

The salient features of this standpoint are as follows:

1. Unless so bound by the provisions of existing international agreements, the Commission intends to grant licences under patents to non-member countries or to persons or enterprises outside the Community in the following cases only:
    - *a.* In exchange for the granting of a licence to the Community, to the Member States or persons or enterprises in the Community;
    - *b.* In exchange for advantages of an industrial or commercial nature granted to the Member States or to Community persons or enterprises in a territory to which the Treaty does not apply;
    - *c.* In consideration of the payment of royalties when the licence application is submitted by a Community enterprise on behalf of subsidiaries or enterprises operating under the control or for account of the applicant;
    - *d.* In consideration of the payment of royalties when the licence is to be worked in territories to which the Treaty does not apply, insofar as it has proved impossible to grant a licence to a Member State or a person or enterprises in the Community for such territories.

2. Where the patented invention has arisen from research carried out under contract, the granting of licences is, as a general rule, a matter for the contract-holder. At all events no licences can be granted without his consent. Should the Commission be called upon to play any part in the granting of such licences, it will act in accordance with the principles set out in 1. above.

VI. Bringing industrial pioperty rights into within the Community

Both the Euratom and the EEC Commissions have participated in the work undertaken by the six Community countries with a view to the establishment of European industrial property rights. A large number of bodies representing the circles concerned have made known their views on the draft European Patent Convention published in November 1962.

The purpose of this draft text, it will be remembered, is to create a patent, to be issued by a European patent office, which is valid throughout the territory of all the contracting States. The grant of a European patent would be subject to the favourable outcome of a patentability examination, which would not be compulsory during the first five years from the date of filing. The

European patent system would exist side by side with that covering national patents, the applicant being allowed to choose between the protection offered by the one system or the other.

The draft convention and the opinions of the circles concerned are now being examined by the competent Under-Secretaries of the six Community countries. Particular attention is being given to the questions of whether adhesion to the convention should be confined to the EEC Member States and whether access to the European patent should be granted to nationals of States signatories to the Convention only.

I. Field of application of Regulations Nos. 7 and 8

The table below shows the extension of the field of application of the Commission's Regulations Nos. 7 and 8 to installations in the Community.

	1.1.1961	1.1.1962	1.1.1963	1.1.1964
Regulation No. 7	72	84	97	117
Regulation No. 8	111	127	134	155

Regulation No. 7 lays down the basic technical characteristics to be communicated to the Commission by all nuclear installations.

Regulation No. 8 prescribes the data relating to stocks and movements of source materials or special fissile materials to be supplied to the Commission regularly by the undertakings concerned.

II. Notification of technical characteristics of installations (Regulation No. 7)

Installations whose basic technical characteristics had been communicated to the Commission at 1.1.64 are set out in the following table according to industry:

	Belgium	Germany	France	Italy	Netherlands	Community
Concentrate fabrication	1 (1)	1	4	1 (2)		7
Fuel fabrication	1	1	6			8
Fuel element fabrication	3 (3)	1	4	1		9
Reactors	6 (5)	19	21 (4)	17	7	70
Irradiated fuel processing			1			1
Laboratories	4	4	6	8 (6)		22
	15	26	42	27	7	117

(1) At present outside the Community.
(2) Installation halted.
(3) Including two halted.
(4) Including one reactor halted.
(5) Including one reactor at present outside the Community.
(6) Including one laboratory now no longer reprocessing nuclear material.

III. Materials stocks and movements (Regulation No. 8)

The figures hereunder show the position regarding the implementation of Regulation No. 8 at 1.1.1964:

a. Stocks held and stock movements within the Community:
- Ores: 10 undertakings send the Commission quarterly statements of output and stocks at 29 mines.
- Source and special fissile materials: 61 transmit to the Commission the balance-sheets and inventories 126 installations.

b. Export and import transactions with third countries:

Twenty-four undertakings sent the Commission 306 import or export declarations relating to the transfer to or from non-Community countries of the following:

	Imports	*Exports*
— Natural uranium	37	26
— Depleted uranium	9	3
— Thorium	11	71
— Special fissile material	130	19
Total	187	119

Fifty-eight of these imports and 5 of the exports involved materials delivered to the Community under agreements for cooperation.

The following is a breakdown of undertakings, establishments and installations to which Regulation No. 8 applies:

	Belgium	Germany	France	Italy	Netherlands	Community
Undertakings	8	23	15	15	8	69
Establishments	9	25	50	20	8	112
Installations :						
— Mines		2	26	1		29
— Concentrate fabric.		1	4			5
— Fuel fabrication	1	1	6			8
— Fuel element fabrication	1 } 13	2 } 33	4 } 68	} 26	} 15	7 } 155
— Reactors	5	18	19	17	8	67
— Irradiated fuel processing			1			1
— Laboratories	6	9	8	8	7	38

IV. Inspections

At end 1963, 50 inspections had been carried out, 30 of them in research establishments and 20 in industrial establishments. The categories of installation inspected were:

	Nr. of inspections
— Ore concentration plant	2
— Uranium and thorium concentrate chemical processing and refining plant	8
— Fuel manufacture plant	1
— Fuel element fabrication plant	7
— Power reactors	3
— Research reactors	30
— Research laboratories	20
Total	71

DOCUMENT No. 25

ACTIVITIES OF THE SUPPLY AGENCY

I. Market Survey

On the Commission's instructions, the Agency carried out a second market survey covering users and producers in the Community for the period 1963 to 1967, and is supplementing this survey by an enquiry into market prospects in the free world as a whole.

The survey confirms the trend in the Community towards a balance between supply and demand in the natural uranium market. The estimated figures of accrued needs for the period in question are in the region of 7,700 metric tons against production in the region of 7,500 metric tons. However, this small deficit can be fully met by drawing on existing output capacity and stocks held in the Community.

In the course of the years 1963-7 the French Atomic Energy Commission (CEA) the main producer and virtually sole user, will be in a position to adjust supply to demand. Requirements of ore and preconcentrates are expected to decline by 15% between 1963 and 1965 from 1,650 to 1,400 metric tons contained uranium, and to level out at the latter figure until 1967. Furthermore, a reduction in mining activity in the Community is to be noted from 1963 onwards, stocks having fallen from 675 metric tons contained U, or about six months' mining output in 1961, to 366 metric tons, or two to three months' output in 1963. Community reserves, estimated at 28,400 metric tons contained U—roughly the same as in 1958—would be depleted fairly rapidly if no new deposits were discovered. They were estimated in 1962 at 18 years' production.

For the free world as a whole, a fall both in demand and in output capacity is forecast, with figures of 9,000 - 10,000 metric tons in 1970 compared with 35,000 metric tons in 1960.

In view of the survey results, and with the assent of the Consultative Committee, the Agency extended until 31 December 1969 the term of contracts which may be concluded by means of the simplified procedure. This procedure makes possible the direct negotiation of contracts for the supply of ores and source materials between users and producers.

As regards special fissile materials, the Community market shows a marked deficit.

Estimates of the Community's present accrued needs of U 235 total 14,934 kg for the period 1963-67 as against 8,975 for 1960-65, an increase of approximately 40%. This indicates a future enriched uranium demand greater than that predicted by the first survey.

Since the Community for the moment has no enrichment capacity of its own, all enriched nuclear fuel has to be imported, almost entirely from the United States. An increase in imports must therefore be expected.

The 1958 Agreement for Cooperation between Euratom and the United States, with its additional clauses and amendments, provided for a quantity of 30,000 kg of U 235 to be made available to the Community for fuelling power reactors and for research programmes. This amount having proved insufficient, a supplementary agreement was negotiated and signed by which the USAEC, after authorization by the American authorities, can make U 235 available to the Community in quantities to be decided. Congress recently authorized the USAEC to deliver 40,000 kg of U 235, thus bringing the total destined for the Community to 70,000 kg.

As regards plutonium, only rough estimates exist of consumption and output. Requirements are bound up with the development of the fast breeder reactor string. Plutonium is exclusively generated in power reactors, and production is expected to total around 1,000 kg in 1970. For the period under consideration, the demand will arise before output becomes available. Moreover, it must be stressed that the plutonium contained in irradiated fuel elements cannot be recovered until a certain cooling period has elapsed and the capacity of reprocessing plant in the Community at present bears no relation to the volume of irradiated fuel elements from which the plutonium will have to be extracted. Thus for plutonium, as for enriched uranium, the Community will be dependent on available capacity in non-Community enterprises.

II. Transactions

Certain transactions have been concluded in respect of source materials but the Agency's main activity has been focussed on special fissile materials.

1. *Enriched uranium*

The position since 1962 is that all the Community's power reactors can be supplied, whether they come under the Euratom/United States power reactor programme or not. Thus contracts have been signed between the USAEC, the Agency and SELNI (Società Elettronucleare Italiana) by which 8,000 kg of U 235 contained in 200 metric tons of fuel and representing in the raw state a sum in the region of 25 million EMA units of account could be made available to SELNI. Negotiations are in progress for supplying the SENA and KRB reactors, projects which have been accepted as part of the US/Euratom joint power reactor programme and which have comparable fuel requirements.

Under these various contracts, the USAEC guarantees the fuel supply for the reactors for 20 years. The guarantee does not rule out the right of operators to obtain supplies from other sources which may prove more economical in the future. The USAEC has undertaken, moreover, within the quantity restrictions set by American legislation, to give all reactors in the Community a fuel guarantee, irrespective of their origin and type. Under this policy of non-discrimination, operators are left with a free hand to have fuel fabricated in the Community if they wish. This is important for the development of the fuel element industry in the Community, which the Commission is encouraging within the context of its power reactor participation programme, in particular by sharing financially in the costs of fuel element fabrication insofar as this is carried out in the Community.

In the field of research, under the multi-lease contracts for special fissile material signed on 18 July 1962 and 1 December 1963 between the Agency and the USAEC, several orders were filled for enriched uranium totalling 807 kg. These quantities were mainly earmarked for fuelling research reactors belonging to the Community, the CEA, the CNEN and the Kernforschungszentrum, Karlsruhe.

2. *Plutonium*

The Agency has purchased from the USAEC several batches of plutonium to a total of 8.7 kg for use in plutonium research under contracts entered into with the CEA and CEN, within the Euratom/United States research programme.

It has signed, on behalf of the CEA, a contract for the purchase from the UKAEA of 45 kg of plutonium intended for the first charge of the RAPSODIE fast reactor administered by the CEA in association with the Community. This is the biggest international transaction so far concluded for plutonium for peaceful uses. In addition, the Agency has obtained from the UKAEA an option until June 1964 for a further 45 kg of plutonium to supply the same reactor.

Finally, the Agency has recently completed negotiations with the USAEC concerning the purchase of 355 kg of plutonium needed to carry out the research programme on fast breeder reactors in which the Community is engaged in association with the Kernforschungszentrum, Karlsruhe, and the French and Italian Atomic Energy Commissions (CEA and CNEN).

DOCUMENT No. 26

SUMMARY OF LEGISLATIVE AND ADMINISTRATIVE PROVISIONS RELATING TO PROTECTION AGAINST IONIZING RADIATIONS AND DRAFT PROVISIONS SUBMITTED DURING 1963

I. Belgium

Principal legislation

— Nuclear Law of 29 March 1958.
— Royal decree enacting "General regulations for the protection of the general public and of workers against the hazards of ionizing radiations", of 28 February 1963.
— Royal decree amending the "General regulations for the protection of workers", of 28 February 1963.

II. Germany

1. *Principal legislation*

— Atom Law of 23 December 1959, amended 23 April 1963.
— First decree on radiological protection of 24 June 1960.

2. *Draft texts communicated to the Commission during 1963 pursuant to Article 33 of the Treaty*

— Dated 3 May 1963, a draft "Regulation to amend and supplement Regulation No. 1 on radiological protection of 24 June 1960". The object of this draft is to revise Regulation No. 1 to bring it into line with the new contents of Annexes 1 and 3 to the Basic Standards.

The Commission made certain recommendations on a number of individual points. Implementation of these recommendations was facilitated by contacts between Euratom representatives and the competent government departments of the Federal German Republic.

— Draft "Regulation on protection against the hazards of ionizing radiations in educational establishments", of 5 july 1963.

The Commission had no recommendations to make on this draft, the first in the Community on this specific subject, judging its provisions to be appropriate to ensure compliance with the Basic Standards. The adoption of this text is intended to provide for the protection of a population group which is peculiarly vulnerable, by reason of its age, to radiations to which they may be exposed when handling equipment or substances emitting ionizing radiations for educational purposes.

III. France

Principal legislation

— Circular of 7 March 1962 making the Euratom Basic Standards applicable in France.

— Decree of 11 December 1963 concerning nuclear installations.

IV. Italy

1. *Principal legislation*

— Nuclear Law of 31 December 1962.

2. *Draft texts communicated to the Commission during 1963 pursuant to Article 33 of the Treaty*

— The Italian Government transmitted to the Commission on 30 November 1963 draft "Provisions concerning safety of nuclear installations and protection of the health of workers and of the general public against hazards from ionizing radiations arising from the peaceful use of nuclear energy".

This important text aims at providing Italy with a system of regulations consonant with the Basic Standards in implementation of the Atomic Law of 31 December 1962. The intention is to supplement this regulation by a series of texts dealing with specific problems of protection.

V. Luxembourg

Principal legislation

— Law of 25 March 1963 concerning protection of the public against hazards from ionizing radiations.

In addition a draft "Regulation by the Sovereign of the Grand Duchy on the implementation of the law on protection of the public against hazards from ionizing radiations" was transmitted to the Commission on 23 January 1964.

VI. Netherlands

Principal legislation

— Nuclear Law of 21 February 1963.
— Decree on protection against ionizing radiations of 18 March 1963.

BACKGROUND RADIOACTIVITY

Background radioactivity control is handled satisfactorily through a network covering all six countries and woıking in close collaboration with Euratom. As provided in Article 36 of the Treaty, the results of measurements taken are communicated regularly to the Commission which processes and interprets them from the health standpoint and draws up comparative tables for the Community as a whole; these are then circulated to the competent authorities and agencies in the six Member States.

Background radioactivity control involves:

— the monitoring of dust suspended in the air
— the monitoring of fallout and precipitation
— the monitoring of surface waters
— the monitoring of radioactivity in the food-chain

The routine measurement of overall beta radioactivity has been general practice since 1958. At present, samples of airborne dust are taken at 119 posts and of fallout and precipitation at 131 posts spread over the six Community countries in a tight and regular network (see map). The rise in overall beta radioactivity observed from October 1962 onwards continued until July 1963 when the peaks were recorded. After that date radioactivity declined steadily to values in the region of 1 pc/m^3 in December 1963, or about one-tenth of the July figures.

An advantage of measuring overall beta radioactivity is that it is a relatively easy process which yields data quickly on the trend of artificial airborne radioactivity, but it does not allow of accurate interpretation from the health angle. For this reason specialized laboratories in each country also analyze this radioactivity for particular radioelements which are of great significance from the angle of public health surveillance.

One of these radioelements, strontium-90, is, on account of its high toxicity, a special target of detection and measurement devices. A number of laboratories have made regular determinations; for example, in 1963 the mean atmospheric concentration established on the basis of monthly readings amounted to 0.05 pc/m^3. Although this is the heaviest concentration observed in recent years it still equals only 1.5% of the maximum permissible level according to the Euratom Basic Standards.

Airborne dust and surface water measurement results obtained by the networks sited in the territory of Member States and by the Ispra Centre are published in a document issued annually, together with comments on the general trend of background radioactivity. Document EUR 461, published in 1963, also contains a recapitulation of the trend of background radioactivity for a number of stations since they were opened in 1958. In July 1964, the report on the year 1963 will appear, with even fuller tables and comments.

A general card index of control posts has been compiled, covering sampling and atmospheric radioactivity measuring posts, and has been widely distributed within the Community. It gives full technical details of the methods, instruments and facilities employed and special site features of the posts. This card index will be kept constantly up to date and added to, in pace with network development and changes in existing posts.

An effort to make results more readily comparable has been made by means of special studies directed towards the harmonization of methods.

Scientific investigations undertaken in collaboration with Member States or farmed out to specialist bodies under contract are likewise helping to advance control techniques in respect of background radioactivity both in the air and in inland waterways.

Links have been forged with numerous laboratories, measurement centres and technical bodies engaged in background radioactivity control.

EURATOM DRAWING

31/12/1965

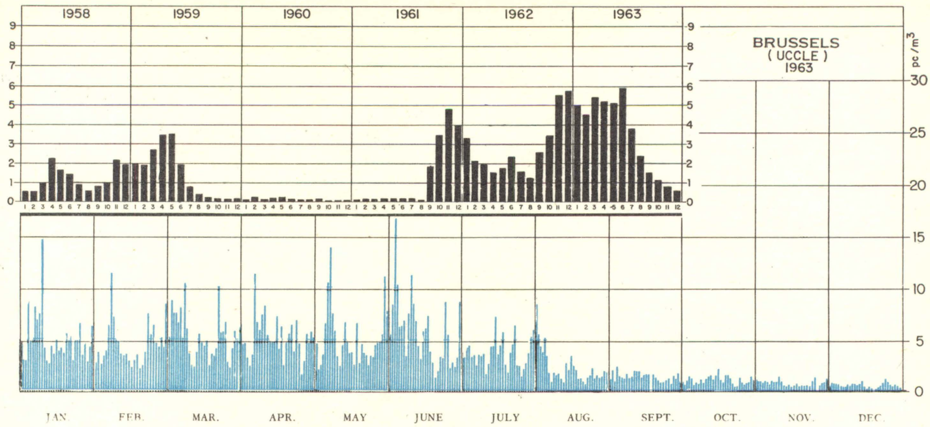
● *Sampling posts*

★ *Measuring posts,*

connected with Euratom, for monitoring artificial beta radioactivity in the air at ground level.

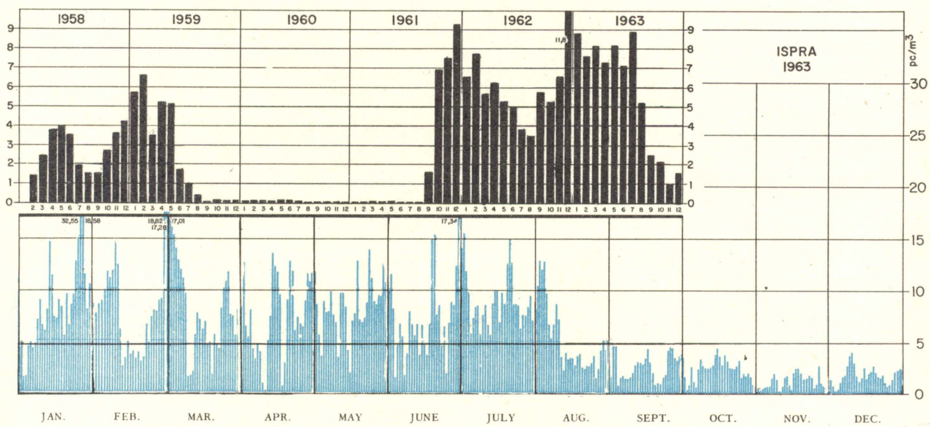
PICORURIES PER M^3 = PC/M^3

EURATOM DRAWING



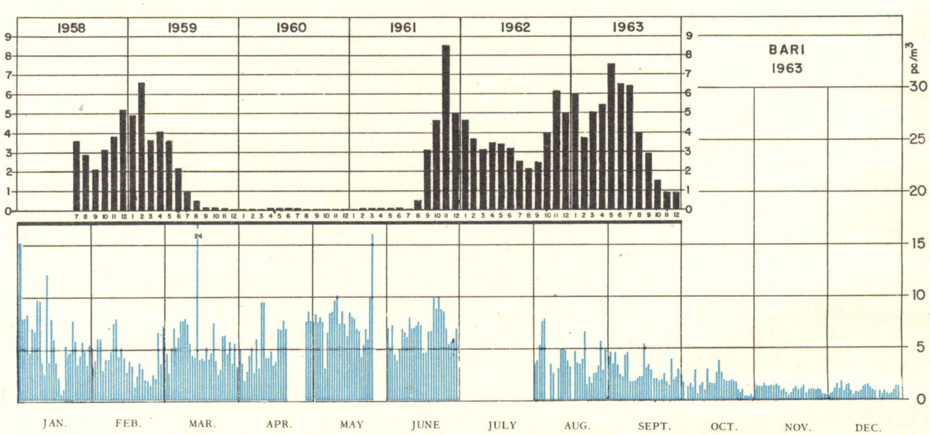
PICORURIES PER M^3 = PC/M^3

EURATOM DRAWING



PICORURIES PER M^3 = PC/M^3

EURATOM DRAWING



Exemple of artificial atmospheric beta radioactivity measurement in 1963 and from 1958 to 1963 at Brussels, Bari and Ispra.

I. Operational Safety

Opinions as to safety have been delivered in respect of the ECO critical assembly, the safety report for which was submitted to a Community expert group meeting in October 1963.

A number of technical reports have been drawn up on the safety problems raised by radioactive waste from the Ispra Centre, the electron accelerator and the storage of radioactive sources and fissile materials.

Opinions on the safety and protection of workers and of the general public were issued in the course of examination of projects submitted to the Commission, under Article 41. The safety reports in respect of the SENN power plant on the Garigliano and the Franco-Belgian power plant at Chooz received especially careful attention.

Furthermore, the Commission takes an active part in the monthly meetings of the Eurochemic/Belgian Public Health Liaison Committee held to discuss the initial drafts of the various chapters of the safety report now being drawn up.

II. Examination of radioactive waste disposal projects

Opinions delivered to date by the Commission pursuant to Article 37 of the Treaty are listed in the table hereunder.

PROJECT	Initial communication received	Commission's opinion delivered
BELGIUM		
1 — Plan for disposal of radioactive waste from BR 2 reactor (Mol)	30.1.1961	27.7.1961
2 — Plan for disposal of radioactive waste from BR 3 nuclear power plant (Mol)	21.6.1961	20.12.1961

PROJECT	Initial communication received	Commission's opinion delivered
3 — Disposal of radioactive waste from the processing plants operated by the Société Belge de Chimie nucléaire (BELCHIM) for processing radioactive waste from CEN (Mol)	5.10.1961	9.5.1962
4 — Plan for disposal of radioactive waste from the plutonium laboratories of the "Belgonucléaire/CEN" Research Programme (Mol)	20.11.1961	9.5.1962
GERMANY		
5 — Plan for disposal of radioactive waste from FR 2 reactor (Karlsruhe)	19.9.1960	17.3.1961
6 — BER (Berlin)	28.7.1960	17.3.1961
7 — FRM (Munich)	19.9.1960	17.3.1961
8 — ARGONAUT reactor (Munich)	19.9.1960	17.3.1961
9 — AEG test reactor PR 10 (Grosswelzheim)	19.9.1960	17.3.1961
10 — Disposal of radioactive waste from the Institute of Nuclear Physics plant at Johann-Wolfgang Goethe University, Frankfurt (Main)	16.11.1960	20.7.1962
11 — Disposal of radioactive waste from the Nuklear-Chemie und Metallurgie GmbH (NUKEM) plant (Wolfgang)	16.11.1960	20.7.1962
12 — Disposal of radioactive waste from the Karl (Main) experimental nuclear power plant	19.9.1960	12.10.1962
13 — Plan for disposal of radioactive waste from the Jülich nuclear research centre, North-Rhineland/Westphalia	28.7.1960	11.7.1963
FRANCE		
14 — Plan for dumping radioactive waste in the Mediterranean (CEA)	28.5.1960	26.7.1960
15 — Plan for disposal of radioactive effluents from the EDF 1 power plant, Chinon	4.11.1964	under examination
NETHERLANDS		
16 — Plan for dumping in the sea effluents from the Reactor Centrum Nederland, Petten	21.3.1962	20.7.1962

DOCUMENT No. 29

THE JOINT NUCLEAR RESEARCH CENTRE

The Joint Nuclear Research Centre, set up in implementation of Article 8, para. 1 of the Treaty, at present consists of four research establishments. Two of the four have a specific task, which clearly emerges from their designations. They are:

— the Central Nuclear Measurements Bureau, at Geel in Belgium, which is concerned with metrology;

— the European Transuranium Institute at Karlsruhe, whose task it is to increase present knowledge of the properties and technology of transuranium elements. In the forefront of these is of course plutonium, the prime choice as fuel for several types of power reactor.

The multi-purpose establishments at Ispra and Petten, on the other hand, may be called upon to handle any job within the general context of Euratom's scientific and technical activities, as and when needed. Their equipment is therefore designed to allow for the variety of activities which they may be expected to undertake over a period of time.

The activity of the Joint Centre is determined by the five-year research programmes. A Central Programmes Committee is responsible for allocating the work and sees that it is duly performed; the deliberations of this committee make it possible in particular to lay the technical basis needed to calculate the estimates to be included in the preliminary draft annual budgets.

I. Ispra establishment

Site: An area of 160 hectares in northern Italy, 2 km from Lake Maggiore, 25 km from Varese and 70 km from Milan.

Origin: The existence of Ispra as a Joint Research Centre establishment derives from an agreement by which the Italian Government agreed to transfer to the Community 160 hectares of land on which it had shortly before erected a research reactor and certain ancillary laboratories. The hand-over was supplemented by an undertaking on the part of Italy regarding the construction of additional buildings to a value of 9 million EMA units of account. The Centre was transferred to the Community on 1 March 1961.

Staffing at 31 January 1964: Established officials and other staff, 1302, of whom 1010 in scientific and technical posts.
Personnel will be increased to 1700 by 31 December 1967.

Principal research facilities:

— Three reactors, of which
one in operation (ISPRA 1 research reactor),
one approaching completion (Orgel Critical Experiment - ECO),
one under construction (ESSOR test reactor).
— A large bank of electronic computers, including an IBM 7090;
— Some 40 laboratories, test halls, workshops and buildings for office use.

Programme:

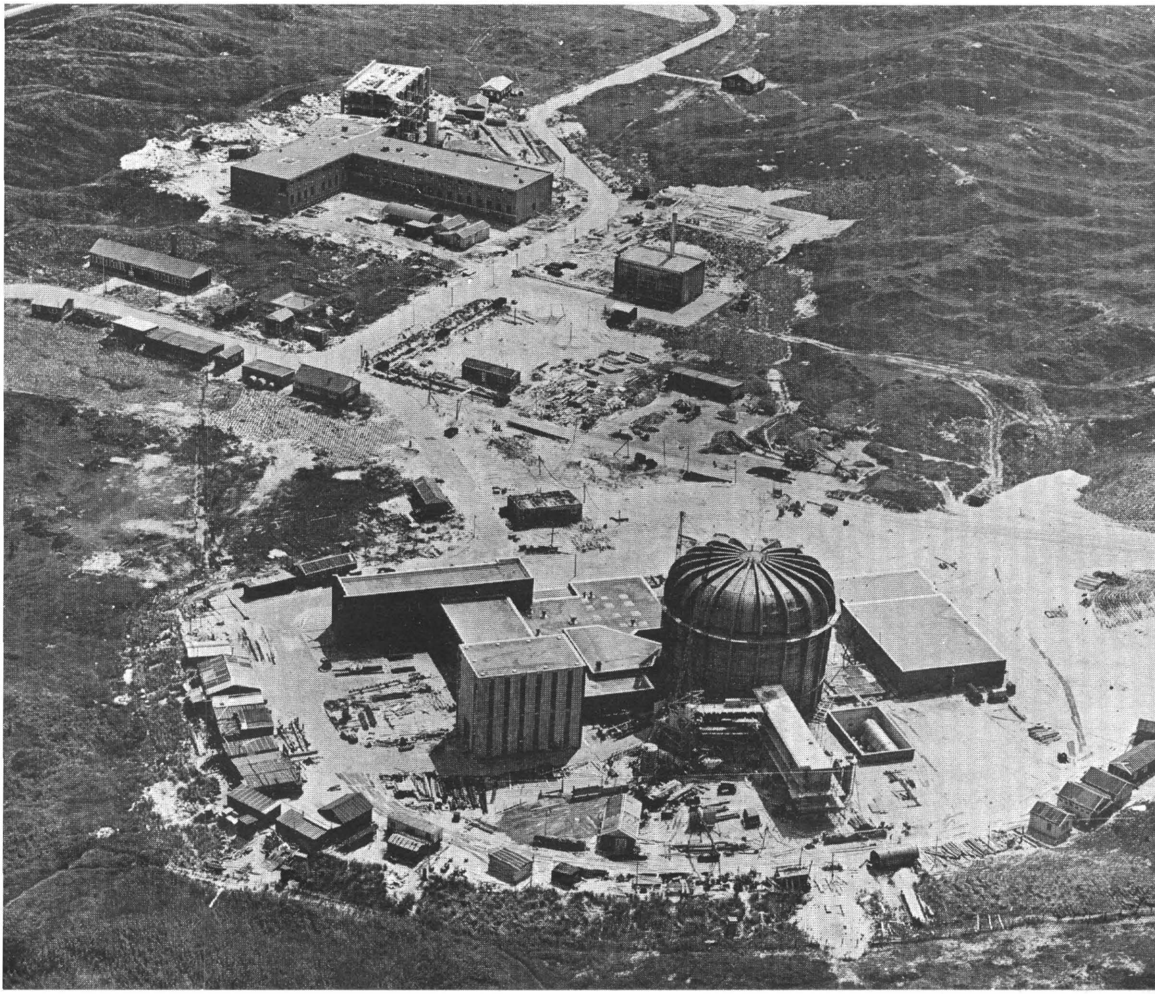
— Research and development work for a heavy-water-moderated organic-liquid-cooled type power reactor (ORGEL project);
— Calculation, translation and documentation by computer, together with certain allied researches;
— Complementary research in fields mainly covered by contract or association arrangements (relating to proven type reactors, advanced gas reactors, fast reactors, irradiated fuel processing, processing of radioactive waste, and to biology);
— Research into reactor physics;
— Miscellaneous research: fuel chemistry, solid state physics, magnetic resonance, direct conversion, and low-energy nuclear phenomena.

Some of these research projects are carried out by means of contracts administered by Ispra.

Budget: 78.6 million EMA units of account for the period 1963/67, which figure includes the balance from the first five-year plan. These appropriations will be supplemented by a substantial part of the 57 million u.a. earmarked for ORGEL in the five-year programme.

II. Petten establishment

Site: An area of 25 hectares (with an option on another 20 hectares) on the North Sea Coast, 60 km north of Amsterdam.



Petten — General view of Centre.

Origin: The Euratom establishment is being formed round a materials testing reactor constructed by RCN and transferred by the Dutch Government in 1962.

Staffing at 31 January 1964: Established officials and other staff, 72, of whom 54 in scientific and technical posts.
Personnel will be increased to 350 by 31 December 1967.

Principal research facilities

— One high-flux materials testing reactor with its ancillary laboratories and other installations;
— Molten-salt loop (installed in the Delft University laboratories).

Programme

— Irradiation in the high-flux materials testing reactor of samples of materials intended for nuclear purposes, and analysis of the results obtained. Design of the irradiation devices needed and the various techniques by which the efficiency of this type of high-flux reactor may be improved.
— Technical coordination in respect of high-temperature gas reactors developed by Euratom in association with various countries or groups of countries.
— Physico-chemical study of certain materials intended for nuclear purposes, in particular of molten salts and nuclear-grade graphite. Compatibility studies on these materials.

Budget: 27,5 million EMA units of account for the period 1963/67, Which figure includes the balance from the first five-year programme.

III. Geel establishment - Central Nuclear Measurements Bureau

Site: An area of 36 hectares in Antwerp province, Belgium, a few kilometres from Mol.

Origin: This establishment started work in 1960 on land made over by the Belgian Government. The Belgian contribution includes, in addition to the land, part of the infrastructure and a laboratory building.

Staffing at 31 January 1964: Established officials and other staff, 116, of whom 104 in scientific and technical posts.
Personnel will be increased to 180 by 31 December 1967.

Principal research facilities:

— One 3 MeV Van de Graaff accelerator;
— One linear accelerator equipped with six positions for neutron time-of-flight measurements;
— Various laboratory buildings.

Programme:

— High precision neutron measurements;
— Manufacture of isotope standards;
— Radioisotope counting;
— Preparation of samples required in the measurement of nuclear constants.

Budget: 11.3 million EMA units of account for the period 1964/67, which figure includes the balance from the first five-year programme.

IV. Karlsruhe establishment - European Transuranium Institute

Site and origin: Institute under construction on land provided by the Land Baden-Württemberg, alongside a German research centre possessing the major part of the infrastructure necessary for running both establishments. The German authorities share in the financing of these buildings up to a limit of 5.7 million EMA units of account.

Staffing at 31 January 1964: Established officials and other staff, 65, of whom 58 in scientific and technical posts. Some of them are on assignment to other nuclear centres in Europe and the United States pending completion of the laboratories.

Principal research facilities: A series of laboratories (under construction) equipped with all the apparatus necessary for handling highly radioactive substances. The first phase of the construction schedule has just been concluded and the whole complex is due for completion in 1966.

Programme:

— Basic studies on transuranium elements, with particular reference to plutonium;
— Study of industrial applications of these elements. This work comprises in particular the development of prototype plutonium fuel elements for all reactors suitable for this type of fuel.

Pending completion of the laboratories, certain research work figuring in the Karlsruhe programme is being done under contract in the Community (plutonium recycling in thermal reactors, production of transplutonium elements and research into their properties).

Budget: 28 million EMA units of account for the period 1963/67, which figure includes the balance from the first five-year programme.

DOCUMENT No. 30

CONTRACTS AWARDED BY THE COMMISSION IN 1963 UNDER ITS RESEARCH PROGRAMME

Table 1

RESEARCH CONTRACTS AND SUPPLEMENTARY CONTRACTS (1)

Subject	Number	Total sum payable by the Commission during the overall period of (2) the contracts (in EMA u. a.)
Contracts relating to establishments of the Joint Centre		
a) Ispra		
— Scientific data processing	4	157,000
— Direct conversion	3	132,000
b) Karlsruhe		
— Transplutonium elements	2	425,000
c) Petten	2	93,000
ORGEL project	22	1,237,000
Proven-type reactors (with particular reference to the US/Euratom Agreement)	23	3,619,000
Technical and economic studies	12	305,000
Processing of radioactive waste	2	119,000
New reactor types	1	669,000
Radioisotopes (research)	18	199,000
Biology and health and safety	13	1,103,000
Total	102	8,058,000

(1) Including 18 supplementary contracts raising the financial ceiling of the previous contracts.
(2) Amounts quoted in round figures.

Table 2

CONTRACTS OF ASSOCIATION AND SUPPLEMENTARY CONTRACTS (1)

Subject	Number	Total sum payable by the Commission during the overall period of the contracts (in EMA u. a.)
Fast neutron reactors	3	27,381,000
Aqueous suspension reactors	1	3,104,000
Biology and health and safety	4	1,441,000
	8	31,926,000

Table 3

PARTICIPATION IN THE CONSTRUCTION OF POWER REACTORS

Subject	Number	Total sum payable by the Commission during the overall period of the contracts (in EMA u. a.)
Participation in the construction of a nuclear power plant by N.V. Samenwerkende Elektriciteits-Productiebedrijven (SEP), Netherlands	1	5,000,000
Participation in the construction of a nuclear power plant by the Kernkraftwerk RWE-Bayernwerk GmbH (KRB), German Federal Republic	1	8,000,000
	2	13,000,000 (2)

(1) Including two supplementary contracts raising the financial ceiling of the previous contracts.
(2) Chargeable against appropriation earmarked for the first five-year programme.

LIST OF NEWS CONTRACTS
(not including supplementary contracts) awarded in 1963

I. *Contracts relating to establishments of the Joint Centre*

a) **Ispra**

— Scientific data processing

No. of contract	Name of contractor	Title
029-63-1 CETF	University of Paris, Faculty of Science, Paris	Application of stochastic processes to problems of data processing
031-63-3 CETI	Société PRAXIS Milan	Continuation of programming studies for the APACHE project
032-62-12 CETN	University of Amsterdam Amsterdam	Research into mathematical logic
033-63-9 CETU	Georgetown University Georgetown	Improvement of automatic translation programmes for Russian/English-English/Russian

— Direct conversion

No. of contract	Name of contractor	Title
002-63-9 CODI	Fabbrica Italiana Automobili Torino (FIAT) Turin	Preparation of certain types of materials (natural UO_2 cermets) for use in cathode construction
003-63-10 CODF	Société française THOMSON HOUSTON Paris	Study of a ceramic-metal joint able to withstand a temperature of 1000°C, and study of the thermal cycling in vacuo and in inert gas atmosphere of aluminium oxide-niobium assemblies
005-63-11 CODD	Technische Hochschule Stuttgart (Prof. Kluge) Stuttgart	Measurement of extraction potential of complex compound materials

b) **Karlsruhe**

— Transplutonium elements

No. of contract	Name of contractor	Title
007-62-11 TPUB	Centre d'Étude de l'Énergie Nucléaire (CEN) Brussels	Continuation of research into transplutonium elements initiated under a previous contract (002-61-2 TPUB)
009-63-10 TPUD	Kernforschungsanlage Jülich and Bonn-University Jülich/Bonn	Determination of distribution ratio of plutonium, americium, curium and rare earths in a liquid-liquid extraction system

c) **Petten**

No. of contract	Name of contractor	Title
017-63-12 PETN	University of Delft Delft	Construction and operation of a molten salt loop
023-62-12 PETD	Deutsche Gold- und Silber-Scheideanstalt (DEGUSSA) Frankfurt/Main	Development of platinum and palladium alloy thermocouples for accurate in-pile temperature measurements in high-flux and/or advanced gas reactors

II. *ORGEL Project*

No. of contract	Name of contractor	Title
080-63-1 ORGB	Centre d'Étude de l'Énergie Nucléaire (CEN) Brussels	Design and construction of metal diffusion barriers between uranium and aluminium while providing a good combination between them
081-63-1 ORGF	Compagnie pour l'étude et la réalisation des combustibles atomiques (CERCA) Bonneuil/Marne	Study of the use of chromium as diffusion barrier between uranium and aluminium

No. of contract	Name of contractor	Title
083-63-1 ORGF	Compagnie Industrielle des Combustibles Atomiques Frittés (CICAF) Corbeville p/Orsay	Development of semi-industrial manufacture of porous uranium monocarbide pellets or rods and of dense UC-U cermets
084-63-2 ORGI	Fabbrica Italiana Automobili Torino (FIAT) Turin	Preparation of fuel rods
085-62-12 ORGF	Commissariat à l'Énergie Atomique (CEA) Paris	Research into thermal exchanges using organic coolants
089-63-1 ORGF	Société TREFI-METAUX Paris	Design and improvement of fabrication techniques for aluminium-oxide substances of aluminium structural materials
092-63-4 ORGI	S.A. per l'Esercizio dell'Istituto Sperimentale dei Metalli Leggeri (ISML) Milan	Study of sintered aluminium powder (SAP)
096-63-1 ORGN	Centrale Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (TNO) The Hague	Polyphenyl analysis
097-63-6 ORGN	Centrale Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (TNO) The Hague	Study of burn-out in terphenyl mixtures
101-63-2 ORGB	Centre d'Étude de l'Énergie Nucléaire (CEN) Brussels	Development of fuel elements destined for the feeder channel of the ESSOR test reactor
104-63-12 ORGN	ROENTGEN TECHNISCHE DIENST (RTD) Rotterdam	Non-destructive tests for soft X-rays or hard gamma rays

No. of contract	Name of contractor	Title
110-63-1 ORGN	Centrale Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (TNO) The Hague	Terphenyl ozonolysis
111-63-9 ORGI	Centro di studi per la difesa contro le radiazioni Rome	Study of the ultraviolet spectra of a group of compounds of the polyphenyl family
113-62-11 ORGI	Istituto dinamometrico italiano Turin	Development of special strain-gauges for measurements at high temperature and under irradiation
119-63-7 ORGB	Free University of Brussels, Brussels	Experimental study of points at which local boiling occurs in an Orgel reactor vessel

III. *Proven-type reactors* (1)

No. of contract	Name of contractor	Title
002-63-4 TEGF	Commissariat à l'Énergie Atomique (CEA) Paris	Development of integral fuel loading/unloading processes for the gas-graphite reactor string; construction of a model integral loading/unloading device and trials with same
004-63-10 TEEI/RD	Società Ricerche Impianti Nucleari (SORIN) Milan	Research into the behaviour of nitrogen and carbon in iron and steels subjected to neutron irradiation
005-63-12 TEEB/RD.	Centre National de Recherches Métallurgiques (CNRM) Brussels	Plastic fatigue embrittlement of reactor vessel steels
008-63-12 TEEB/RD	Société SOUDO-METAL Brussels	Studies on the stainless plating of heavy-gauge steel

(1) The initials RD after the reference number mean that contracts are awarded under the US/Euratom Agreement for Cooperation.

No. of contract	Name of contractor	Title
009-63-12 TEGC	Allgemeine Elektrizitäts-Gesellsch. (AEG) Frankfurt/Main Société ALSTHOM Paris	Study of the economic value of improving the specifications of the primary circuit of a gas-graphite type reactor
010-63-3 TEEB/RD	Centre d'Etude de l'Énergie Nucléaire (CEN) Brussels	Study of the basic physical features of UO_2 single crystals, and of their irradiation behaviour
012-63-10 TEEB/RD	Free University of Brussels (ULB), Brussels	Study of some problems relating to the oxidation of metals, and application of impedance measurement methods to the study of the resistance of such metals to corrosion in aqueous medium
013-63-12 TEED/RD	Nukleare Chemie und Metallurgie GmbH (NUKEM) Frankfurt/Main	Development of a powder-preparation technique suitable for the industrial-scale fabrication of high-density UO_2 powders consisting of particles possessing the characteristics required for shaping by means of vibration- and swaging-compacting
016-3-10 TEGC	Deutsche BABCOCK-WILCOX GmbH, Oberhausen	Submission of firm offer for a thermal insulation system for pressurized gas-cooled nuclear reactors
017-63-11 TEGD	Deutsche BABCOCK-WILCOX GmbH, Oberhausen	Study of graphite corrosion by CO_2 in conditions of relatively high specific power
018-63-11 TEGC	FONDERIE DE PRÉCISION Nanterre (Seine) Société KARL SCHMIDT Neckarsulm	Development of casting technique for fabricating magnesium-zirconium alloy cans for fuels used in gas-graphite reactors
019-63-11 TEED/RD	METALLGESELLSCHAFT Frankfurt/Main	Development of Zr-Nb 3 % Sn 1 % type alloys as cladding for light water reactor fuels

No. of contract	Name of contractor	Title
022-64-1 TEGN	N.V. BREDERO Utrecht	Study of the effect of high temperatures (up to 400°C) on the mechanical, physico-chemical and thermal properties of concrete and its components
023-63-12 TEEN/RD	N.V. RESCONA, Amstelveen	Development of a turbine-type flowmeter for in-pile measurements
003-63-3 DIRB	Free University of Brussels (ULB), Brussels	Thermodynamic studies by mass spectrometry of fuels and refractory compounds
099-63-10 RDB	Centre d'Étude de l'Énergie Nucléaire (CEN) Brussels	Development of a semi-conductor neutron detector for the temperature range above ambient temperature

IV. *Technical and economic studies relating to the development of proven-type reactors*

No. of contract	Name of contractor	Title
009-62-11 ECII	Comitato Nazionale per l'Energia Nucleare (CNEN) Rome	Development of a method for calculating cost of fuel cycles in power reactors
011-63-2 ECIF	Société INDATOM Paris	*a*) Preparation of a questionnaire for consumers of thermal power at low temperature, designed to assess their requirements for this form of power *b*) Analysis and interpretation of replies
014-62-11 ECII	Comitato Nazionale per l'Energia Nucleare (CNEN) Rome	Preliminary study of the economic effects of the inclusion of nuclear power plants into electricity generation grids

No. of contract	Name of contractor	Title
015-63-1 ECIB	Free University of Brussels (ULB), Institut de Sociologie, Brussels	Pilot survey on the quantitative and qualitative requirements of industry and nuclear research in Belgium as regards scientific and technical personnel
016-63-12 ECII	Comitato Nazionale per l'Energia Nucleare (CNEN) Rome	Study of economic aspects of the U-233/thorium fuel cycle
017-63-7 ECIN	NEDERLANDS ECONOMISCH INSTITUUT Rotterdam	Study of economic conditions for development of electricity grids, with particular reference to the inclusion of nuclear power plants
018-63-12 ECID	Bureau d'Études Nucléaires (BEN) Brussels Société belge de Mathématiques appliquées (SOBEMAP) Brussels	Development of a method for optimizing nuclear electricity generation
019-63- ECIF	Commissariat à l'Énergie Atomique (CEA) Paris	Studies on the long-term value of plutonium
020-63-12 ECID	Technische Hochschule, Aachen	Study of factors enabling costs of installation of nuclear power plant to be reduced
021-63 ECID	Technische Hochschule, Aachen	Preliminary development study for a reactor programme designed for optimum utilization of world uranium and thorium reserves
022-63-9 ECIC	Commissariat à l'Énergie Atomique (CEA) Paris Société INDATOM-Paris Siemens-Schuckertwerke A.G. — Erlangen Società Ricerche Impianti Nucleari (SORIN) Milan	Development of methodology for calculating the cost per kWh of nuclear electricity

V. *Fast neutron reactors*

No. of contract	Name of contractor	Title
009-63-1 RAAD (1)	Gesellschaft für Kernforschung Karlsruhe	Theoretical and experimental studies in the field of fast neutron reactors
010-63-1 RAAI (1)	Comitato Nazionale per l'Energia Nucleare (CNEN) — Rome	Studies and work in the field of fast neutron reactors

VI. *Processing of radioactive waste*

No. of contract	Name of contractor	Title
001-63-10 WASI	Istituto Idrobiologia di Pallanza Pallanza	Study of dynamics of Lake Maggiore
002-63-12 WASB	Centre d'Étude de l'Énergie Nucléaire (CEN) — Brussels	Study of migration of radio-elements in the soil

VII. *New reactor types*

No. of contract	Name of contractor	Title
002-62-1 NTAN (1)	N.V. tot Keuring van Elektrotechnische Materialen (KEMA), Arnhem	Research in the field of homogeneous aqueous suspension reactors
005-63-7 NTRI	Centro Informazioni Studi ed Esperienze (CISE) Segrate/Milan Società Ricerche Impianti Nucleari (SORIN), Milan	Preliminary development programme for a heavy-water-moderated « fogcooled » reactor design

(1) Contract of association.

VIII. *Radioisotopes*

No. of contract	Name of contractor	Title
027-63-2 RISD	University of Heidelberg, Heidelberg	Research into the 14-C marking of marked molecules
032-63-12 RISF	University of Dijon, Dijon	Synthesis of thyroid hormones and strongly-tritiated adrenalin derivatives and research into optimum storage conditions
033-63-12 RISF	University of Dijon, Dijon	Supply of marked molecules
034-63-7 RISD	University of Frankfurt, Professor Wacker, Frankfurt/Main	Improvement of the Wilzbach method
035-62-10 RISN	Centrale Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (TNO) The Hague	Synthesis of new marked molecules
036-63-5 RISF	University of Montpellier, Montpellier	Synthesis of a series of ^{14}-C-marked high specific activity cholesterol esters and study of storage conditions
037-62-10 RISD	Battelle Institut Frankfurt/Main	Basic study of the effects of radiation on heterogeneous catalytic reactions
038-62-10 RISB	University of Liège, Liège	*a*) development of three tritiated compounds *b*) study of a racemic separation technique applicable to tritiated compounds of adrenalin and various amino-acids
039-62-10 RISB	Free University of Brussels (ULB), Brussels	Tritium labelling of lysozyme peptides, and study of a method of preparing tritium-marked proteins and lipoproteins
041-62-11 RISF	Collège de France Paris	Synthesis of tritium-labelled hormones and study of storage methods

No. of contract	Name of contractor	Title
042-62-12 RISF	Institut Pasteur Paris	Synthesis of purine and pyrimidine bases with strong ^{14}C marking
045-63-11 RISB	Centre d'Étude de l'Énergie Nucléaire (CEN) Brussels	Preparation of marked molecules by gamma irradiation
048-63-2 RISI	University of Milan Institute of Pharmacology and Therapeutics, Milan	Biosynthesis and chemical synthesis of marked molecules
049-63 RISI	University of Milan, Milan	Synthesis and storage of marked molecules
050-63-8 RISB	University of Liège, Liège	Preparation of tritium targets for neutron generators
052-63-8 RISD	University of Frankfurt, — Prof. Wacker, Frankfurt/Main	Supply of marked molecules
055-63-8 RISB	University of Liège, Liège	Supply of marked molecules

IX. *Biology and health and safety*

No. of contract	Name of contractor	Title
009-62-10 BIOF	Commissariat à l'Énergie Atomique (CEA) — Paris Institut National d'Agronomie (INA) Paris	Study of the effects of mutagenic chemicals compared with the effects of physical mutagens
015-62-2 BIOB	Free University of Brussels (ULB), Brussels	Research into the mechanism governing selective concentration of strontium in acantharia spicules

No. of contract	Name of contractor	Title
018-62-4 BIOB	Centre d'Etude de l'Energie nucléaire (CEN), Brussels	*a*) Study of the radiation-induced perturbation of DNA metabolism in rat liver isolated and perfused after partial hepatectomy *b*) Study of radiological change in the rate of cellular absorption of amino-acids and related compounds
019-63-3 BIOF	Association CLAUDE BERNARD, Paris	Effects of radiation on blood platelets
020-62-12 BIOB	Free University of Brussels, Brussels	Study of the relative biological effectiveness of fast neutrons and gamma radiation in lymphosarcoma of the thymus and accelerating the aging process in certain mice
021-63-3 BIOI	Comitato Nazionale per l'Energia Nucleare (CNEN) Rome	Immunogenetics research
022-62-10 BIOB	University of Liège, Liège	Study of the effect of marked mutagens on heredity
023-63-2 BIOI	University of Pavia, Pavia	Study of human genetics and cytogenetics
024-63-2 BIAI (1)	Comitato Nazionale per l'Energia Nucleare (CNEN) Rome	Research into the absorption, accumulation and loss of radio-elements in marine organisms, and study of marine biology equilibrium
026-63-4 BIAC	Free University of Brussels (ULB), Brussels University of Pisa, Pisa	Research into new methods of diagnosis and treatment using methods employing nuclear techniques
027-63-10 BIOF	Institut GUSTAVE ROUSSY Villejuif (Seine)	Participation in a study of the incidence of leukemia in patients who have had radium or X-ray treatment for cervical cancer

(1) Contract of association.

No. of contract	Name of contractor	Title
028-63-10 BIOF	Centre LEON BERNARD Lyons	Participation in a study of the incidence of leukemia in patients who have had radium or X-ray treatment for cervical cancer
029-63-1 BIAN (1)	Centrale Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (TNO) The Hague	Treatment of the radiation syndrome in monkeys, and breeding of specific-pathogen-free animals
030-63-3 BIOF	Institut PASTEUR (Prof. Latarjet) Paris	Fundamental radiobiological research
005-63-9 PSTI	Società Elettronucleare Nazionale S.P.A. (SENN) — Naples	Research into health safeguards against ionizing radiations in a nuclear plant

X. *Participation in the construction of power reactors*

No. of contract	Name of contractor	Title
005-63-3 REPD	Kernkraftwerk RWE-BAYERNWERK GmbH Gundremmingen/ (KRB) Günzburg	Design, construction and operation, in accordance with the normally accepted standards of electricity producers, of a full-scale nuclear power plant
006-63-4 REPN	Samenwerkende Elektriciteitsbedrijven (SEP) Arnhem	Design, construction and operation, in accordance with the normally accepted standards of electricity producers, of a full-scale nuclear power plant

(1) *Contract of association*

DOCUMENT No. 31

ACTIVITIES OF THE INFORMATION AND DOCUMENTATION CENTRE (CID)

The activities of the Information and Documentation Centre (CID), founded in 1961, are concerned with documentation, publications and library management. Its staff has grown as planned, to reach the total of 93 forecast for 1963.

There was constant improvement in the CID's working programme, with particular reference to the project for installing an electronic computer for the storage and processing of technical and scientific data, thanks to suggestions from the Consultative Committee on Information and Documentation (CCID), which consists of acknowledged experts from the six Member countries. This project has been planned in close collaboration with CETIS, the European Scientific Data Processing Centre at Ispra.

Cooperation and the division of labour between the CID and the national centres remain under the permanent control of the Working Group of heads of documentation services of the national nuclear research centres and can at any time be adjusted to new requirements. This system will bring about the conditions needed for mobilizing all available Community resources for the ever more profitable use of existing information.

At a meeting of head librarians of specialist nuclear science libraries in the Community, measures were adopted for resolving common problems, in particular that of acquiring the more remote technical publications.

The documentation departments of both the USAEC and UKAEA have been informed of the project for electronic storage of technical and scientific data, and negotiations are currently in progress with a view to increased cooperation with the USAEC division responsible for publishing. *Nuclear Science Abstracts.*

At the general assembly of the International Documentation Federation (FID), a paper read on regional cooperation within the European Atomic Energy Community in the field of nuclear information.

The CID also continued to participate in the work of the European Translation Centre at Delft and of International Cooperation in Information Retrieval among Examining Patent Offices, insofar as it is relevant to nuclear information.

During 1963 the CID, which had been provided with a budget totalling one million EMA units of account, entered into commitments for expenditure amounting to 986,088 EMA units of account.

I. Documentation

The functions of the Documentation Section were extended considerably in 1963, with broader and more detailed studies by the Manual Documentation, Documentary Analysis, and Documentary Sources groups as planned.

1. *Manual documentation*

Until such time as the computer is ready to furnish analytical results—i.e., probably towards the end of 1965—bibliographical research must be effected by the group responsible for manual documentation by traditional methods: catalogues, card-indexes, bibliographies, abstracts, and so on. This group, sometimes with the assistance of the Community's specialist documentation services, carried out altogether 209 bibliographical research operations in 1963. Because manual research is always timeconsuming and involves a considerable volume of work, requests were accepted only from the Commission's departments, its Joint Research Centre and Euratom contractors.

2. *Documentary analysis and preliminary work for the commissioning of an electronic computer*

In order to be able to supply all interested parties in the Community's Member States, and in particular the national centres and industry, with the information on nuclear matters necessary for their own research more quickly, more accurately and more fully than is possible by manual methods, the Commission decided on the installation of an electronic computer at Brussels, under the second five-year plan. The computer is also intended to meet the manifold and ever-growing needs of the Directorate-General for Budget and Finance, and the Directorate-General for Administration and Personnel, and to assist the Statistics Office of the European Comunities to fulfil its many and various duties. The plant was delivered at the end of October 1963. It was possible to supply the statistics, administrative and finance departments at once with data in immediately utilizable form. On the other hand, technical and scientific data programming demands the prior design of an appropriate coding system for document content ([1]) which must then be kept constantly up to date. The number of specialist staff proved insufficient to cope successfully with this preparatory work as rapidly as was wished. As the coding system developed can, after a suitable initiation period, be employed by third persons without the coding concordance being too much affected, it has been possible to enlist the services of a large number of specialist correspondents, to such good purpose that coded data relating to documents on nuclear subjects fed into the computer up to the end of 1963 numbered nearly 85,000.

To supplement the data given in the *Nuclear Science Abstracts,* which are to be stored in the computer in their entirety, two contracts have been concluded for improving the system of compiling reports; in collaboration with Euratom, the Excerpta Medica Foundation of Amsterdam will publish a new review called *Nuclear Medicine,* and the firm of Brevatome, Paris, will in future give fuller details in its review *La Propriété industrielle nucléaire* of patents of a nuclear character of interest to Community industry. These two reviews will supply Euratom (CID) with their bibliographical data in a form enabling them to be stored in the electronic memory by means of simple mechanical operations without further complications.

The hope is that between now and the end of 1965 it will be possible to store all the data outstanding (more than 300,000 books, articles, reports and other papers) as well as the present flow of data on publications dealing with nuclear technology (at present 50,000 references a year with a powerful trend towards expansion), so that all interested parties in the Community can then be given access to the electronic memory.

3. *Bibliographical sources*

The Working Group responsible for this task is assembling exact data, particularly in marginal nuclear sectors and in collaboration with a great number of research and documentation centres, libraries, publishers and so on, on technical and scientific information which can be furnished on the sources of such information and concerning the terms on which it can be transmitted. These data will likewise be stored in the memory ready for transmission to persons requesting them, who will thus be saved much time and work in obtaining the information needed.

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(1) L. Rolling: Un répertoire des mots-clefs pour la documentation mécanisée dans le domaine de la technique nucléaire. Bulletin des Bibliothèques de France 8 (1963) No. 1, pp. 11-25.

II. Publications

1. *Principles applying to the dissemination of information acquired through implementation of the Community's research programme*

On 1 April 1963, the Euratom Commission made a full report to the Council on its policy for disseminating information obtained in the course of implementing the Community's research programme. This was a sequel to conversations with the competent departments of the Council. The guiding principles of the policy adopted are as follows:

The Commission must make sure that a balance is maintained between efforts to secure full and rapid dissemination of knowledge acquired by it and care not to prejudice the smooth progress of its research work by premature disclosure.

Before disseminating the result of a particular piece of research, it must be ascertained that this is ready for publication so as not to compromise the reputation of the research worker concerned and the standing of the Commission itself. The result, too, must be sufficiently accurate and complete to rule out the risk of disappointment when it is subsequently exploited. Lastly, premature publication of such results must not be allowed to give outsiders an opportunity of following them up for their sole advantage, before the Commission had had time to do so, and thus deprice the Community of the benefit of the final results.

As regards publication, the Commission will comply with the practice followed by the large national centres, by publishing with the minimum possible delay basic scientific information and matters of humanitarian interest relating, for instance, to medicine and biology. Publication can take various forms: the issue of a Euratom Report, an article appearing in one of the Commission's periodicals or in a specialist scientific journal, papers read at congresses, conferences, symposia and so on.

On the other hand, free publication of information of industrial value can only be allowed if this does not infringe on the right of the Community's nuclear industry to priority in its use, with the advantages inherent in that right. Accordingly, a procedure has been instituted for communicating such information of industrial value (detailed reactor designs, fabrication processes, plans, drawings, etc.) only to Member States and to persons and enterprises in the Community, in conformity with the terms of Article 13 of the Treaty.

This information is not to be communicated to persons or enterprises in the Community other than those with a legitimate interest in its use who are prepared to respect its confidential nature. It is for the Commission to decide if these conditions are fulfilled. Acceptance of requests for information and transmission of the same is to be effected through national correspondents. Other methods for disseminating information include: the organization of technical meetings and symposia, steps to facilitate the exchange of personnel and to promote contacts between research workers and firms, and so on. In all cases these measures are confined to Member States and persons or enterprises in the Community.

On the other hand, such information is communicated to non-Community countries and organizations in those countries only in cases where it is in the general interest of the Community and takes place within the context of an exchange of information to the benefit of both parties.

2. *Non-periodical publications and "communications" (Article 13 of the Treaty)*

Between 1 March and 31 December 1963 the Commission issued 256 technical and scientific reports which are listed in Document No. 34.

A temporary procedure was applied in 1963 for the distribution of "communications" within the meaning of Article 13 of the Treaty, through the intermediary of the permanent representatives of the Member States. At 31 December 1963, communications distributed by this method numbered 434. The permanent procedure of distribution through national correspondents will come into force on 1 January 1964.

3. *Periodicals*

The three periodicals *Transatom Bulletin, Quarterly Digest* and *Euratom Bulletin* appeared regularly in 1963 and were issued to a slowly but steadily growing number of subscribers.

During 1963 the monthly *Transatom Bulletin* published a total of 7977 bibliographical notices of translations, existing or in hand, of scientific or technical documents on nuclear questions in the lesser known languages such as the Slavonic languages and data on how to get hold of these translations. Thanks to the introduction in 1962 of a machine system for their compilation, it has been possible to send out the annual indexes at the same time as the last issue for the year, thus simplifying the user's task substantially and saving him considerable time.

The *Quarterly Digest*—lately issued in 1,200 copies-has been appearing for two years and contains information on the US/Euratom Joint Research and Development Programme. Henceforward it is not to be issued as a separate publication; its articles will appear in the *Euratom Information,* which will be published every six weeks from 1 January 1964 onwards.

The quarterly review *Euratom Bulletin,* issued separately in five languages, enters its third year with a circulation of 7,600 copies in all. This periodical covers the peaceful use of nuclear energy and the Commission's activities from all angles of general interest, in a form designed for the vast lay public interested in technical questions. There has been a satisfactory rise in the number of paying subscribers.

The first number of *Euratom Information* appeared in 1963. This review gives abstracts, accompanied by the usual bibliographies, of the research programme, of research contracts and contracts of association signed and, more especially, of the Commission's technical and scientific publications relating to its own research programe or to research under contract, as well as of registered patents and designs.

The launching of a special journal directed to the specialist circles concerned was dictated by the growing number of publications, patents and contracts.

III. Libraries

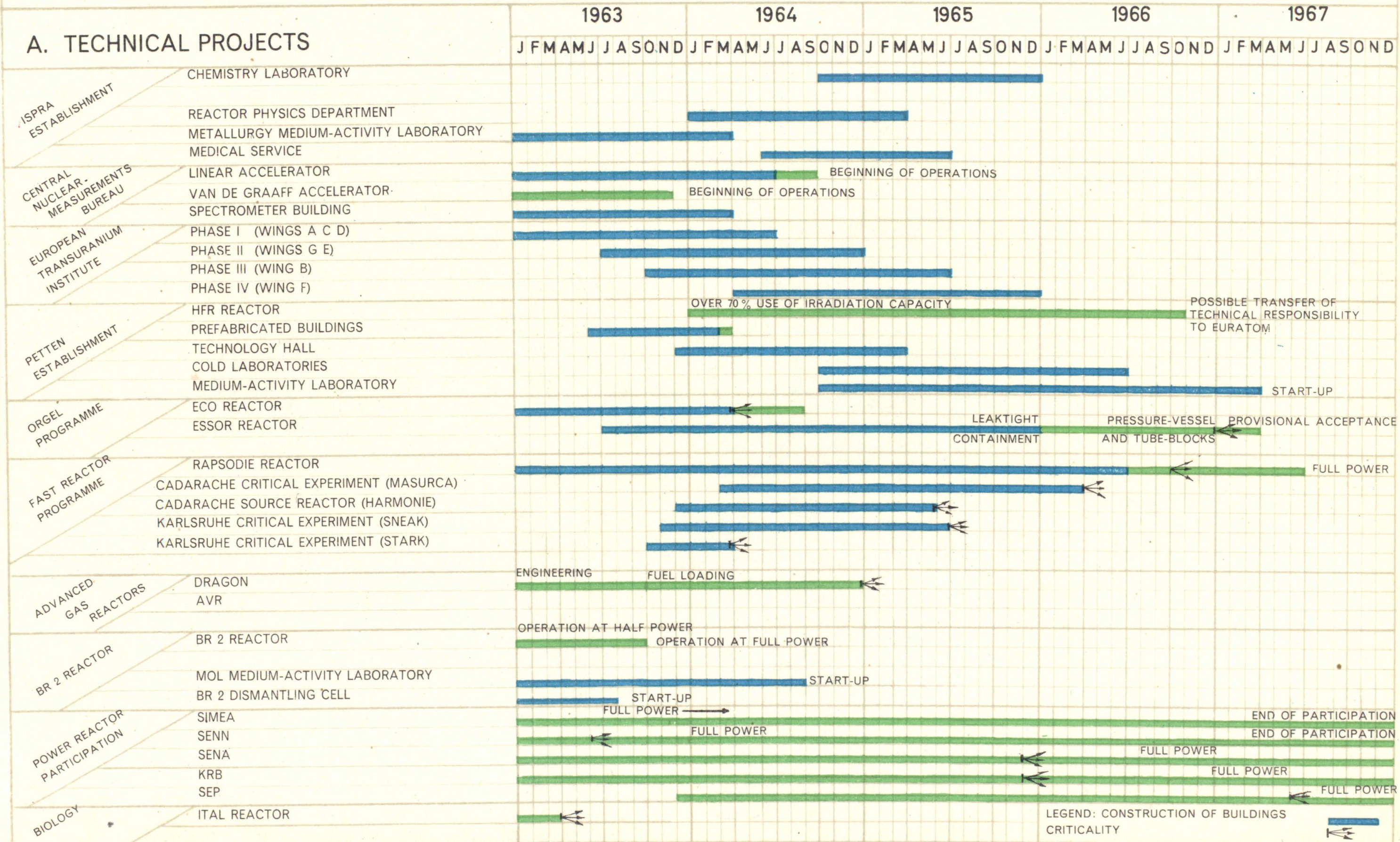
The Euratom Commission's five libraries together constitute one of the most important media for the internal distribution of information. Installation of the libraries at Brussels and at Ispra is almost completed. The specialist library of the Central Nuclear Measurements Bureau at Geel is administered by the Brussels library, which is also responsible for preparing the ground for the setting up of libraries at Petten and Karlsruhe. The Brussels library also provides documentation for Euratom staff assigned to projects elsewhere than in Euratom institutions, either in connection with contracts of association or for other reasons.

Various measures have been taken with a view to coordinating the work of the several Euratom libraries, in particular as regards compilation of catalogues. Furthermore, a programme for the use of flexewriters is under study in collaboration with CETIS. These machines will facilitate the printing of catalogues and later on, when the new computer is available, they will make it possible to rationalize the system for placing orders and to keep closer track of the manner in which they are filled.

DOCUMENT No. 32

SCHEDULE FOR EXECUTION OF LARGE-SCALE PROJECTS PROVIDED FOR UNDER 2nd FIVE-YEAR PLAN

SCHEDULE FOR EXECUTION OF LARGE-SCALE PROJECTS PROVIDED FOR UNDER 2nd FIVE-YEAR PLAN



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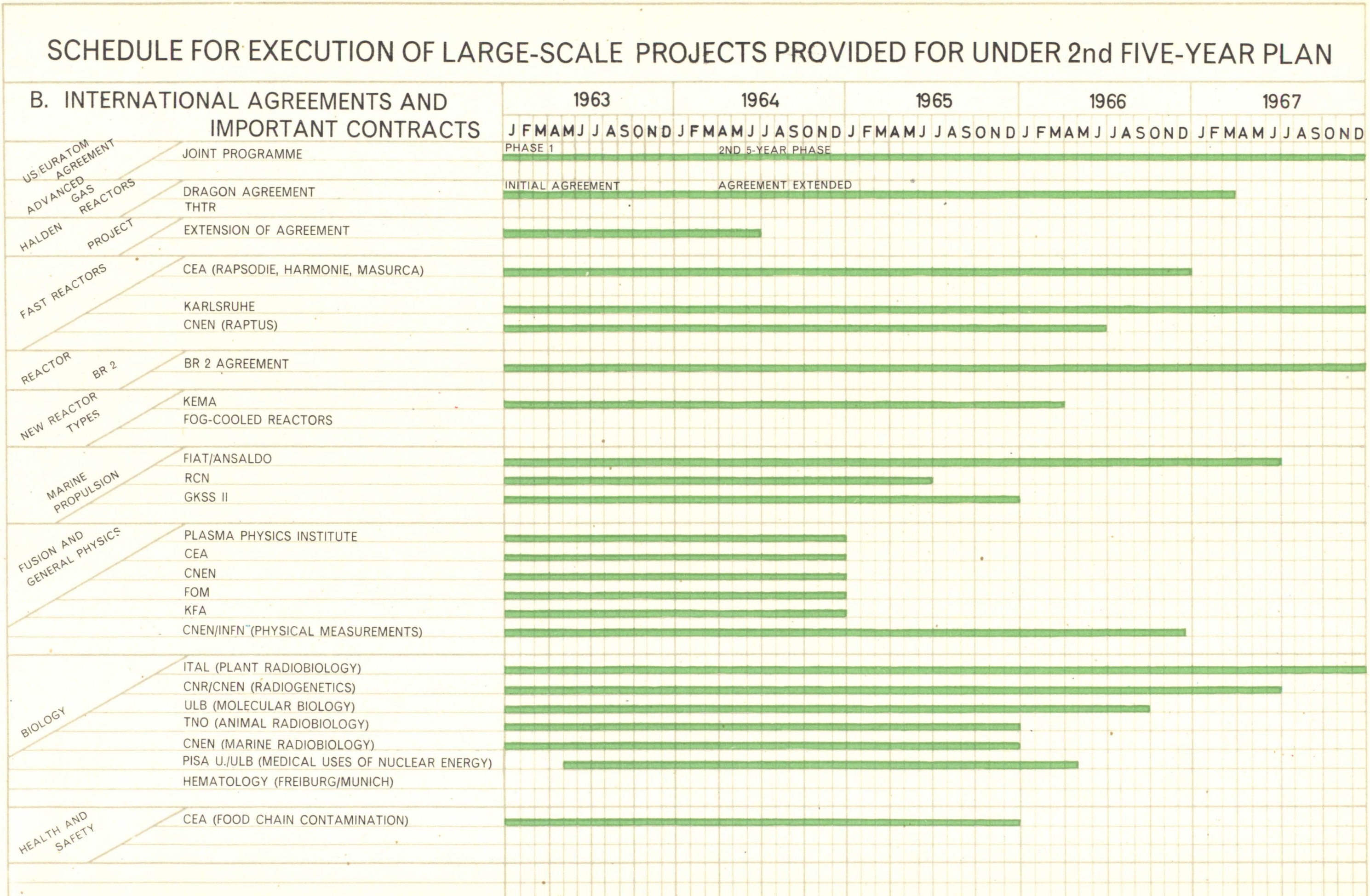

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DOCUMENT No. 33

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(1) Not included in this list: some 1,000 reports stemming from the research and development programme under the Agreement for Cooperation between the European Atomic Energy Community (EURATOM) and the United States of America.

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PATENT APPLICATIONS FILED BY THE COMMISSION AND ITS CONTRACTORS TO SAFEGUARD INVENTIONS DEVELOPED UNDER THE EURATOM RESEARCH PROGRAMMES

(from 1 March to 31 December 1963)

File No.	Title of Patent	Inventor (1)	Holder	Origin
I/57	Metodo per produrre sinterizzati Al-Al $_2O_3$ di elevata purezza per applicazioni nucleari	Jehenson (EUR) Gualandi (ISML)	Euratom ISML	ISML 067 Contract ORG I
I/117	Carbon particles having a fibrous structure	Bickerdike (UKAEA) Hughes (UKAEA)	UKAEA	DRAGON project
I/143	Improvements in or relating to gas-cooled reactors	Beutler (UKAEA) Mayerhofer (UKAEA)	UKAEA	DRAGON project
I/171	Improvements in or relating to high temperature gas-cooled reactors - Preventing graphite corrosion by mass transfer in reactors with main coolant bleed purification	Lothe (UKAEA)	UKAEA	DRAGON project
I/172	Improvements in or relating to heat exchange systems - Temperature control of liquid N2 cooling plant	de Haas van Dorsser (UKAEA)	UKAEA	DRAGON project
I/177	Improvements in or relating to tools - A hand broaching tool	Groves (UKAEA) Smith (UKAEA)	UKAEA	DRAGON project
I/178	Werkwijze voor het onoplosbaar maken van radioactieve concentraten door insluiting in teer, en inrichting voor het uitvoeren van deze werkwijze	Dejonghe (CEN) Van de Voorde (CEN) Pyck (CEN) Gery (CEN)	CEN	CEN 048-61-4 RD B

(1) Inventors whose names are followed by the letters (Eur) are members of the Commission staff.

File No.	Title of Patent	Inventor (1)	Holder	Origin
I/191	Verfahren und Anlage zur Herstellung von Karbiden spaltbarer oder brütbarer Stoffe	Wurm (EUR) Baucherie (EUR)	Euratom	Ispra
I/192	Improvements in or relating to gas-cooled reactors - Core seal mechanism	Smith (UKAEA) Hart (UKAEA)	UKAEA	DRAGON project
I/193	Improvements in or relating to the separation of fluids - No-snow freezer	Basting (UKAEA) De Bruijn (EUR) Wood (UKAEA)	UKAEA	DRAGON project
I/196	Crayon Chauffant	Besse (SEPR)	SEPR	Contract 033-61-7 ORGF
I/197	Werkwijze voor de bereiding van een fosforisotoop	Godar (EUR)	Euratom	Euratom
I/199	Apparatus for the separation of spherical particles from non-spherical particles		Österreichische Studiengesellschaft für Atomenergie, GmbH	DRAGON project
I/200	Procedure and apparatus for the manufacture of spherical particles		Österreichische Studiengesellschaft für Atomenergie, GmbH	DRAGON project
I/201	High temperature materials for use as fuel elements		Metallwerk Plansee	DRAGON project
I/202	Process for coating powder reactor fuels with carbon		Metallwerk Plansee	DRAGON project
I/205	Procédé pour la fermeture étanche de tubes à une ou deux extrémités	Di Piazza (EUR)	Euratom	Ispra
I/212	Procédé et dispositif pour supprimer certains effets de perte de charge dans des canaux de réacteur nucléaire parcourus par un liquide	Angelini (EUR) Dufresne (EUR)	Euratom	Orgel Ispra
I/214	Splijtstofelement voor kernreaktoren	Richards (CEN)	CEN	CEN 023 ORG B contract

File No.	Title of Patent	Inventor (1)	Holder	Origin
I/223	Réacteur nucléaire du type à tubes de force	Laurent (Indatom)	Indatom	Indatom contract 087-61-1 ORG C
I/230	Improvements in or relating to apparatus for differential thermal analysis - Apparatus for differential thermal analysis	Voice (UKAEA)	UKAEA	DRAGON project
I/234	A device for measuring the rate of flow and the temperature of a fluid	Buis (EUR)	Euratom	Euratom
I/235	Werkwijze voor het vervaardigen van éénkristallen van vuurvast materiaal met hoog smeltpunt en inrichting voor het uitvoeren van deze werkwijze	Van Lierde (CEN)	CEN	CEN contract 055 RD B
I/238	Improvements in or relating to methods and apparatus for comparing the magnitude of two numbers in binary code	Becker (EUR)	Euratom	Ispra
I/240	Improvements in or relating to apparatus for processing particulate material - Spheroidisation of larger fuel particles	Jacques Smyth Sturge (UKAEA)	UKAEA	DRAGON project
I/241	Improvements in or relating to the manufacture of graphite - Acid vapour curing of impregnated graphite	Bentolila (Pechiney) Graham Price (UKAEA)	UKAEA	DRAGON project
I/242	Improvements in or relating to face seals - Rubbing graphite seals	Coast Fricker (UKAEA)	UKAEA	DRAGON project
I/243	Fluides organiques utilisables dans un réacteur nucléaire comme fluides caloporteur, modérateur au réflecteur	Giuliani (IFP)	CEA and IFP	CEA contract 062 ORG F
I/245	Installation pour le contrôle continu de l'activité béta des effluents faiblement contaminés	Fleury (EUR)	Euratom	Ispra
I/246	Röntgenkristallspektrometer mit kontinuierlicher Impulshöhen-diskrimination	Weber (EUR)	Euratom	Ispra

File No.	Title of Patent	Inventor (1)	Holder	Origin
I/249	Dispositif de commande par basculeurs rotatifs à positions multiples	Jamet (EUR)	Euratom	Ispra
I/250	Passage étanche à l'extrémité d'un canal de réacteur nucléaire refroidi par un liquide organique	Cogez (EUR) Guiducci (EUR)	Euratom	Orgel
I/251	Joint d'étanchéité par changement d'état physique	Cogez (EUR) Charrault (EUR)	Euratom	Orgel
I/253	Verfahren und Vorrichtung zur Herstellung gegossener Formkörper aus Metallen oder Metallverbindungen mit einem sehr hohen Schmelzpunkt, insbesondere aus Urankarbid	Himmelstein Kühn (NUKEM) Schäfer	Euratom	NUKEM contract 088-62-7 RD D
I/254	Verfahren und Vorrichtung zur Fertigung von rohrförmigem Gut mit Pulverfüllung hoher Dichte, insbesondere von Brennstoffstäben für Kernreaktoren	Hess (EUR) Bürgers (EUR)	Euratom	Ispra
I/255	Unité motrice à fluide sous pression	Van Nieuwenhuysen (CEN)	Euratom	CEN contract BR 2 Mol
I/256	Joint entre deux tôles épaisses, à souder bout à bout		Soudometal	Contract 042-61-9 RD B
I/257	Appareillage électronique de tri automatique de linge contaminé	Fleury (EUR)	Euratom	Ispra
I/258	Procédé et dispositif pour fermer les deux parties d'un tube au cours de son sectionnement	Hespel (Société Michel Frères) Pesenti (EUR)	Euratom	
I/259	Dispositif pour la mesure continue des flux de neutrons	Wilmart (GAAA) Laxague (GAAA)	GAAA	GAAA/Interatom contract 045 ORG C
I/260	Improvements in or relating to gas-cooled Nuclear Reactors - Dragon fuel with purge flow path through centre of the spine	Marien (EUR)	UKAEA	DRAGON project
I/261	Samengestelde warmtewisselaar en reactorinstallatie, voorzien van zulk een warmtewisselaar	Bonsel (RCN) Van Haarst (RCN) Weevers (RCN)	RCN	RCN contract 007 PIN N

File No.	Title of Patent	Inventor (1)	Holder	Origin
I/262	Microbalance de haute précision sous vide	Moret (EUR)	Euratom	BCMN Geel
I/263	Zirkonium-Legierungen	Anderko (Metallgesellschaft) Schleicher (EUR)	Euratom	Acquisition by Metallgesellschaft
I/264	Perfectionnements aux réacteurs nucléaires	Foure (SNECMA) Moussez (SNECMA)	SNECMA	SNECMA contract 058 RDF
I/270	Improvements in carbon particles - Consolidation by gas cracking	Bickerdike Hughes (UKAEA)	UKAEA	DRAGON project
I/271	Alliage nouveau à base de zirconium	Bonmarin Syre (Pechiney)	Pechiney	Pechiney contract 067 RDF
I/272	Applications nouvelles des alliages de zirconium et de vanadium	Bonmarin Syre (Pechiney)	Pechiney	Pechiney contract 067 RDF
I/273	Verfahren zur Rückgewinnung von Karbiden spaltbarer und/oder brütbarer Stoffe	Baucherie (EUR) Wurm (EUR)	Euratom	Ispra
I/274	Glühemissionskonverter mit ummanteltem Brennelement	Busse (EUR)	Euratom	Ispra
I/277	Fuel for nuclear reactors	Jonckheere (CEN)	UKAEA	DRAGON project
I/278	Refractory Coated Tracers		SGAE (Österr. Studien-Gmbh. f. Atomenergie)	DRAGON project
I/279	Kernreaktor insbesondere für Versuchazwecke mit schnellen Neutronen	Beckurts Häfele Meister Ott	Kernreaktor Bau- u. Betriebs GmbH	Contract 009 RAD
I/280	Elektromagnetisches Messgerät zur Anzeige des Flüssigkeitsstandes in Behältern	Ohlmer (EUR)	Euratom	Ispra
I/281	Improvements in or relating to gas-cooled nuclear reactors - means of forcing fuel into contact with enclosing fuel tube	Barr (UKAEA) Gough (UKAEA)	UKAEA	DRAGON project

File No.	Title of Patent	Inventor (1)	Holder	Origin
I/282	Improvements in or relating to coating of particles - coating of carbide nuclear particles with pyrolytic carbon using hydrogen as a fluidised gas	Carley-Macauly Williams (UKAEA)	UKAEA	DRAGON project
I/283	Improvements in or relating to meters - High Pressure Hersch Cell	Enzmann (UKAEA) Gray (UKAEA)	UKAEA	DRAGON project
I/284	Improvements in or relating to processes for the production of pellets from particulate material-binder for nuclear fuel particles	Horsley (UKAEA)	UKAEA	DRAGON project
I/286	Improvements in or relating to apparatus for use in the production of spherical particles - Double inclined endless belt for grading spherical particles	Nybo (UKAEA)	UKAEA	DRAGON project
I/288	Dispositif expansible pour radiographie rotative	Jansen (EUR)	Euratom	Ispra
I/289	Vanne à obturateur sphérique	Martin (CEA)	Euratom	CEA Fusion
I/290	Als schneller gepulster Reaktor ausgebildete Neutronenquelle	Kistner (EUR) Meister (EUR) Raievski (EUR)	Euratom	Ispra
I/291	Als schneller gepulster Reaktor ausgebildete Neutronenquelle	Kistner (EUR) Misenta (EUR) Raievski (EUR)	Euratom	Ispra
I/292	Verfahren und Einrichtung zum Pulsieren von Kernreaktoren	Dierckx (EUR) Kistner (EUR) Meister (EUR)	Euratom	Ispra
I/294	Elektrisch isolierende Flanschverbindung	Schupp (EUR)	Euratom	Ispra
I/296	Procédé pour la fermeture étanche de tubes en matériaux composites métal-oxyde, particulièrement gaines d'éléments combustibles pour réacteurs nucléaires	Agace (EUR) Alfille (EUR) Klersy (EUR) Musso (EUR) Parisotto (EUR) Schrader (EUR)	Euratom	Ispra
I/297	Sas démontable étanche pour cellules de manipulations dangereuses	Basso-Bert (St. Gobain Nucléaire) Pesenti (EUR)	Euratom	Contract 019-63-6 PETF

File No.	Title of Patent	Inventor (1)	Holder	Origin
I/298	Perfectionnements aux dispositifs de transport pneumatique	Basso-Bert (St. Gobain Nucléaire)	Euratom	Contract 019-63-6 PETF
I/302	Verfahren zum Pulsieren und/oder Modulieren eines Atomkernreaktors		Belgo nucléaire/ SIEMENS	SORA-Belgo-nucléaire/ SSW
I/303	Procédé de fabrication d'objets compact en composition uranium/carbons	Accary (CEA) Rousset (CEA) Trouve (CEA) Herenguel (TLH) Lamotte (TLH) Whitwham (TLH)	CEA	Contract 080 RD f
I/304	Nitrided electrode process of preparing uranium mononitride	Endebrock (Battelle) Foster (Battelle)	USAEC	Contract (W-7405-eng-92) R & D BATTELLE USAEC
I/305	Dispositif de mesure de la densité d'un liquide	Elberg (CEA) Bessouat (EUR)	CEA	Contract 007 ORG
I/306	Mesureur d'impédence fonctionnant en hyperfréquences	Bled (CEA) Bresson (CEA) Papoular (CEA) Wegrowe (CEA)	CEA	Fusion contract
I/307	Déphaseur fonctionnant en hyperfréquences	Bled (CEA) Bresson (CEA) Papoular (CEA) Wegrowe (CEA)	CEA	Fusion contract
I/308	Coupleur directif réglable fonctionnant en hyperfréquences	Bled (CEA) Bresson (CEA) Papoular (CEA) Wegrowe (CEA)	CEA	Fusion contract
I/309	Atténuateur réglable fonctionnant en hyperfréquences	Bled (CEA) Bresson (CEA) Papoular (CEA) Wegrowe (CEA)	CEA	Fusion contract
I/310	Focaliseur d'onde de très courte longueur	Bled (CEA) Bresson (CEA) Papoular (CEA) Wegrowe (CEA)	CEA	Fusion contract
I/311	Improvements in or relating to the manufacture of graphite - Graphite without ultrafine pores	Bentolila Dubief (Pechiney) Price (UKAEA)	UKAEA	DRAGON project

File No.	Title of Patent	Inventor (1)	Holder	Origin
I/312	Improvements in or relating to the manufacture of graphite	Bentolila (Pechiney) Cornuault Price (UKAEA)	UKAEA	DRAGON project
I/313	Procédé de préparation de particules sphériques ou sphéroïdales particules obtenues	Gorlé (CEN) Huddle (UKAEA)	CEN	DRAGON project
I/314	Source d'ions du type Penning	Dei Cas (EUR) Valckx (EUR)	CEA	CEA fusion
I/315	Tauchkörper für Meßgeräte zur Anzeige des Flüssigkeitsstandes in Behältern	Ohlmer (EUR)	Euratom	Ispra
I/316	Chambre d'ionisation permettant l'introduction et l'extraction rapide d'une source radioactive dont les radiations sont à mesurer	Benoit (EUR) Bertolini (EUR) Restelli (EUR)	Euratom	Ispra
I/317	Verfahren zum Niederschlagen von Metallen durch Reduktion ihrer flüchtigen Salze, und Anlage zur Durchführung des Verfahrens	Brossa (EUR) Schleicher (EUR) Venker (EUR)	Euratom	Ispra
I/320	Spire conductrice large pour le confinement magnétique d'un gaz ionisé	Andreoletti (CEA)	CEA	CEA fusion
I/321	Structure conductrice double pour le confinement magnétique d'un gaz ionisé	Andreoletti (CEA)	CEA	CEA fusion
I/322	Subcooled Liquid Inlet Fog-Cooled Nuclear Reactors	Raber (NDA) Sofer (NDA)	USAEC (USA)	R & D CAN-NDA
I/323	Appareil permettant la mesure de la résistance thermique entre différentes matières		SEPR	Contract 053 ORG F
I/324	Verfahren zur Herstellung des Phosphorisotope ^{32}P	Godar (EUR)	Euratom	Euratom
I/327	Assemblage d'éléments combustibles pour réacteurs nucléaires	Charrault (EUR) Lafontaine (EUR) Orlowski (EUR)	Euratom	Orgel
I/329	Methods for stabilizing uranium monocarbide	Stoops (NCSC) Hamme (NCSC)	USAEC	R & D North Carolina State College

File No.	Title of Patent	Inventor (1)	Holder	Origin
I/334	Kernbrennstoffpartikel für gas-gekühlte Kernreaktoren	Theisen (EUR)	Euratom	Ispra contract CON/WIN 52230 DRAGON
I/337	Activity counting device in multi-channel arrangement	Fraysse (EUR) Hage (EUR) Pelah (EUR)	Euratom	Ispra
I/340	Kernreaktor		Ges. f. Kern-forschung	Contract 009 RAA D
I/341	Kernreaktor		Ges. f. Kern-forschung	Contract 009 RAA D
I/342	Kernreaktor		Ges. f. Kern-forschung	Contract 009 RAA D
I/343	Brennelement für Kernreaktoren und Verfahren zu seiner Herstellung		Ges. f. Kern-forschung	Contract 009 RAA D
I/344	Verfahren zum Herstellen von Werkstoffkugeln für Brennelemente von Kernreaktoren		Ges. f. Kern-forschung	Contract 009 RAA D
I/346	Procédé et dispositif pour la production de radio-isotopes	Bodnarescu (EUR)	Euratom	Euratom GCE-BR 2
I/347	Brennelement für Kernreaktoren		Ges. f. Kern-forschung	Contract 009 RAA D
I/349	Perfectionnement à la purification d'un plasma	Veron (CEA)	CEA	Fusion contract
I/351	Kernreaktor		Ges. f. Kern-forschung	Contract 009 RAA D
I/352	Dampfgekühlter Kernreaktor		Ges. f. Kern-forschung	Contract 009 RAA D
I/353	Halterung für Brennelemente		Ges. f. Kern-forschung	Contract 009 RAA D
I/354	Einrichtung zum Beladen von Kernreaktoren mit Brennelementen		Ges. f. Kern-forschung	Contract 009 RAA D
I/355	Brennelement für Kernreaktoren		Ges. f. Kern-forschung	Contract 009 RAA D
I/356	Vorrichtung zum Ändern des Füllgrades von Elementen von Kernspaltzonen		Ges. f. Kern-forschung	Contract 009 RAA D

File No.	Title of Patent	Inventor (1)	Holder	Origin
I/357	Brennelement für Kernreaktoren		Ges. f. Kernforschung	Contract 009 RAA D
I/358	Verfahren zum Kühlen von Kernreaktoren		Ges. f. Kernforschung	Contract 009 RAA D
I/363	Fusibles de protection pour condensateurs à haute tension et autres applications analogues	Leon (CEA) Lehongre (CEA) Kloeckner (CEA)	CEA	CEA Fusion
I/364	Kernreaktor		Ges. f. Kernforschung	Contract 009 RAA D
I/365	Vorrichtung zum Be- und Entladen der Spaltzone von Kernreaktoren		Ges. f. Kernforschung	Contract 009 RAA D
I/366	Kernreaktor		Ges. f. Kernforschung	Contract 009 RAA D
I/367	Spanneinrichtung für Spaltzonen von Kernreaktoren		Ges. f. Kernforschung	Contract 009 RAA D
I/368	Procédé d'imprégnation de bobines supraconductrices	Weil (CEA)	CEA	Fusion contract
I/370	Improvements in or relating to lifting devices-automatic coupling/uncoupling Grab	Pitchford (UKAEA)	UKAEA	DRAGON project
I/371	Hotte de démontage des appareils, notamment des pompes et échangeurs, d'un circuit de réacteur	Delisle (CEA)	CEA	Contract 006 RAA F CEA
I/372	Thermal process to improve ductility of sintered aluminium powder	Beghi (EUR) Piatti (EUR)	Euratom	Ispra
I/379	Procédé de réduction des contraintes mécaniques aux extrémités d'un bobinage et dispositif en comportant application	Leroux Leon (Com. Générale d'Électricité) Cotsaftis (CEA)	CEA	Fusion Contract
I/386	Method of testing coated particles	Bildstein (UKAEA) Knotik (UKAEA)	UKAEA	DRAGON project
I/387	Coating for fuel particles	Huddle (UKAEA) Beutler (UKAEA)	UKAEA	DRAGON project

I. Research and investment budget

The Commission had at its disposal for the financial year 1963 the following fixed appropriations:

	Millions of EMA u.a.
1963 research and investment budget adopted by the Council of Ministers on 17 December 1962	94,186
Supplementary research and investment budget for 1963 adopted by the Council on 24 September 1963	1,700
Budgetary commitments carried forward from previous financial years pursuant to Article 4, para 1 b of the Financial Regulation governing the establishment and implementation of the research budget	27,942
Total:	123,828

The budgetary commitments entered in the books at 31 December 1963 amounted to 95,100 million EMA u.a., the breakdown being as follows:

Heading	Chapter	Description	Budgetary Commitments : credits available in 1963	Amounts entered in books at 31.12.1963
I		Staff expenditure	12,031	11,848
I		Operating expenditure	5,005	4,824
III		*Joint Nuclear Research Centre*		
	30	Apparatus and equipment	8,991	6,244
	31	Real property investments	11,206	6,231
Total under Heading III			20,197	12,475

Heading	Chapter	Description	Budgetary Commitments : credits available in 1963	Amounts entered in books at 31.12.1963
IV		*Reactor development and construction*		
	40	Gas reactors	4,900	4,000
	41	Light water reactors	800	793
	42	Heavy water reactors	300	244
	43	Organic reactors	19,929	15,385
	44	Homogeneous reactors	450	432
	45	Fast reactors	20,783	14,565
	47	Nuclear marine propulsion	200	36
	48	Research and applied technology relating to the proven-type reactor development and construction	7,090	3,675
	49	Power reactors	13,344	13,307
Total under Heading IV			67,796	52,437
V		*Other scientific and technical activities*		
	50	High flux irradiation	2,700	2,647
	51	Fusion — plasma study	5,723	5,534
	52	Biology	3,138	2,635
	53	Radioisotopes	746	199
	53-A	Miscellaneous research	3,274	865
	54	General documentation	1,118	986
	55	Training and instruction	600	504
	56	Reprocessing of irradiated fuels	950	—
	57	Processing of active effluents	550	139
Total under Heading V			18,799	13,509
Grand total			123,828	95,093
			100 %	76.8 %

The payment authorizations covered by the 1963 budget amounted to 75,376 million EMA u.a., while a total of 59,040 million EMA u.a. had been paid out at 31 December 1963.

Of the payment authorizations of 13,663 million EMA u.a. brought forward from 1962 to 1963, 8,364 million have been paid out.

II. Operating budget

The operating budget for the financial year 1963 (Section III - Commission) totals 7,761,654 EMA u.a.

At 31 December 1963, the implementation of this part of the budget shows expenditure commitments to the amount of 6,820,256 EMA u.a. and payments totalling 6,090,309 EMA u.a.

DOCUMENT No. 36

STAFF BREAKDOWN UNDER THE RESEARCH AND INVESTMENT BUDGET ACCORDING TO CATEGORY OF POST

(Posts filled as at 31 January 1964)

	A	B	C	D	Establishment personnel	Total
Ispra	398	425	149	—	343	1,315
Orgel	25	5	9	—	—	39
Transuranium Institute	31	26	13	—	1	71
BCMN	42	37	24	1	21	125
Petten	38	19	17	—	4	78
Fast reactors	28	8	4	—	—	40
Advanced gas reactors	22	2	—	—	—	24
BR 2	19	19	8	—	—	46
Proven-type reactors	19	2	5	—	—	26
Irradiated fuel reprocessing	1	—	—	—	—	1
Waste	1	—	—	—	—	1
New type reactors	2	1	—	—	—	3
Marine propulsion	3	—	—	—	—	3
Radioisotopes	7	—	4	—	—	11
Fusion	44	19	12	—	1	76
Health and safety	6	3	—	—	—	9
Biology	35	5	6	—	2	48
Training	1	1	2	—	—	4
Directorate-General and programmes	6	—	—	—	—	6
Dissemination of information	23	21	41	5	—	90
Total :	751	593	294	6	372	2,016

DOCUMENT No. 37

STAFF BREAKDOWN UNDER THE RESEARCH AND INVESTMENT BUDGET ACCORDING TO PLACE OF POSTING

(as at 31 January 1964)

I. In the Community

	Number of personnel
1. *Belgium*	
— Brussels	215
— BCMN Establishment — Geel	103
— Ghent	1
— Liège	6
— Mol	63
Total :	388
2. *Germany*	
— Transuranium Institute — Karlsruhe	28
— Karlsruhe	8
— Aachen	1
— Frankfurt	1
— Freiburg	1
— Munich	11
Total :	50
3. *France*	
— Fontenay-aux-Roses	65
— Saclay	14
— Grenoble	6
— Cadarache	18
— Paris	1
— Genlis	1
— Strasbourg	1
Total :	106

	Number of personnel
4. *Italy*	
— Ispra Establishment	995
— Bologna	1
— Casaccia	3
— Fiascherino	1
— Frascati	15
— Garigliano	3
— Latina	1
— Milan	2
— Pallanza	1
— Pavia	1
— Turin	1
Total :	1,024
5. *Netherlands*	
— Petten Establishment	36
— Amsterdam	1
— Arnhem	1
— Jutphaas	1
— The Hague	1
— Rijswijk	1
— Wageningen	5
Total :	46
Total in the Community :	1,614

II. Posted outside the Community

	Number of Personnel
1. *Great Britain*	
— Winfrith	16
2. *United States*	
— Allston (Massachusetts)	1
— Argonne (Illinois)	3
— Boulder (Colorado)	1
— Colombus (Ohio)	1
— Detroit	1
— Oak Ridge (California)	2
— Piqua (Ohio)	1
— Raleigh (N. Carolina)	1
— Richland (Washington)	1
— Vallecitos (California)	2
Total :	14
Total outside Community:	30
Grand total (1) :	1,644

(1) Add to this total:

Establishment staff working at Ispra	349
Establishment staff working at Karlsruhe	1
Establishment staff working at Geel	21
Establishment staff working at Munich	1
Total:	372

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