Community Topics 23

Euratom's second five-year research program 1963-67

european community
information service

Euratom's second five-year research program 1963-67

This document is a revised edition (October 1966) of Topic 7 published in January 1963

Summary of Euratom research budget, 1963-67*

		$ million
Reactors and associated research	"Proven" reactors and their industrial development	22·75
	Advanced gas reactors	32·50
	ORGEL	64·00
	Fast reactors	83·30
	New reactor types	7·00
	Ship propulsion	6·00
	Operation of BR2 (Belgian) materials – testing reactor	14·00
	Reprocessing of irradiated fuel	5·75
	Radioactive waste disposal	3·00
	Total	238·30
Fusion	Thermonuclear fusion studies	34·00
Radiation	Radioisotopes	3·00
	Health protection and biological research	16·00
	Total	19·00
Joint Research Centr	Ispra	86·60
	Petten	25·50
	Geel	12·30
	Karlsruhe	29·10
	Total	153·50
Training		2·00
Dissemination of information		8·50
Reserve		1·08
	Grand total	456·38

*The figures shown include a residual sum of $25·8 million from the 1958–62 program; they also take account of the modifications decided by the Council of Ministers in May 1965.

Introduction

Euratom – the European Atomic Energy Community – has a dual role. Its executive body, the Euratom Commission, must on the one hand coordinate research undertaken in the six member countries and, on the other, it must supplement national efforts "by carrying out the Community's own research and instructional program" (Articles 4 and 5 of the Euratom Treaty).

Euratom's role of coordinator is exercised formally by means of surveys of national research programs (Article 5), through the work of a Scientific and Technical Committee and of the Council of Ministers' Consultative Committee for Nuclear Research, and, informally, at meetings on various subjects where experts from the Commission, national authorities and industry exchange information. These formal and informal exchanges of information also help the Commission in drawing up Euratom's own research program – carried out at its Joint Research Centre and under "association" and other contracts with industry – and in ensuring that this program effectively supplements and dovetails with national research programs.

The broad lines of Euratom's first five-year research program (1958–62) were laid down in Annex Five to Article 215 of the Euratom Treaty. Under this Article, a total of $215 million was allocated for the initial research program; all but $26 million of this sum had been earmarked by the end of the five-year period. This period saw the launching of the Euratom program, the recruitment of some 1,900 research staff, the setting up of the four establishments of the Euratom Joint Research Centre (JRC),* and the signing of well over 300 research or association contracts.

On June 19, 1962, the Council of Ministers approved the Commission's proposals for a second Five-Year Research Program for the years 1963–67, providing for expenditure of $425 million, or nearly double the outlay for the first period. The second program aims at continuing and expanding the work already under way: to improve existing types of reactors, to develop new types, and to carry out research on a wide variety of subjects related to the peaceful uses of nuclear energy. The program was revised by a decision of the Council of Ministers in May, 1965. The revision involved a number of modifications to the sums allocated to various sectors, the most important being a modest increase in the credits available for the *ORGEL* program and fast reactor and thermonuclear fusion research, and a reduction in those for proven-type reactors and for certain ancillary activities. The overall sum for the program was raised to $430·58 million.

The table opposite shows the emphasis laid in the second research program on research into the production of nuclear power and to ancillary problems, such as waste disposal, to which roughly 90% of the total expenditure (including the funds allocated to the JRC) are being devoted. The total number of research staff required to carry out the second five-year program will be raised from slightly over 1,900 at the end of 1962 to around 3,000 by the end of 1967. It is now (mid-1966) about 2,500.

***Topic 16: The Euratom Joint Nuclear Research Centre** describes the work and organization of the centre in more detail.

The organization of Euratom Research

Under the second program, Euratom is organizing its research in the same way as it did under the first: in the four establishments of the Joint Research Centre, under association contracts and under contracts farmed out to public or private bodies in the member countries.

The Joint Research Centre

A total of $153 million is being spent on building up the Joint Research Centre, and about half the total expenditure of $456 million under the current program is allocated to work carried out at the Centre's four establishments.

The Joint Research Centre establishments are:

Ispra (at the southern end of Lake Maggiore, Italy). The largest establishment, both in terms of personnel and equipment, it has been allotted $686.6 million. The staff at Ispra already exceeds 1,500; by the end of the period it will have risen to 1,700.

Ispra is the location of the *ORGEL* project (see page 6), to which its laboratories are largely devoted; a critical assembly, *ECO*, part of the *ORGEL* program, is in operation; and a test reactor, *ESSOR*, is under construction. The Scientific Information Processing Centre (CETIS), equipped with high-performance computers, is also located at Ispra. CETIS, which includes in its equipment IBM 360, IBM 1401 and 7090 computers, is one of the most advanced organizations of this type in the world and serves the Brussels headquarters and other research centres in the Community. In addition to straightforward calculations, CETIS is undertaking research on the formation and exploitation of nuclear codes.

Petten (on the Dutch coast, 40 miles north-west of Amsterdam) was transferred to Euratom in 1962. The centre-piece of this general-purpose establishment is the high-flux reactor (HFR) built by the Dutch and transferred to Euratom. Altogether 300 people will be working at Petten, which has been allotted $25·5 million under the program. Apart from the use of the HFR, this establishment is concerned with technical coordination of the work carried out under contract in the field of advanced gas-reactors (the *Dragon* project in Great Britain* and AVR† "pebble-bed" reactor in Germany) with research into liquid fuels and with the standardization of methods of irradiating materials.

Geel (in Belgium, near the Dutch frontier) is the location of the Central Nuclear Measurements Bureau (CNMB), a highly specialized laboratory for standardizing and perfecting fundamental nuclear measurements. The CNMB program covers, amongst other things, the improvement of standards and of measuring instruments, the preservation of primary standards and the distribution of secondary standards for use in science, industry, commerce and medicine.

Among the most important items of equipment at the CNMB are a van de Graaff particle accelerator, a powerful linear accelerator and a laboratory for the preparation of samples. The sum of $12·3 million is being devoted to the CNMB, and the number of staff is being raised from 150 to 180.

Karlsruhe (Germany) is the site of the European Transuranian Institute, formally opened in 1965. This institute is concerned with the study of transuranian elements in general and plutonium-based fuel elements in particular – the latter in view of the promising prospects for plutonium as a nuclear fuel for future power reactors. Karlsruhe is the Community's headquarters for plutonium work, coordinating the work performed directly by Euratom with that done under contract. An important part of the work consists of studying the recycling of plutonium in reactors. The sum of $29·1 million has been allocated to this institute, whose staff will eventually total 300.

Ordinary and association contracts

The Community is undertaking research under two other formulae: ordinary contracts for specific research assignments which are farmed out to industrial organizations or other research centres in the Community, or association contracts under which Euratom and a national concern form joint research teams for long-term assignments. In the latter case the two parties share costs.

In this way, work by a large number of public and private organizations is encouraged and coordinated and the best possible use is made of available resources. So far, some 700 contractual assignments have been concluded or are being carried out. The contracts cover work in a wide range

*This project is being carried out by the European Nuclear Energy Agency of the OECD (see page 6).
† For explanation of abbreviations see Appendix II.

of fields, from reactor research to the uses of isotopes in industry, agriculture and medicine.

Association contracts cover long-term and usually large-scale research projects under way or planned by private or public research authorities, universities or private firms. Under them, Euratom and the institution concerned form a partnership, Euratom contributing between 30% and 66% of the total costs. The Commission also contributes staff to the project and joint research teams are formed. The direction of the project is undertaken by a joint management committee which is responsible for the preparation and execution of the research. All or most of the research in certain sectors has been linked together through Euratom participation. All fast-reactor and fusion-research projects, for instance, are integrated into the Euratom program under five and six association contracts respectively. In these cases, liaison committees bringing leaders of the various projects together at frequent intervals, have been set up. This has facilitated a certain degree of coordination and rationalization of the programs.

The reactor program

'Proven-type' reactors

There is still some scope for improvements to the "proven-types" of nuclear reactor (boiling water, pressurized water-cooled, or gas-cooled) types now installed in many areas of the Community. Nearly all the work on water-cooled reactors is being performed under the Joint Research and Development Program of the US-Euratom Cooperation Agreement of November 1958. This research is performed under contract in the Community and the USA for the joint account of the two parties. Altogether $54·5 million expenditure on this program had been approved by the end of 1964, of which $26 million in the USA. Among the fields of research are:

- improvement of reactor parts, including automatic equipment and heat exchangers;
- improvement of structural materials, especially steel;
- development of metallic and ceramic fuel elements, and cladding materials;
- improvement of reactor performance, particularly as regards thermodynamics, increasing power output, and control instrumentation.

Euratom has also carried out technico-economic studies on a wide range of subjects concerned with nuclear-energy production costs, including radioactive materials transport costs, and the incidence of fiscal policies and security measures, as well as sea-water desalination.

The sum allocated to the proved-reactor program is $22·75 million.

ORGEL: heavy water-moderated, organic liquid-cooled reactor

ORGEL is a heavy water-moderated, organic liquid-cooled and natural or enriched uranium-fuelled reactor concept selected by Euratom as especially promising for the "second generation" or "intermediate" stage of nuclear-power stations to be installed in the Community from the early 1970s onwards. The *ORGEL* program is being carried out principally at and directed from the Ispra establishment of the Joint Research Centre, though something over 10% of the expenditure is going to contractual work. However, nearly 65% of the design and construction costs of the *ECO* and *ESSOR* reactors have been for work carried out by outside contractors.

Among the potential advantages of *ORGEL:*

- natural or even slightly enriched uranium is an atomic fuel which can be obtained with relative ease, and *ORGEL* fuel cycle costs are expected to be low;
- heavy water as the moderating material provides for an excellent neutron economy;
- an organic liquid tolerates both relatively high temperatures (of the order of 400°C) in low pressure circuits and allows the use of conventional structural materials.

Among the subjects studied under the program are metallurgy (sintered aluminium, uranium carbide), chemistry and reactor physics. The equipment for the *ORGEL* studies includes the *ECO* reactor ("*ORGEL* critical experiment"), now in operation at Ispra, which permits precise studies to be made of techniques for obtaining the best neutron economy in *ORGEL*-type reactors.

A further stage in the *ORGEL* program is the construction of a 25 MW test reactor (*ESSOR*), which will be completed in 1967. The *ESSOR* reactor is being built by private industrial groups from most of the Community countries.

By mid-1965, research was sufficiently advanced to justify consideration being given to a full-scale prototype.

The sum of $64 million has been allocated to the *ORGEL* program.

High temperature gas-cooled reactors

High temperature gas-cooled reactors are another promising "intermediate" reactor string. They represent an advanced development of the natural uranium, graphite-moderated, carbon dioxide gas-cooled (graphite-gas) reactors installed under the French and British national programs.

The *Dragon* project was conceived by the British and is one of the projects of the OECD's European Nuclear Energy Agency. It involves the study and construction of a pressurized helium-cooled reactor (the outlet temperature of the gas being at least 750°C). Instead of using natural uranium, the fuel elements consist of enriched uranium (U 235) mixed with fertile thorium (an alternative and plentiful mineral). The latter is convertible by irradiation into the fissile uranium 233, which can also be employed as a reactor fuel. Euratom is not only covering the Community countries' share of the reactor construction costs and of associated research on *Dragon*, but has also sent some 30 engineers to work on the project at Winfrith, England. The initial five-year agreement on *Dragon* which was due to expire on April 1, 1964, has now been prolonged until 1967.

Euratom is also associated with the THTR (thorium, high temperature or "pebble-bed" reactor) of the BBC-Krupp concern, at the German Jülich centre. In addition to participating in the operation of this reactor, Euratom is pursuing an associated research and development program covering reactor materials and fuel elements in particular. A study is also being undertaken of a full-scale high temperature reactor in which the thorium-U 233 cycle could be employed.

The Petten establishment has been allotted the task of technical coordination between the *Dragon* and pebble-bed projects, and its own research activities include studies of thorium and graphite, the development of liquid fuels, and the technological study of active circuits. This requires dismantling cells and a medium-activity laboratory, which has been installed.

A total of $32·5 million has been allocated to the high-temperature gas reactor program.

Fast-breeder reactors

Fast-breeder reactors may be regarded as the "third generation" of reactor development, and are likely to reach the stage of commercial operation in the late seventies or early eighties.

Earlier ("thermal") reactors rely on moderators to slow down the neutrons and ensure that they bring about fission in the fissionable material employed. Fast reactors, on the other hand, lack a moderator and rely on fast neutrons to bring about fission. At the same time they breed plutonium from a blanket of natural uranium which surrounds the fast reactor core. "Breeder" reactors can thus produce as much or even more fissile material than they consume. Once they become suitable for large-scale power production, great economies in fuel consumption will result. Euratom's fast-reactor research is being performed under five association contracts, with the active participation of the Transuranian Elements Institute at Karlsruhe. One such association is with the French for the construction and operation of the *RAPSODIE* sodium liquid-cooled test reactor at the Cadarache Centre, in Provence, along with the *MASURCA* reactor and *HARMONIE* critical assembly. Another is with the German KBB concern. Here, Euratom is participating in the construction of three critical assemblies at the Karlsruhe research centre. The Euratom-KBB Association is in its turn participating in the *SEFOR* fast-reactor project at Fayetteville, Arkansas, USA. The three others are with the Italian, Dutch and Belgian authorities. By means of these association contracts Euratom is playing an important coordinating role in European fast-reactor research.

Euratom in May 1964 concluded also a far-reaching exchange of information agreement with the USA on the results of fast-reactor research and is embarking on more limited cooperation in the same field with the UK.

A total of $83·3 million, the largest sum for any single item, is devoted to this sector.

Other advanced reactors

Euratom is also working on two other advanced reactor concepts. One project is the *SUSPOP* reactor, which is being studied under an association contract with the Dutch KEMA concern at Arnhem. *SUSPOP* is an homogeneous suspension reactor in which fuel is suspended in a liquid moderator instead of taking the form of bars surrounded by a moderator.

Another project is for research on the development of "two-phase liquid coolants" (so-called "fog" reactors using a mixture of water and vapour). This work is being performed under an association contract with the Italian CISE concern. A design study of a full-scale reactor operating on this system (designated *CIRENE*) is being undertaken. The sum of $7 million is being spent on these projects.

Materials-testing reactors

It is essential for the development of new types of reactors and for the improvement of existing types that there should be facilities for testing the behaviour of construction materials under radiation. The ideal instrument is a reactor with an extremely high neutron flux, enabling the long-term behaviour of these materials to be tested rapidly after submission to intense neutron bombardment. Euratom has concluded an association contract under which the Belgian Government has put its BR2 high-flux materials-testing reactor at the Community's disposal for twenty years. This reactor, which produces the highest neutron flux of any in Europe, entered into service in 1962 and is operated in association with the Belgian CEN nuclear research centre. It is available for experiments both to the Joint Research Centre and to other national or private concerns in the Community. Alongside BR2, a very high-activity "hot" laboratory is in service.

Another important materials-testing facility is the HFR at the Petten establishment of the JRC.

The allocation for the BR2 materials-testing reactor is $14 million.

Other research activities

Reprocessing of irradiated fuel

Spent fuel withdrawn from a reactor retains fissile elements which can be recovered for further use. The material becomes partly "poisoned", however, in the sense that by-products are formed which obstruct the smooth functioning of the reactor. The process of eliminating these poisons still leaves wide scope for improvement.

Research on improving the treatment of spent fuel takes on increasing importance in view of the likely rapid growth in the number of power reactors to be installed in the Community in the coming years. Here also the aim is to reduce production costs of what may be regarded as an industrial process. The research, for which $5·75 million is allotted, is performed under contract. Euratom is taking part under contract in the building operation and exploitation of the Italian Eurex plant at Saluggia, near Turin, and is contributing $3 million to the project.

Tr atment of radioactive waste

The problem of disposing of radioactive waste from reactors, reprocessing plants and laboratories using radioactive materials has not yet been satisfactorily solved. This is all the more important in an area like the European Community where the population density is high and where vast areas of desert, such as those found in the USA, are not available for the stocking of waste materials. Apart from the demands of public safety, it is also essential to put these operations on the best possible economic footing.

Euratom is undertaking research on a number of ways of disposing of waste. One is the storage of active residues under the ground in semi-desert regions. Another is injecting waste into such suitable geological formations as salt mines or domes.

A sum of $3 million has been allotted to this field of research, which is being performed mainly under contract.

Nuclear ship propulsion

Although nuclear ship propulsion is not yet an economic proposition, this field of research cannot be neglected, and several studies for using reactors as power plant in ships have been started in Europe. Euratom's role is to coordinate this work so as to avoid wasteful duplication and to give backing to the more promising of the research projects.

Euratom's participation in ship propulsion research is taking place under association contracts, of which four were concluded during the first five-year period. They cover three projects:

- the design, construction and operation of the *Otto Hahn* research ship under contract with the German GKSS company. This 15,000 ton vessel was launched at Kiel in June, 1964 and will be completed in 1967. It is equipped with several laboratories and will accommodate a scientific staff of 40. Euratom is contributing to the cost of building and installing the 38 MW pressurized-water reactor which will drive the ship.
- the study, in association with the Dutch authorities, of a pressurized-water marine reactor.
- an Italian project for a draft design for a large nuclear-powered tanker.

Along with these projects Euratom is undertaking with her partners various associated experiments, notably collision and shielding tests. A sum of $6 million has been allotted to nuclear ship propulsion.

Controlled thermonuclear fusion

While fission energy is produced from the splitting of atomic nuclei, nuclear fusion involves a combination of two light nuclei (hydrogen, deuterium or tritium) to form a heavy nucleus, thus releasing vast amounts of energy. There is probably still a great distance to go before thermonuclear power stations can be built, and the research is consequently of a long-term character. Euratom's work is being done under six association contracts with the French CEA nuclear authority at its Fontenay-aux-Roses and Saclay laboratories, with the German Institüt für Physik und Astrophysik at Munich-Garching and KFA research centre at Jülich, with the Italian CNEN authority at its Frascati centre, and with the Dutch FOM laboratories. Euratom is not only directly involved in the research, but also is coordinating the projects. It has allocated $34 million for the fusion program.

Radioisotopes

Radioisotopes are elements (gold, cobalt, phosphorous, iodine, etc.) which have been made radioactive through insertion in an atomic reactor. They can be of great value in biological research, medicine, agriculture and industry, in which their use has already brought about substantial financial economies. Euratom has set up an Information

Bureau (Eurisotop) to promote the use of isotopes and fission products in industry and to stimulate research into new uses for them. Its activities include the distribution of information on the ways isotopes can be used in various industries and aiding potential users in carrying out experiments on their application. It is also setting up a collection of marked molecules to enable users to have access to certain variants not yet obtainable on the commercial market.

Euratom has allocated $3 million for this work, which is being done mainly under contract.

Health protection and biology

The main priority in Euratom's biological research program, which is being carried out largely under association contracts with national institutions but also at Ispra, is research into the effect of radiation on living bodies.

The most important research fields under this heading are:

- problems of diagnosis – for example through haematological examination – and the treatment of radiation effects by bone-marrow transfusion;
- the genetic risks of radiation for human beings;
- statistical studies of the after-effects of radiation on human beings;
- the absorption, retention and elimination of certain radioisotopes by animals, with the aim of defining precise tolerance levels;
- the movements of the most important radioisotopes in the atmosphere, sea, surface waters and plants in order to obtain a better understanding of contamination risks;
- the improvement of protection equipment and the perfection of instruments and apparatus to measure the degree of radiation absorbed by individuals.

Research into the application of nuclear techniques to agricultural problems is being directed towards the improvement of vegetable specimens by radiogenetic methods and the preservation of foodstuffs by irradiation. In the medical field, the program is being concentrated on the development of new therapies.

Health protection and biological research has been allocated $16 million.

Training

Euratom has an important role to play in the training of scientific staff and in the provision of specialized courses for fully-qualified scientists. Courses are arranged in Community research centres, particularly the JRC establishments, for students nearing the end of their studies. The student trainees take part in the day-to-day work of the research teams at the centre or carry out studies on minor problems. A number of qualified research students from other research centres or industrial concerns (including some from non-member countries) are accepted for periods in the JRC establishments. The Euratom Commission also makes grants aimed at supporting the training courses by providing further education in nuclear science and techniques for university graduates. The grant-holders work more or less independently on specific subjects within the context of the host-centre's research program.

Dissemination of information

Euratom's Information Department fulfills two functions. One is to make available to all interested parties in the Community the results of Euratom research, along with nuclear information the Commission has obtained from any other sources. The second is to bring into operation a patent policy covering information resulting from its own or contractual research.

The first function is the responsibility of Euratom's Information and Documentation Centre (IDC), the operations of which fall within the scope of the research program. Its task is to keep the Community informed of the results of research under the program and to afford Community research organizations and industry access to scientific and technical information published anywhere in the world. The IDC circulates to member states and other bodies in the Community information arising from Community research likely to be of value for industrial development. It also publishes and circulates more general research reports, along with periodicals such as *Euratom Information,* which contains abstracts of published research results, outlines of research programs and the subject matter of contracts signed and patents granted; and *Euratom Bulletin*, which, catering for a wide public, provides articles on Euratom's activities and on nuclear developments in general.

The IDC also publishes the monthly *Transatom Bulletin,* which gives information on nuclear documents translated from Slavonic and oriental languages, as well as various other publications. In addition, the Commission and the KFA, Jülich, have jointly formed a documentation centre, Eastatom, which acquires and translates nuclear literature from eastern bloc countries.

Another important field of activity is automatic documentation. The IDC will soon have in operation a semi-automatic bibliographical reference system equipped with a computer. Some 400,000 items of nuclear information (which are appearing at the rate of 50,000 – 60,000 per year) are being stored in the computer which, once in operation, will be able to undertake rapid bibliographical researches for clients in the Community and, later, outside it. Apart from the results of Community research, one of the major sources of documentary information is the American *Nuclear Science Abstracts* (NSA). Here there is close cooperation between Euratom and the US Atomic Energy Commission: for instance, the NSA may reprint any article appearing in Euratom publications, while Euratom receives directly a copy of all abstracts to be published in English.

Finally, the IDC operates five libraries, in Brussels and at each of the research establishments.

APPENDIX I
A simplified explanation of nuclear reactors

The basic principle of producing electricity in nuclear power stations is simple enough. An atomic reactor provides heat obtained from the controlled disintegration of its fuel (uranium), and the heat thus produced merely needs to be harnessed to feed a turbogenerator. (Similarly, it can be made to turn the screw of a ship).

There are many difficulties in practice, however, and in addition many different combinations are possible in the design of an atomic reactor. These possibilities must be explored to determine those best suited to the requirements and capacity of European industry. The main variables are the fuel, the coolant, the moderator and the heat exchange system, as well as the shape of the nuclear charge on the one hand and the layout of the moderator, coolant, monitoring equipment, etc., on the other.

The fuel used in almost all nuclear reactors hitherto is based on natural uranium or U 238 (only 1/140 of which is fissile U 235) or "enriched" uranium (in which the U 235 element has been artificially raised). An additional potential fuel, however, is plutonium, a fissile product produced in all reactors by the fission process, the U 238 being converted into plutonium through the capture of neutrons. Plutonium is likely to be used increasingly as a reactor fuel, particularly in fast reactors, for which it promises to be an ideal fuel.

While the use of enriched uranium permits important reductions in the dimensions and equipment of the reactor, extremely expensive plant is required for its preparation. At the present time there is no isotope-separation plant in Europe in which nuclear fuels based on enriched uranium can be manufactured (although a factory for this purpose in the military field is being built at Pierrelatte, France).

Natural uranium, on the other hand, while having the disadvantage of requiring large reactors, is available in Europe and large quantities are available on the world market. The Euratom Commission therefore considers research into the development of natural uranium-fuelled reactors to be of major importance.

The shortage of supplies of enriched uranium is also an additional reason for developing the use of plutonium, as well as for developing the thorium-U 233 cycle in advanced high-temperature reactors.

The type of fuel is not the only factor affecting the type of reactor chosen, however. The moderator and the coolant are also important factors.

The moderator is a substance which reduces the speed of the neutrons and so increases their chance of causing fission in the nuclei of fissile uranium. It should not be confused with the control rods, which slow down the reaction when necessary and constitute the basic safety element of the reactor. Without the moderator (ordinary or heavy water, or graphite, for example) too many of the neutrons – which are emitted at a velocity of about 12,500 miles per second – would be captured by non-fissile nuclei (U 238) before having time to cause the fission of the U 235 nuclei. A moderator is therefore essential to a natural uranium reactor.

The coolant is used to transfer the heat produced by the reaction process. Reactors developed in the United States (operating on enriched uranium) usually employ boiling or pressurized water as a coolant. The temperatures reached in reactors of this type are in the order of several hundred degrees centigrade. In the natural-uranium reactors developed in Great Britain and France, a gas (usually carbon dioxide) is used to transfer the heat. The use of organic liquids obtained on an industrial scale from coal and petroleum offers a number of advantages, including low cost and a relatively high boiling point.

APPENDIX II

Abbr viations

AVR	Arbeitsgemeinschaft Versuchs-Reaktor (Test Reactor Study Group), Jülich, Germany. Responsible for the "pebble-bed" reactor.
CEA	Commissariat à l'Energie Atomique (France: Nuclear Energy Commission).
CEN	Centre d'Etude de l'Energie Nucléaire (Belgium: Nuclear Energy Study Centre).
CETIS	Centre de Traitement de l'Information Scientifique (Scientific Information Processing Centre), Ispra, Italy.
CIRENE	The CISE "fog-cooled" reactor project.
CISE	Centro Informazioni Studi ed Esperienze (Information, Study and Experimental Centre), Milan, Italy.
CNMB	Central Nuclear Measurements Bureau, Geel, Belgium.
FOM	Fundamenteel Onderzoek der Materie (Fundamental Materials Research).
GKSS	Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt (Nuclear Shipbuilding and Shipping Company), Hamburg, Germany.
HFR	High-Flux Reactor, Petten, Netherlands.
JRC	Joint Research Centre.
KBB	Kernreaktor Bau- und Betriebgesellschaft (Atomic Reactor Construction Company), Karlsruhe, Germany.
KEMA	NV tot Keuring van Electrotechnische (Electrotechnical Testing Company), Arnhem, Netherlands.
KFA	Kernforschungsanlage (Atomic Research Installation), Jülich, Germany.

Community Topics

An occasional series of documents on the current work of the three European Communities

1. **The Common Market 1960–1** (July 1961) *out of print*
2. **Economic integration and political unity in Europe, by Walter Hallstein** (August 1961) *out of print*
3. **A guide to the study of the European Communities** (November 1961) *out of print*
4. **The Common Market and the law, by Michel Gaudet** (November 1961) *out of print*
5. **French industry and the Common Market** (December 1962) *out of print*
6. **The right of establishment and the supply of services** (November 1962) *out of print*
7. **Euratom's second five-year research program 1963–7** (January 1963) *see Topic* 23
8. **Ten years of ECSC 1952–1962** (January 1963) *out of print*
9. **Energy policy in the European Community** (June 1963) *out of print*
10. **The Common Market's Action Program** (July 1963) *out of print*
11. **How the European Economic Community's Institutions work** (August 1963)
12. **The Common Market: inward or outward looking, by Robert Marjolin** (August 1964)
13. **Where the Common Market stands today, by Walter Hallstein** (August 1964) *out of print*
14. **ECSC and the merger, by Dino Del Bo** (September 1964) *out of print*
15. **Initiative 1964** (December 1964) *out of print*
16. **The Euratom joint nuclear research centre** (January 1965; revised May 1966)
17. **Some of our "faux problemes", by Walter Hallstein** (January 1965)
18. **Social security in the Common Market, by Jacques Jean Ribas** (May 1965) *out of print*
19. **Competition policy in the Common Market, by Hans von der Groeben** (June 1965) *out of print*
20. **Social policy in the ECSC** (January 1966)
21. **Agriculture in the Common Market** (November 1965)
22. **Social policy in the Common Market 1958–65** (July 1966)
23. **Euratom's second five-year research program 1963–67** (*Topic* 7 revised to October 1966)

Enquiries about these and other publications of the Information Service should be made to:

European Community Information Service

London: 23 Chesham Street, SW1

Washington: 808 Farragut Building, 900 17th Street, NW, Washington D.C. 20006.

New York: 2207 Commerce Building, 155 East 44th Street, New York N.Y. 10017.

Printed for the European Community Information Service by Edwin Snell & Sons, Printers, Yeovil, England