EURATOM AT THE ATOMIUM

PERMANENT EXHIBITION

euratom at the atomium

The European Atomic Energy Community (EURATOM) has the task of contributing, by creating the conditions necessary for the establishment and rapid growth of nuclear industries in Europe, to the raising of living standards in the Member States and the expansion of trade with other countries.

Energy consumption in the six Community countries is rising fast. To satisfy their growing needs, new sources of power will be needed, above all atomic energy. In 1980 nuclear power will be needed to produce as much electricity as was produced by all conventional sources in 1960. However, all sorts of preparations for this new industry are required. Euratom is to put these preparations — research, the formation of a Community nuclear industry, « atomic legislation », co-operation with other countries, the dissemination of nuclear information and so on — onto a Community basis.

Euratom carries out its research under five-year programmes, the funds for which are provided by contributions from Member States ($ 455 million is available for the current programme). Most of the research is executed at the four establishments of the Joint Research Centre (Ispra, Petten, Karlsruhe and Geel) or under large-scale association contracts with undertakings in member countries. Euratom has concluded numerous international links, in particular co-operation agreements with the United States, the United Kingdom and Canada.

The lowest sphere of the Atomium is devoted to a description of the atom and to some of the applications of nuclear energy.
On the second floor of the exhibition, stands and models will be found illustrating Euratom's various activities in the fields of research, the promotion of industry, health and safety and the dissemination of information.

PANELS

1 DEMOCRITUS. Some 2,500 years ago, Democritus, the Greek philosopher, used the deductive method to study the composition of matter.

2 (first part). We find in his writing the etymology of the word « Atomos » meaning « indivisible ».

(second part). 92 different types of atoms comprise about 400,000 known molecules.

3 Modern scientists have discovered that the atom, held to be indivisible, is composed of a nucleus around which electrons revolve.

4 The nucleus in turn consists of two different types of particles, protons and neutrons. When the nucleus contains only a small number of protons and neutrons, the latter are light particles.

(lower part). The picture shown here gives an approximate idea of the distances between the nucleus and the electron.

5 Nucleus and element : the nucleus characterises the element into the composition of which it enters.
The various known atoms are classified by means of a serial number which is the atomic number corresponding to the number of protons contained in the nucleus. The simplest of the atoms has one proton, i.e. hydrogen. The most complex has been allotted the number 92, this being the uranium atom, the nucleus of which contains 92 protons.

6 In the atomic units system, protons and neutrons have a mass approximately equal to figure 1.

7 The atomic nucleus thus has a mass which depends on the number of nucleons. It also possesses an electric charge, which is determined by the number of protons, each proton having a unit charge of positive electricity. The neutron is electrically neutral. The total positive charge of the nucleus is balanced by the negative charge of the outer electrons. As the atom, in its normal state, has no electric charge, it may be concluded that there are as many outer electrons as there are protons in the nucleus.

8 This panel represents the structure of the atom. It clearly illustrates the size of the nucleons compared with the other constituents.

9 The mass of the electron is negligible (1/200th of that of the proton or the neutron) ; its rôle is of great significance, since, while the nucleus determines the nature of the elements, the electron shells determine their chemical properties.

10 An analysis of the characteristic nuclei of a given element shows that for a specific number of protons there may be a variable number of neutrons. The electrons revolving around these nuclei being similar in number, the chemical properties of the atoms thus formed are the same. These different nuclei characterising one and the same element are called the isotopes of that element.

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12 The stability of the nucleus is remarkable. In most cases, an energy known as « mass defect » holds the atom together. It is calculated from the difference between the total mass of the nucleus and the sum of the masses of its constituent nucleons, the latter being higher than the former.

13 Some nuclei are radioactive, i.e. they emit particles or radiations which may modify their nature. The particles emitted are designated alpha and beta and the radiation is called gamma. Their properties and their effects are different.

14	The particles and radiations emitted differ considerably as regards powers of penetration, protection against which is vital. The power of alpha ray penetration is very low, of beta rays low, but that of gamma rays very high.
15 16	Radiation is detected by measuring devices such as the WILSON CHAMBER or the GEIGER-MULLER COUNTER (see panel 22).
17	Radioactivity over certain period leads to decay of the nuclei. The name **half-life** is given to the time it takes for half the atoms in a given radioactive mass to decay.
18	Nuclear reactions result from contact between a nucleus and a projectile — usually a particle which has the formation of a compound nucleus, is unstable and relatively short-lived. The instability of the nucleus causes an emission, in one or more stages, of different particles from a single radiation.
19	This nuclide chart shows how the various known isotopes are classified according to the number of protons and neutrons forming their nucleus.
20	Here we see exactly how the atoms are classified. This method of classification was devised by the Russian chemist MENDELEYEV and the German chemist Lothar MEYER.
21	A recapitulation of the composition of molecules.
22	Geiger counter — a radiation-detection device.
23	In nuclear fission, the target nucleus and the projectile form a fresh nucleus which in turn breaks up into several fragments. The projectile is a neutron which can be slowed down or not as required.
24	The first nuclear fission was achieved, technically speaking, by the German scientist Otto Hahn by means of the extremely

simple device illustrated here. We shall see later on how it is possible, from a mathematical formula determined by EINSTEIN, to measure the energy produced by fission.

25 As a result of the fission of a nucleus, fragments are projected and in turn bring about the fission process in other nuclei.

26 Energy from fission.
The sum of the masses of the fission fragments is less than the sum of the masses of the target nucleus and the projectile. The mass which has disappeared has been converted into energy — following the mass-energy equivalence principle established by EINSTEIN (see panel 29).

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28 From nuclear fission has been built up the applied nuclear science on which the atomic power industry is based. Fission naturally recurs and multiplies rapidly. Once started, the fission reaction may become a chain reaction.

29 Among the many European-born scientists, most of them Nobel Prize winners, to whom we are indebted for progress in nuclear science, an outstanding place is occupied by Albert EINSTEIN. His apparently simple formula $E = mc^2$ (mass-energy relationship) represented a revolution in established concepts about the nature of matter.

entry hall to the second part of the first floor

PANELS

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32 Europe's energy needs are rising fast — doubling, in fact, every 20 years. Electricity consumption — as in all industrial areas — is rising every decade. While only 5 % of the Community's energy came from abroad before the war, by 1960 imports represented a quarter and by 1964 nearly a half of the total. The proportion imported will continue to grow, but more and more slowly with the recourse to nuclear power. Euratom forecasts that by 1975 between half and two-thirds of the Community's energy will come from outside sources ; by the year 2000 it will be down again to one half. By 1980 about one quarter of the Community's electricity will come from nuclear sources ; by 2000 nearly two-thirds ! And all power stations after 1980 — or 1990 — are likely to be atomic.

33 Map of nuclear installations in the six countries.

34 **(Show case)** : Here is a power reactor, the main components of which are :

a) **a fuel** (natural or enriched uranium) arranged in fuel elements.

b) **a moderator**. In order to maximise the chances of fission, the neutrons must be slowed down (i.e. moderated). Depending on the type of reactor, the moderator may be water (boiling and pressurised water types) or graphite (British and French gas-cooled type).

c) **a coolant** which transfers the heat produced by the nuclear fuel fission to the turbines.

d) **a reflector** which prevents particles from escaping from the reactor.

e) **a protective cladding** for the reactor — for safety.

f) **control rods** which enable the chain reaction to be controlled and maintained within limits of safety.

35 What is a nuclear fuel?
A fissionable substance which releases energy after disintegrating.
The main nuclear fuels are natural uranium (one element of which in 139 is fissile) and uranium enriched in the fissile isotope uranium 235. Plutonium — natural uranium after irradiation — is an important supplementary fuel. Uranium 233 is another potential fuel and is obtained from the naturally-occurring mineral, thorium.

36 A model of a reactor fuelled by enriched uranium, moderated and cooled by ordinary water.

37 A model of a graphite-moderated reactor. Reactors of this type are already producing electricity (the Italian Latina reactor and the French EDF reactors).

38 The aim of this stand is to give an idea of the speed of advance in nuclear reactor construction. It affords a comparison of the first atomic pile, built in 1942 by Professor FERMI, with the first modern reactor to produce electricity (Calder Hall, in Britain, 1957). The different combinations of fuel, moderators and coolants make possible a number of reactor strings. Each has its advantages and drawbacks. Research is continuing to improve their performances.

39 This is a model of the Melusine swimming pool reactor type at Grenoble (France); the model in panel 40 is of a homogeneous reactor known as SUSPOP (Netherlands).

40 Under an association with Euratom, the Dutch Company KEMA is studying a homogeneous-type reactor called SUSPOP. The panel illustrates the vast range of possible new reactor types.

41 Here are the major reactor strings; proven-type reactors, using either natural or enriched uranium, form a first generation. By the early 1970s, reactors of the « intermediate » (advanced converter) type promise to be ready for industrial exploitation. Among those on which Euratom is working are the « Orgel » (organic-cooled, heavy water-moderated) and « Dragon » (high-temperature, gas-cooled) types. « Orgel » is the main project at Euratom's Ispra centre ; « Dragon » is a 12-nation project at Winfrith, United Kingdom in which Euratom is participating on behalf of its member countries. Following on this second generation will be a third : « breeder » reactors are one of Euratom's leading fields of research. Producing more fissionable material than they consume, and thus permitting a major economy in the nuclear fuel reserves, the perfection of these reactors will represent a major breakthrough. Looking still further ahead, Euratom is studying controlled thermo-nuclear fusion. Once this — H-bomb — energy has been mastered the problem of energy reserves will cease to exist : for the new raw material will be sea water.

aspects of euratom's work

PANELS

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— Aid and encouragement to industry.

— Exchange of information, joint research and other co-operation with non-member countries.

— The use of radioisotopes in industry, medicine and agriculture.

— A common market for nuclear equipment and fuel and the free movement of workers.

— Complementing, co-ordinating and stimulating nuclear research in the Community.

— Adequate and regular supplies of nuclear fuel.

— Adequate health and safety regulations.

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At the foot of the staircase leading to the second floor, there is a representation of the remarkable CERENKOV effect, observed in all swimming pool reactors when in operation. Under the action of the electrons, the water assumes an attractive luminescent blue colour.

43 The atom can be used in medicine, agriculture or industry (isotopes). It can be applied to the satisfaction of the energy needs of the industrialised countries (power reactors). In addition, it can be used for the propulsion of ships. This aspect of the use of the atom is illustrated in panel 43 by a model of the U.S. merchantship « SAVANNAH ».

second part of the exhibition

Euratom's aim is to co-ordinate and stimulate the essential preparatory scientific work, supplement it by Community-scale activities and aid the coherent and harmonious development of a nuclear industry. Euratom research takes place under five-year programmes. The second of these is now under way, $ 455 million being available for its execution.
Research is being carried out in the Joint Research Centre establishments (Ispra, Geel, Petten and Karlsruhe), under large-scale association contracts (e.g. fast reactors, controlled thermonuclear fusion, ship propulsion and so on) or contracts farmed out to industry, universities, etc. The fruits of this research are made available to industrialists and others likely to be able to exploit them.
Euratom contributes to the development of the nuclear industry in many ways, in particular by its power reactor participation scheme, by awarding research contracts and by its periodic forecasts of the rôle of atomic energy.

44 Five-year research programmes.

45 This panel illustrates the means of action open to the Community.

46 The organisation chart in panel 46 gives an idea of the range of the Euratom Commission's activities.

47 The Members of the Euratom Commission are M. Pierre CHATENET, President, Prof. Antonio CARRELLI, Vice-President, M. Paul Hubert DE GROOTE, M. Emanuel M.J.A. SASSEN and M. Robert MARGULIES, Members.

48 The Karlsruhe Centre, which was officially inaugurated in April 1965, is one of the four Joint Research Centre establishments. Here Euratom is studying plutonium, a fuel for the future.

49 At Geel, near Belgium's Mol Centre, there is the Central Nuclear Measurements Bureau where standards for nuclear measurements are worked out. This centre, which has many close links with the United States and the United Kingdom, has a staff of over 100 research workers. It is equipped with a large particle accelerator.

50 The Ispra Centre, near Lake Maggiore in Italy, is the largest of Euratom's four establishments. It has a research staff of about 1,200. Although it is a « general competence » establishment, most of Ispra's work is concerned with the ORGEL project, for which they have at their disposal a critical assembly (ECO) and (in 1967) an experimental reactor (ESSOR). Another research reactor, available for various research assignments, is ISPRA-1. Ispra has physics, materials', scientific information and protection departments. A European School has been set up at nearby Varese.

51 The smaller « general purpose » centre, at Petten, Holland (on the North Sea coast) has a research staff of around 250. It is equipped with a materials' testing reactor.

52 Major Community research projects are also carried out under association contracts. These contracts provide for a partnership between Euratom and a national private or public organisation involved in research : joint research teams are formed and the work is jointly financed. Research is also carried out under contracts farmed out to industry, national research authorities and universities.

53 One association contract provides for joint operation of the Belgian BR-2 materials' testing reactor at the Belgian Mol research centre by Euratom and the CEN (Nuclear Studies Centre). Having a very high neutron flux, this reactor is being used to study the behaviour of the materials used in nuclear reactors under intense irradiation, thus simulating the irradiation effects of long periods of operation.

54 The Rapsodie model shows what fast reactors will look like. The Rapsodie (réacteur RAPide refroidi au SODium) project is being carried out at Cadarache in Provence under an association contract between Euratom and the CEA (French Atomic Energy Commission).

55 Euratom is also working on the use of atomic energy for ship propulsion. Four association contracts are under way. The model shown here is that of a nuclear vessel designed jointly by Euratom and the Italian Fiat-Ansaldo concerns who are working together under one of these contracts.

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57 By 1980 it is expected that the Community will have some 40,000 MWe of nuclear capacity, and by the end of the century 370,000 MWe. Nuclear power produced from stations under construction in many areas of the world is now as cheap or cheaper than electricity from conventional sources.

58 The SENA nuclear power plant at Chooz (French Ardennes), a 250 MWe unit, recently completed. It will supply electricity to the French and Belgian grids. Euratom contributes towards the costs of construction.

59 CETIS : the Scientific Data Processing Centre at Ispra. Powerful electronic-calculation equipment is at the disposal of this department, which is engaged on a programme of research on the automation of reactor calculations. CETIS also assists other Community institutions in statistical and other forms of calculation.

60 Here is a list of the research projects comprised in the Community's second research programme.

61 Information booklets are available on application to the Official Spokesman's Office of the Euratom Commission. Fill in the application cards stating the type of material required and the name and address to which it should be sent.

62 The use of radioactive isotopes in industry, biology, medicine and agriculture is expanding daily.

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These panels give some idea of the dangers of radiation for the human body and of the biological research in this field. They also show the maximum permissible radioactivity levels and the location of the monitoring posts which co-operate with Euratom in detecting the levels of radioactivity in the water, the air and the soil.

68 Euratom furthers nuclear research by making available information on the results of its own research and nuclear data collected from other parts of the world.

69 Nuclear installations could be considered dangerous if far-reaching measures of protection were not taken. Basic

standards of protection are uniformly applied in the six Community countries. Thanks to extremely stringent protective measures, this is one of the safest industries there is.

71 Euratom receives young graduate trainees in its research establishments. They receive laboratory instruction and practical experience.

72 Nuclear energy offers a new and better life for future generations.

73 This is the work of the painter Médard TYTGAT and symbolises the hopes inspired by the peaceful use of the atom.