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THE EUROPEAN COMMUNITY AND NUCLEAR SAFETY

Citizens of the Community are often unaware of what is being done to protect them and their environment from the hazards liable to result from the development of nuclear energy. We have therefore devoted this issue to a brief look at Community activity in the field of nuclear safety.

X/540/75-E

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CORRIGENDUM

THE EUROPEAN COMMUNITY AND NUCLEAR SAFETY

An error crept into "Industry and Society" No 35/75, which was devoted to "The European Community and Nuclear Safety". On page 11, at the end of the last paragraph, the text should read:

"In other words, between 1969 and 1972, radioactivity from nuclear power plants in the Community was estimated at less than 1% of the natural background radioactivity."

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The information published in this bulletin covers the European Communities' activities in the fields of industrial development, protection of the environment and consumer welfare. It is therefore not limited to recording Commission decisions or opinions.

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THE EUROPEAN COMMUNITY AND NUCLEAR SAFETY

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I. WHY USE NUCLEAR ENERGY?

For centuries man has everywhere sought aids to work: by using the strength of oxen or the weight of falling water, then by inventing machines fuelled with wood, coal, oil and electricity. Energy has been an important contributory factor in economic and social progress. In industry it has served to diminish physical effort and in some cases abolish it altogether without at the same time reducing the level of employment. It has increased output, and therefore shortened the working day. It has made it possible to institute the 40-hour working week, paid holiday and free weekends.

However, it is not only at work that energy has changed our way of life. Over the last 25 years private consumption of energy has increased even more rapidly than industrial consumption; in Europe it rose from a quarter to more than a third of total consumption between 1950 and 1970. Whether it is applied in domestic electrical equipment, cars, central heating or telephones, energy is now part of the daily life of each and every one of us.

The benefits of energy are now an established feature of our lives, which no one in present-day society would seriously contemplate calling into question. A sudden fall-off in consumption because of a drop in the amount of energy available might even throw our economic and social structures seriously out of gear - and no responsible politician can afford to take such a risk. Just imagine for a moment a world where hospitals were without electricity, food could no longer be deep-frozen, public transport had ceased to operate, clothes were spun and woven by hand, and so on.

A world-wide problem ...

In the world today, economic activity is closely related to energy consumption.

The total world consumption of primary energy at present amounts to about 60 000 million gigacalories a year*. This is an average annual consumption of 17 gigacalories by each citizen, although such an average does not mean a great deal as energy consumption is directly, and universally, linked to the level of a nation's economic activity and therefore varies considerably from one country to another. Thus, while the average in North America is 75 gigacalories a year, in India it is only 2 gigacalories. The corresponding figure for the European Community of the Nine is an intermediate 35 gigacalories.

*One gigacalorie = 1 000 million calories.

Even though consumption in the more industrialized countries shows a certain degree of stagnation, it is obvious that there will be a vast increase in world energy requirements as the economies of the developing countries get off the ground. Population increases and social progress will also have the same effect.

Over the last 40 years, world energy consumption has increased at an annual rate of about 3.5% to keep pace with economic growth in the western world. Between 1961 and 1971, energy consumption in the European Community of the Six rose by 5.6% and in Japan by more than 11% each year. By contrast, half the world's population makes do with one-eighth of the energy consumed yearly in the world as a whole.

If energy requirements continue to increase at the present rate demand will be about 20 000 million toe (tons oil equivalent) a year by the end of the century, which means that each year the world will be consuming about one-fifth of current proven oil reserves.

This is the scale of demand which we must be prepared to satisfy. Are there sufficient resources available? The answer is yes, provided we use our gifts of imagination and organization in good time - which means straight away.

On the one hand, energy resources and the ability to exploit them are not distributed equally throughout the world. Some parts, like the Middle East, have energy resources far in excess of their needs; others, like Europe, have insufficient resources; others again, like Japan, have virtually none. Sufficient supplies can therefore only be forthcoming if, first and foremost, relations between the various countries are such as to permit satisfactory technical, financial and commercial exchanges. This lies behind the diplomatic moves being conducted, with greater or lesser degrees of success, by various capitals and by the European Community.

On the other hand, judicious research into and use of new technologies can make a major contribution to world supply. In the case of coal, the extraction conditions can be improved, and it is possible to obtain non-pollutant synthetic fuels by gasification and liquefaction where deposits are sufficiently large. In the case of oil and gas, improved exploitation and recovery techniques can help to step up considerably the exploitation of reserves. There is too little awareness of the fact that on average only about 30% of oil is actually brought forth; improved techniques could raise this yield to 60% by the end of the 1980s, which in the case of the United States alone would increase reserves from 15 000 to 25 000 million barrels. Likewise, deep-drilling in the ocean beds could give known reserves a new dimension. On top of all this, new forms of energy exist and are being developed and should be commercially viable in the medium or long term.

It seems, therefore, that in the long term it will be possible to satisfy world energy requirements. There are, however, a number of short-term problems and the solutions vary considerably from one part of the world to another.

... and a European problem

Europe calls on the rest of the world for more than 60% of its energy requirements, which consist almost entirely of oil. It is therefore particularly vulnerable from the supply angle and this energy dependence has inevitable economic, social and political consequences. It is therefore quite natural that Europe should be acutely aware of the unavoidable interdependence between energy-exporting and energy-importing countries, and that the European Community should endeavour to further its cooperation with oil-producing countries, especially in the Near East.

However, our oil imports are expensive and we pay for them in foreign currency. We also know that, as shown above, world oil resources are not inexhaustible. Lastly, and perhaps most important, the security of energy supply which is vital to the European economy necessitates a certain diversification of imported primary energy and, in consequence, of traditional suppliers.

Although there is no question of Europe aiming at self-sufficiency - which would not be possible in any case - Member States should try to evolve a strategy which makes them less dependent on the outside and better able to keep a balance between their various energy sources. In other words, to ensure short- and long-term security of energy supply.

The objectives adopted by the Member States in this respect should mean that by 1985 the Community will depend on imports for only 50%, and possibly no more than 40%, of its energy. Oil should then account for only 41-49% of the total, the proportion of imported oil dropping to 75% or even 70%. On the other hand, the share of natural gas should increase from the present 11% to 18% or 25% as a result of Community production being stepped up and imports being diversified to a greater extent. The decline in coal consumption will be halted and production should stay at its 1973 level until 1985.

Notwithstanding the efforts being made throughout Europe, which are to receive a fresh impulse, new energy sources - such as geothermal energy, solar energy, wind energy, and in particular thermonuclear fusion - are unlikely to make a significant contribution to the energy balance in Europe in the foreseeable future. Meanwhile, European countries are being obliged to turn to nuclear energy, especially as, with oil the price it now is, the former affords appreciable savings. According to Commission estimates, electricity produced by a light-water nuclear reactor costs .017 dollars per kilowatt-hour. By way of comparison, electricity produced by an oil-fired power station (at 11 dollars a barrel in September 1975) costs .027 dollars per kilowatt-hour. For electricity to be competitive, the price of fuel oil would have to be 5-7 dollars a barrel. And it is nowhere near that.

According to present forecasts, then, nuclear energy should by 1985 be supplying 13-16% of the energy requirements and accounting for about half the electricity production of the Community countries.

Naturally, if the economic situation evolves in such a way as to bring about a drop in energy demand in Europe, less nuclear energy will be required and it will then be possible to slow down the currently planned rate of expansion in the use of nuclear energy. Similarly, the role which nuclear energy is expected to play may be reviewed by the Community if a technological breakthrough were to make other new sources of energy, such as solar energy or geothermal energy, sufficiently accessible.

A nuclear action plan for the European Community

To keep pace with development of nuclear energy which is taking place in most of the Community countries, the European Commission has drawn up an overall nuclear plan for the Community, to harmonize, amplify and reinforce the plans which have already been embarked upon by undertakings or Government in the Member States.

One of the aims is, of course, to ensure that "supply lines will be maintained", i.e., that the European nuclear industry will be able to furnish the necessary equipment, that European research will be able to improve present techniques and that there will be fuel available for the reactors.

The plan is also, and above all, designed to ensure that the planned expansion in the use of nuclear energy in the Community will be accompanied by very strict measures to protect the health of the general public and safeguard the environment. For this purpose the European Commission is undertaking various activities to supplement what is being done in the Member States, and these come under five main headings:

(i) Protection of the health of workers and of the general public against ionizing radiation;

(ii) Protection of the environment, particularly against the effects of thermal discharges from nuclear power stations and by processing and immobilizing radioactive waste;

(iii) Operative reliability of the actual plant components;

(iv) Transport of radioactive materials;

(v) Supervision of fissionable materials used in non-military nuclear installations in the Community.

II. THE POWERS OF THE EUROPEAN COMMUNITY AND THEIR LIMITS

Nuclear facilities for peaceful purposes are generally built by undertakings, whether public or private, either because their object is to produce and sell electricity (like the EDF in France, the ENEL in Italy, the CEGB in the United Kingdom or the RWE in Germany), and feel that it is commercially appropriate to produce this electricity from nuclear energy, or because they consume large quantities of electricity in their industrial activities and prefer to produce their own. In either case the choice of nuclear energy in preference to another energy source is a matter of discretion, based on considerations of profitability.

It is accordingly the undertakings themselves that determine the power and other technical features of the nuclear generating plants they want to construct, and it is they who choose where to locate them.

Of course, the investment involved must have the prior authorization of the national authorities. Hence it is the governments who have the final say on the installation of nuclear power plants and the rate of development of nuclear energy in each country, often after consulting regional or local authorities or with their agreement.

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The Euratom Treaty, signed by the nine Member States of the European Economic Community, assigns to the Community the dual task of promoting the development of nuclear energy in Europe whilst ensuring that man and his environment are protected against the risks associated with the use of nuclear energy.

In order to encourage the development of nuclear industries, the European Commission has since 1958 carried out a number of research projects in the field of atomic science. It undertakes the dissemination of nuclear information among the various interested bodies, facilitates investment, sometimes involving itself in the process; it attends to the supply and supervises the use of nuclear fuel in the Community. It also publishes periodical illustrative programmes on Community nuclear energy objectives and on whatever investments are needed to achieve them.

Undertakings have to inform the Commission of their nuclear investment projects three months before work is due to commence or the first construction contracts signed. The Commission examines each project to ensure that it conforms with the general objectives of the Community.

This examination usually leads to technical discussions with the investors, after which the Commission communicates its opinion to the government concerned. This Commission opinion is not binding on the governments, and therefore not on the undertakings either; in practice, the Commission has hitherto always been able to approve a project after any initial amendments which it may have secured in discussion with the investor when examining the matter. However, the three-month period specified in the Euratom Treaty is extremely short and it will no doubt be necessary in the near future to consider the question of extending it.

Although the Community basically plays a consultative role in nuclear investment, it is much more active in the legislative field where health protection is concerned. An entire chapter of the Euratom Treaty is devoted to the subject (the text of which is reproduced in Annex I) and the respective responsibilities of the governments and the Community are clearly defined in it. For instance, it is the Commission's task, after discussion with European experts, to formulate radiation protection standards, which, after being approved by the Council of Ministers, become mandatory for the Nine Member States. To give scientific backing to these standards, the Community is developing a radiation protection research programme, which is aimed at studying the effects of ionizing radiation on man as well as the biological and ecological consequences of the nuclear industry's activity. This programme will provide the objective scientific information necessary for accurate assessment of the nuclear hazard, and for laying down Community radiation protection standards.

The national governments are responsible for ensuring that these standards are complied with. They must set up permanent machinery to monitor the level of radioactivity within their territory and must send their findings to the Commission. They are also required to ask for its opinion on any project for disposing of radioactive waste within their territory, especially if such waste originates from nuclear plants. Here again the Commission's opinion on the risks of radioactive contamination from a projected plant has always been complied with by the national authorities and by undertakings. But it should be emphasized that the governments have the final responsibility for authorizing or not authorizing nuclear facilities in their territory and for deciding that they are to be sited in one place rather than another.

The Commission's tasks do not end once the nuclear plant is in operation. Under the Euratom Treaty the Commission is responsible for checking that fissible material is used for peaceful purposes and that none of it is diverted to any other use. These safeguards are applied in all non-military nuclear installations in the Community.

III. COMMUNITY ACTIVITY

1. HEALTH PROTECTION

In the mind of the general public, nuclear energy is still associated with its original sin - the memory of Hiroshima. To be sure, a nuclear reactor is not a bomb, but for many people the release of atomic energy has for a long time had an alarming and sometimes even a diabolical aspect. Thus, from the outset, the lawmakers have hedged the development of nuclear energy around with safety standards so strict that "accidents at work" occur far less frequently in this sector of industry than in any other.

The Euratom Treaty lays upon the European Commission the task of protecting man against the risks inherent in the use of nuclear energy. Accordingly, the Commission conducts a major programme of research on radiation protection; it lays down radiation protection standards; it undertakes the study and prevention of contamination due to waste from nuclear installations; and it organizes the monitoring of background radioactivity levels.

(a) The Community programme of radiation protection research

It is only possible to prevent danger from radiation and to eliminate or attenuate the harmful effects if scientific research can determine the direct or indirect links between nuclear energy and human health, and between the radiation dose received and the possible effect on the organism. Virtually since the inception of the Community, the Commission has been organizing extensive research on a European scale into radiation protection. Since 1960 the Six - and later the Nine - Member States of the Community have all helped to draft and implement this programme.

This research into radiation protection has resulted in the establishment of "permissible" radiation levels for workers and the general public, with a wide safety margin. More has been learnt about how radiation affects living matter, so that today practitioners are better able to treat injuries in the event of an accident. It is perhaps worthwhile to quote some examples of Community action in this field:

(i) Epidemiological studies, with the Commission's assistance, of groups of patients treated by radioisotopes have provided valuable information on how the effects of irradiation vary according to age and the dose received.

(ii) Extensive interdisciplinary research - encompassing human biology, ecology, soil science, agronomic science, dietetics, and so on - in the widely varying natural regions of the Community has provided greater insight into the transfer and concentration of radionuclides in the food chain. The summary report compiled from these results is probably unique in the world.

(iii) Various activities have caused formerly accepted theories on the toxicology of certain ingested radioactive elements, notably plutonium, transuranic elements and cerium, to be revised completely. These elements affect the metabolism in different ways and with different toxicological effects, depending on the precise way in which they were ingested. The results of these projects mean that nuclear workers now enjoy considerably more safety.

(iv) The treatment of serious irradiation liable to occur in nuclear accidents has been the subject of joint cooperative study by several European institutes. Its main aspects - hematology and immunology - have been investigated in a series of research projects which have led to marked improvements in the treatment of such cases.

(v) Studies on the primary effects of radiation on living matter and work on microdosimetry have been made in Europe with the help of the Commission. The initial and local stages, which are critical in the deterioration process triggered off by ionizing radiation, are of primary importance as they condition the nature of these events, which are precisely those which give rise to the radiological damage.

With the prospect of increased use of nuclear energy, two chapters of the Community programme on radiation protection are especially important. The first concerns radiotoxicology, and particularly long-lived radionuclides like plutonium. The second is directly concerned with environmental protection and deals with research into the ecological effects of radiation, i.e., the joint study of the absorption of radioactive elements and associated pollutants into the various constituent parts of the environment and the effect of heating water on the behaviour of radionuclides in the marine environment.

A Community project planned for the next few years is the establishment of parameters for an overall assessment of the exposure of the general public to radiation. Another is the development of ecological models for pollution, and its effect on health, in international rivers like the Rhine, the Meuse, the Scheldt and the Moselle, as well as in the coastal waters of the North Sea, the Atlantic and the Mediterranean. In addition, DNA lesions due to radiation will be analysed, along with the repair system, to define the role, the mode of action and the requirements of the various repair mechanisms which are triggered off in an irradiated cell. The data, when collated and finally adjusted on micro-organisms and animal cells, may later on prove extrapolable and contribute to the safeguarding of human cells.

(b) Community radiation protection standards

Under the Euratom Treaty, the Commission is responsible for working out radiation protection standards. These standards are determined in the light of the results of the Community research programme and are discussed with Community experts. On a proposal from the Commission, they are published as Community directives with mandatory force. The Member States are not allowed to exceed the maximum irradiation levels laid down for workers and the general public. Both groups are therefore protected against the risk of irradiation from any source or in any form.

There are also Community standards to define the monitoring and surveillance procedures which have to be carried out both inside and outside nuclear plants to protect both the public and the environment.

These standards are obviously reviewed from time to time as scientific knowledge develops.

The Commission, however, not only draws up these standards but ensures that they are incorporated into the laws of the Member States. It also organizes regular discussions on radiation protection with doctors, physicists and ecologists and with representatives of both sides of industry and nuclear plant managers to inform them of the standards adopted and how they will be applied in practice. There is continuous contact between the Commission and the various occupational and social groups affected by the problems of nuclear safety. The Commission prepares and circulates on a wide scale manuals on specific problems like surveillance around nuclear sites or the development of techniques to measure doses of irradiation absorbed by individuals.

(c) Radioactive waste from nuclear facilities

The government of any Member State in which the setting-up of a facility involving the disposal of radioactive waste is being planned must inform the European Commission accordingly. The Commission has six months to ascertain whether there is a risk of radioactive contamination. It is then up to the national governments to decide whether to authorize or prohibit the proposed facility in the light of the Commission's opinion.

As it is automatically consulted on any nuclear installation projects in the Community, the Commission staff were able to assess the amount of radioactive waste discharged from nuclear power plants in the Community between 1969 and 1972. From this assessment it emerged that, generally speaking, radioactive waste from nuclear power plants imparts doses which are only 1% below the limits set by the Community basic standards for the general public. In other words, between 1969 and 1972, radioactivity from nuclear power plants in the Community was estimated at less than half the natural radioactivity.

(d) Monitoring background radioactivity

It is too often forgotten that there is such a thing as natural radioactivity. It has been calculated that each individual absorbs from 80 to 500 millirems* of natural irradiation each year, depending on where he lives. There is also some artificial irradiation, which in Europe originates as to 55-70 millirems yearly from medical applications of radioactivity.

So far, we have adapted very well to the artificial radioactivity which man has added to natural radioactivity. Continuous monitoring is still required, however, to ensure that the limits acceptable to our organisms are not exceeded. It is the governments of the Member States which are responsible for the continuous monitoring of the level of radioactivity in the atmosphere, waters and soil and also for ensuring that the Community health protection standards are observed within their territory; however, they communicate the results of their monitoring to the Commission, which in turn publishes a comparative analysis of this information for the whole of the Community in summary reports.

If the Commission discovers any anomaly, it can call upon the particular government to take necessary steps immediately to ensure that the health regulations are complied with.

2. PROTECTION OF THE ENVIRONMENT

A nuclear facility can affect the environment not only through its radioactive effluents (and it has already been shown how the European Community monitors these effects very strictly) but also, and particularly, through its thermal discharges, the radioactive waste it produces and the problems involved in decommissioning a plant once it has ceased to operate. In these areas too, the Commission is coordinating activity within the Nine, particularly under the Community programme on protection of the environment.

(a) Thermal discharge

While all electric power stations give off heat, thermal generating stations discharge the most heat to the atmosphere. A conventional power station, burning fossil fuel (coal or fuel oil), releases over 60% of the total combustion energy into the water or the air. This percentage reaches about 67% in nuclear power stations, even the most recent concepts. Thus a 1000 MWe nuclear power station cooled by the total-loss system gives off 40-50 cubic metres of water per second approximately 10^{o} above its normal temperature.

*A rem is the dose of radiation imparted by a certain quantity of energy (one millionth of a kilogram metre) to one gram of living tissue.

This heating of water courses, lakes or coastal waters used to cool power stations is liable to disturb the ecological balance of the water systems, even if the cooling water is "cleaned" before disposal to avoid risks of pollution of the natural environment by the products used to prevent damage to the piping systems through which the water flows.

So as not to overheat natural waterways, nuclear plant constructors have developed various processes for circulating the cooling water to offset the disadvantages of the conventional total-loss cooling system, where water passed through the condenser once only before being discharged to the environment.

Two systems are used at present: the partial-loss circuit, where the cooling water - which is heated while being passed through the condenser - is conveyed to a cooling tower, where it is brought into contact with the air by sprinkling, thus transferring its heat to the atmosphere (wet tower); and the no-loss system, where the cooling water passes through a closed system between the condenser and the tower, where the heat is directly transferred from the water to the air through an arrangement of pipes in the tower (dry tower).

Although these cooling towers reduce the heat of the cooling water considerably, they do not by any means adorn the landscape - a 1000 MWe nuclear plant covering about 7 ha would need two towers each about 140 m high. The wet towers also evaporate off huge quantities of make-up water: about 1.1 m^3 per second in a 1000 MWe plant and the resultant plume of smoke can affect the micro-climate by causing local fog to form and reducing the amount of sunlight. Dry cooling towers, on the other hand, although they do not give rise to the make-up water consumption problems, are far larger than wet cooling towers (and therefore more expensive) and reduce the total output of the electric power station quite considerably. Furthermore, their technological development is still in its infancy.

The Commission has therefore set up a small group of Community experts to study the problems of cooling towers both from a technological point of view and with a view to putting the hot water discharged by power plants to use in agriculture, horticulture or fish-rearing.

Community experts are also working towards giving the national authorities of the Member States - who have the final responsibility in these matters - guidance on choosing sites for plant construction and the appropriate cooling systems.

More needs to be known about the effects of thermal waste on the environment before the European Commission can lay down criteria (i.e., in respect of dose/effect relationships) and then propose standards for thermal waste discharge at Community level. A study made for the Commission has already shown fairly accurately the effects of heating on the various characteristics of water (oxygen content, stratification, and so on) on marine ecosystems (flora and fauna) and on the toxicity of certain pollutants.

However, comparative studies of areas in the Mediterranean with similar ecological systems but different temperatures (13°C on the one hand and 23°C on the other) have so far not revealed any startling changes in marine ecosystems.

This work is still going on with the object of gaining a better grip of the problems of thermal discharge which beset the planned development of several nuclear facilities within the Community.

(b) Radioactive waste

The production of radioactive waste obviously continues to increase as the nuclear industry develops. What can be done with this waste, especially if it is highly radioactive with a lifetime which may in some cases extend to hundreds of thousands of years? Isolate and destroy it. But how?

Every undertaking and every country which has a nuclear facility is concerned and is seeking solutions to a problem which obviously affects the public interest. There is a clear need to pool efforts throughout Europe, particularly as the industries which process irradiated fuel are the main producers of radioactive waste and their activities transcend national frontiers considerably.

The European Community is therefore conducting a number of projects in this field, both under contracts with various laboratories in the Community and in its own Research Centre (at Ispra, Italy). The basic aim, within the framework of an overall programme, is to assess the different methods of processing and storing radioactive waste and to develop a global strategy for waste management.

There are studies on reducing the volume of waste, how best to immobilize liquid waste to avoid the risk of leakage; how to separate long-lived emitters from other radioactive waste; how to burn off waste in the facility; what materials to use for containing waste; and the long-term stability of waste encased in vitreous matrices.

The Community programme is also investigating the storage of waste in artificial structures and the disposal of waste in geological formations. It even goes so far as to consider the construction of experimental storage sites.

The Community programme is also examining the legal, administrative and financial framework for the storage and disposal of radioactive waste in the European Community. Problems which cannot be solved under the laws as they stand at present will have to be examined and the necessary additional framework drawn up. Community projects are obviously very closely coordinated with work carried out at national level.

(c) The decommissioning of nuclear power stations

Inevitably every nuclear power station will cease to operate some time or other. What happens then?

Plants which have already been taken out of service or which have been studied from this standpoint have so far either been only experimental installations or belonged to abandoned concepts. Information on the decommissioning of large commercial installations which is planned under the present nuclear electricity programmes, on the other hand, is theoretical and very incomplete. Although these plants should not in the normal course be taken out of service for several decades, the problems involved should be examined without delay.

The Commission has therefore undertaken a study on large LWR power stations (900-1300 MWe) at the end of their normal working life. These power stations form the bulk of the present nuclear programmes and are already sufficiently standardized for them to be the subject of general study. There are several different ways of decommissioning them and it is important to assess the safety of each method and, accordingly, the system of supervision which will have to be laid down:

(i) The plant could be left in such a condition that it could be entered safely, without dismantling the equipment maintaining the leaktightness of the containment.

(ii) The superstructure could be demolished, leaving the foundations and other concrete underground structures in place. The site could then be applied only to limited uses, but the concrete bunkers could be employed for the storage of radioactive components.

(iii) The plant could be demolished completely, including the foundations, and the land freely used for any other purpose.

After studying the advantages and disadvantages of each of these methods, the Commission will be in a position to put forward proposals urging nuclear power station constructors to bear in mind, right from the design stage, the future decommissioning of their plants.

3. NUCLEAR PLANT SAFETY

With the development of nuclear energy, not only do man and the environment have to be protected against radiation, but the installations themselves have to be completely reliable from the safety angle. Strict standards, stricter than in most other industries, are applied to allow for any eventuality, however remote: earthquakes, explosions in a nearby chemical factory, aircraft crashes and even exceptional events such as war, political unrest or attempted sabotage could upset the proper functioning of the plant.

The national authorities and the operators and constructors of nuclear installations are naturally very conscious of these needs and make every effort to meet them. They work within the scope of laws and administrative procedures specific to each country, which are subject to constant change.

The European Commission, for its part, is proceeding along two main lines of action in the field of safety.

First of all, of course, it is harmonizing the techniques employed in the Member States for standardizing the equipment used and coordinating the research performed in Community laboratories with the aim of improving existing technologies in the field of nuclear reactor safety. In addition, reciprocal information is supplied on the approval legislation and administrative procedures in force in the various Community countries. A preliminary report on the present state of these laws and procedures was published at the beginning of 1975 (see Annex 2).

Secondly, the Commission uses, in the Community Research Centre at Ispra (in Italy), large-scale technological installations to make a thorough-going analysis of possible accidents and their causes and to develop detection methods to prevent failures of essential reactor components (material or structural).

The Commission also gives technical support to nuclear plants operators and makes its knowhow and advice available to help them to improve plant safety.

Here too, all Community projects are coordinated with national efforts by a Committee made up of representatives of the Commission and of Member States. There are in addition Community working parties on the various reactor types, whose members are drawn from the Commission, the responsible national authorities and repnesentatives of the plant constructors and operators.

As light-water reactors predominate within the Community, the Commission has updated all the research programmes in progress; it has further had a classification compiled which will make for a systematic and faster exchange of information on programmes under way or planned within the Community. This system should also facilitate exchanges of information with the United States or Japan.

In the case of fast reactors, which are still at the prototype stage, a list of safety research and development projects has been drawn up, along with a list of typical accidents.

4. TRANSPORTING RADIOACTIVE MATERIALS

The quantity of irradiated fuels transported doubles every two years; it may well be up to 800 tonnes by 1980 and 20 000 tonnes by the end of the century. Understandably, the Commission is making every effort to ensure the best possible safety and transport conditions in spite of the massive increase in the carriage of radioactive materials. There are several problems involved: precautions must be taken against radiation during routine transit; the risk of serious accidents, however small, involving fissible or radioactive materials must be avoided at all costs; and lastly, precautions must be taken against deliberate acts of sabotage or theft.

The Commission has made a joint study of these problems with the responsible national authorities, the International Atomic Energy Agency (IAEA) and the United Nations Economic Commission for Europe.

The IAEA, which operates within the framework of the United Nations and to which all Member States belong, has drawn up strict regulations on packaging, which forms the basis of safety during transport. Packaging is therefore designed to minimize the risk of dangerous radiation under normal conditions of carriage and the possibility of leakage even in a serious accident. Packaging should also reduce the risk of a criticality incident, i.e., a spontaneous chain reaction. Thus it is clear that a simple "lead cask" (a container for irradiated fuels) can weigh up to 100 tonnes and cost 250 000 units of account (1 u.a. = US $1.3) and it can take up to four years to design and manufacture.

But there are other safety problems involved in transporting radioactive material in the Community, especially if traffic increases as expected. The Commission has therefore recently taken a number of measures, the aims of which are to:

(i) solve economic and safety problems caused by the large increase in traffic;

(ii) harmonize approval procedures and transport formalities;

(iii) provide services capable of coping with a simple mechanical failure or a serious nuclear incident during air, sea, rail or road transport;

(iv) give all handlers of radioactive consignments the necessary health and safety training;

(v) secure a common approach by the Member States in all organizations concerned with international transport.

The Commission has also begun studies on protecting nuclear materials against theft and sabotage and on the agreements for compensation in the event of nuclear incidents whether in the plant or during transport.

5. SUPERVISING THE USE OF FISSILE MATERIALS

Uranium and other radioactive fissile materials are not just ordinary substances. It is essential that they should not be diverted to uses other than those declared or to purposes other than peaceful ends for which the undertakings intend them. The nine Member States of the Community have entrusted the Commission with the responsibility for such safeguarding.

The Commission departments responsible are in Luxembourg and every week they send out inspectors who have access at all reasonable times and all places to information which has to be provided by all persons or undertakings using or operating material, equipment or installations for peaceful purposes in the nuclear field.

Every undertaking in the Community which handles fissile materials for peaceful purposes must notify the Commission of the plans and capacity of its installations, the nature of the materials used and produced, the technical processes applied and the methods used to measure and check the quantity and quality of the material held in the plant. It must also give particulars of movements of stocks, the sources of its purchases and the destination of its sales.

With all this information the Commission specialists can keep permanent accounting records of fissile materials, with accounts broken down by installation and by material.

Installations are inspected on two levels - accounting and technical. First, the inspectors call for the accounts of materials held by the undertaking and the documents from its suppliers and transporters; they then draw up an accounting "inventory" of the materials stored in the plant and check this against the statements made by the undertaking to the Commission. They also verify that the basic characteristics of the installation conform with those declared to the Commission and check that the materials and finished products correspond to the uses as declared.

The safeguards exercised by the Commission on the peaceful use of fissile materials use techniques and methods developed in the laboratories of the Community Research Centre, especially at Ispra, Italy. Since 1969, some thirty research scientists and technicians have been working on the improvement of the safeguarding techniques, cooperating with the specialist organizations belonging to the European Safeguards Research and Development Association (ESARDA).

When the United Nations Treaty on the Non-Proliferation of Nuclear Weapons (NPT) made the International Atomic Energy Agency responsible for making similar inspections in the NPT signatory States, those of the latter which were Member States of the European Community continued to be subject to the Commission's safeguards as these were recognized by the international community.

6. AVERAGE ANNUAL EXPENDITURE OF THE COMMISSION OF THE EUROPEAN COMMUNITIES ON NUCLEAR SAFETY (in units of account*)

The various activities conducted by the European Community in the field of nuclear safety at Community level (as opposed to purely national activity) account for a total of 24 980 000 units of account each year (including staff expenditure), which is included in the Commission Budget under various chapters.

This is only an approximate average for 1975, as some projects extend over several years and it is very difficult to divide them up accurately into twelve-monthly periods. The following table gives a breakdown by major sectors and is again approximate as some projects concern two or three sectors at the same time:

Health protection	4 615 000 u.a.
Protection of the environment	6 775 000 u.a.
Plant safety	9 300 000 u.a.
Supervision of the use of fissile materials	4 290 000 u.a.
Total	24 980 000 u.a.

*1 European unit of account equals approximately $1.40, DM 3.66, Dkr 7.50, FF 5.55, £0.42, Lit 625, Bfrs 50, Fl 3.62.

IV. OTHER NEW ENERGY SOURCES

In the future, other new energy sources may make a major contribution to world energy supply and at the same time considerably alter the pattern of international economic policies. Throughout the world, numerous research programmes are being undertaken for the purpose of studying new energy sources and ensuring that they are economically sound. Man has always dreamed of taming the wind, ruling the waves, and harnessing the sun. Archimedes and Leonardo de Vinci tried, so did Cyrano de Bergerac. But modern technological resources make practical results more likely, at least in some fields.

The European Commission is making its own contribution and is concentrating on four particularly promising fields: thermonuclear fusion, solar energy, geothermal energy and hydrogen production.

(a) Thermonuclear fusion

Along with the United States and the USSR, the European Community is well to the forefront in this field, with about 3 000 people, including 700 physicists and engineers, working in the Community to develop new energy sources based on the fusion of light atoms (as opposed to the traditional method of splitting heavy atoms) to produce nuclear energy. The basic materials for this new form of energy are deuterium and lithium; these are not radioactive, can both be found in unlimited quantities and are relatively easy to control from an ecological point of view.

This research programme was started in 1959 and is now fully integrated at the Community level. It takes in all the research being done in the Member States, thus ensuring total coordination and maximum efficiency.

The main problem for researchers is to develop devices which can contain matter at temperatures of several hundred million degrees for the fairly long periods necessary. At these temperatures, matter is in a state of plasma and cannot be placed in contact with any form of material containment: it has to be contained in magnetic vessels with very powerful magnetic fields. The Community recently decided to build a new machine for this purpose by 1980, called the JET (Joint European Torus), larger than the one in operation at Fontenay-aux-Roses (France), which over the last few months has given the Community the best results achieved in the world by this kind of machine. The development of the JET will be an essential stage in the development of this nuclear fusion process, which some experts consider could be applied on an industrial scale as early as the year 2000.

(b) Solar energy

Solar energy is available in abundant quantities over a large area, and does not seem to harm the environment in any way. Since the invention of mirrors and lenses, many principles and basic techniques for making use of solar energy have been demonstrated and experimented with. More recently, pilot systems have shown some very interesting results.

In the laboratories of the Community Research Centre at Ispra, Italy, and in other European laboratories, the Commission has been engaged in a variety of scientific projects to develop an economic method of harnessing solar energy. European research scientists have been studying how the sun can help our daily lives, and how solar energy can be used in the home to operate heating, lighting and household appliances. Other scientists have been examining how solar energy can be converted into other forms which can be stored more easily. Others again have been designing a demonstration plant, by which solar energy can be transformed into electricity.

These projects will be backed up by a new programme which has just been adopted by the Community.

(c) Geothermal energy

Italy is at present the only country in the Community which produces electricity from geothermal energy. The plant is in the Lardarello region and has an output of about 400 MWe. More ambitious projects could be undertaken, however, by concentrating on deep-lying geology, in order to discover new geothermal resources and to develop new techniques for extracting the heat from hot rocks.

The research programme developed by the European Community should by 1978 improve surveying techniques, perfect the use of hot-water and steam sources, collate the available geothermal data and provide better training for European specialists.

(d) Hydrogen

Hydrogen is a particularly convenient medium for storing and transporting energy. Moreover, it gives off neither ash nor pollution when it burns. It can be manufactured from water, stored and distributed in gas or liquid form, or bonded with a metal. It can then be reconverted into electricity in a fuel cell, burned in a conventional engine or burned to produce heat. Hydrogen can also be used as a raw material in the chemical, petrochemical and metallurgical industries.

The problem is to manufacture hydrogen at an acceptable cost by electrolysis or by chemical reaction cycles (from the heat given off by a high-temperature nuclear reactor, for example). This would provide an alternative solution to an economy which at present relies too heavily on electricity.

For several years now, the Community Research Centre at Ispra has been investigating the production of hydrogen by the thermochemical decomposition of water, with a skill recognized throughout the world. The results obtained in Ispra have formed the basis of other research projects being conducted in other European laboratories. These are to be developed, over the next few years, involving some 70 research scientists and technicians in the Commission's laboratories.

In addition, the new energy research programme which the Commission has just adopted provides for research into all fields concerned with the production and use of hydrogen, and for the participation of many other specialized European laboratories.

EURATOM TREATY

Chapter III

HEALTH AND SAFETY

Article 30

Basic standards shall be laid down within the Community for the protection of the health of workers and the general public against the dangers arising from ionizing radiations.

The expression "basic standards" means:

(a) maximum permissible doses compatible with adequate safety;

(b) maximum permissible levels of exposure and contamination;

(c) the fundamental principles governing the health surveillance of workers.

Article 31

The basic standards shall be worked out by the Commission after it has obtained the opinion of a group of persons appointed by the Scientific and Technical Committee from among scientific experts, and in particular public health experts, in the Member States. The Commission shall obtain the opinion of the Economic and Social Committee on these basic standards.

After consulting the Assembly the Council shall, on a proposal from the Commission, which shall forward to it the opinions obtained from these Committees, establish the basic standards; the Council shall act by a qualified majority.

Article 32

At the request of the Commission or of a Member State, the basic standards may be revised or supplemented in accordance with the procedure laid down in Article 31.

The Commission shall examine any request made by a Member State.

Article 33

Each Member State shall lay down the appropriate provisions, whether by legislation, regulation or administrative action, to ensure compliance with the basic standards which have been established and shall take the necessary measures with regard to teaching, education and vocational training.

The Commission shall make appropriate recommendations for harmonizing the provisions applicable in this field in the Member States.

To this end, the Member States shall communicate to the Commission the provisions applicable at the date of entry into force of this Treaty and any subsequent draft provisions of the same kind.

Any recommendations the Commission may wish to issue with regard to such draft provisions shall be made within three months of the date on which such draft provisions are communicated.

Article 34

Any Member State in whose territories particularly dangerous experiments are to take place shall take additional health and safety measures, on which it shall first obtain the opinion of the Commission.

The assent of the Commission shall be required where the effects of such experiments are liable to affect the territories of other Member States.

Article 35

Each Member State shall establish the facilities necessary to carry out continuous monitoring of the level of radioactivity in the air, water and soil and to ensure compliance with the basic standards.

The Commission shall have the right of access to such facilities; it may verify their operation and efficiency.

Article 36

The appropriate authorities shall periodically communicate information on the checks referred to in Article 35 to the Commission so that it is kept informed of the level of radioactivity to which the public is exposed.

Article 37

Each Member State shall provide the Commission with such general data relating to any plan for the disposal of radioactive waste in whatever form as will make it possible to determine whether the implementation of such plan is liable to result in the radioactive contamination of the water, soil or airspace of another Member State.

The Commission shall deliver its opinion within six months, after consulting the group of experts referred to in Article 31.

Article 38

The Commission shall make recommendations to the Member States with regard to the level of radioactivity in the air, water and soil.

In cases of urgency, the Commission shall issue a directive requiring the Member State concerned to take, within a period laid down by the Commission, all necessary measures to prevent infringement of the basic standards and to ensure compliance with regulations.

Should the State in question fail to comply with the Commission directive within the period laid down, the Commission or any Member State concerned may forthwith, by way of derogation from Articles 141 and 142, bring the matter before the Court of Justice.

Article 39

The Commission shall set up within the framework of the Joint Nuclear Research Centre, as soon as the latter has been established, a health and safety documentation and study section.

This section shall in particular have the task of collecting the documentation and information referred to in Articles 33, 36 and 37 and of assisting the Commission in carrying out the tasks assigned to it by this Chapter.

COMMUNITY REFERENCE DOCUMENTS ON NUCLEAR SAFETY

1. Eighth General Report on the Activities of the European Communities	1974
2. Communication from the Commission to the Council on the Implementation of the "Guidelines and Priority Measures for a Community Energy Policy"	COM(74)10 final
3. A new energy policy strategy for the Community	Bulletin of the European Communities Supplement 4/74
4. Second illustrative nuclear programme for the Community	EUR 5011
5. 1974 Annual report on the Biology and Health Protection Programme	EUR 5332 d e f i n
6. List of Commission activities on the environment, agricultural and medical research, and activities relating to the Biology and Health Protection programme. Situation in May 1975	XII/75
7. Biology and Health Protection programme Research programme 1976-80	COM(75)351 final
8. Technical recommendations for monitoring the exposure of individuals to external radiation 1975	EUR 5287 e
9. Proceedings - Second symposium on neutron dosimetry in biology and medicine (Neuherberg/München, September 30-October 4, 1974, volumes I and II)	EUR 5273 d e f
10. Proceedings - Fourth symposium on microdosimetry (Verbania Pallanza (Italy) 24-28 September 1973, volumes I and II)	EUR 5122 d e f
11. Council Resolution of 3 March 1975 on energy and the environment (Official Journal of the European Communities)	OJ No C-168/2 25 July 1975
12. Programme on radioactive waste management and storage	COM(74)2285 final
13. Studies on the radioactive contamination of the sea - Annual Report 1972 edited by Mr Bernhardt (1974)	EUR 5271 e
14. Communication from the Commission to the Council on technological problems of nuclear safety	COM(75)60 final

15. The present and future situation of nuclear energy production and its associated industry - normal operation, accident prevention and mitigation, comparative risk assessment EUR 5001

16. Authorization procedure for the construction and operation of nuclear installations within the EEC Member States (1974) EUR 5284 e