The European Community and nuclear safety

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Contents

Photographs

The European Community and nuclear safety

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 without at the same time reducing the level of employment. It has increased output, and therefore shortened the working day.

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.

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.

Over the last 40 years, world energy consumption has increased at an annual rate of about 3.5 per cent 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 per cent and in Japan by more than 11 per cent 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.


Esso

Even though consumption in the more industrialized countries shows a certain degree of stagnation, there will be a vast increase in world energy requirements as the economies of the developing countries get off the ground.

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.

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. In the case of oil and gas, one can help to step up considerably the exploitation of reserves. There is too little awareness of the fact that on average only about 30 per cent of oil is actually brought forth; improved techniques could raised this yield to 60 per cent by the end of the 1980s. 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 a European problem

Europe calls on the rest of the world for more than 60 per cent 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 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.

The objectives adopted by the Member States in this respect should mean that by 1985 the Community will depend on imports for only 50 per cent, and possibly no more than 40 per cent, of its energy. Oil should then account for only 41-49 per cent of the total, the proportion of imported oil dropping to 75 per cent or even 70 per cent. On the other hand, the share of natural gas should increase from the present 11 per cent to 18 per cent or 25 per cent 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; with high oil prices it affords appreciable savings. According to Commission estimates, electricity produced by a light-water nuclear reactor costs .017 dollars per kilowatt-hour. Electricity produced by an oil-fired power station (at 11 dollars a barrel in September 1975) costs .027 dollars per kilowatt-hour.

According to present forecasts, then, nuclear energy should by 1985 be supplying 13-16 per cent 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 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

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 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 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:

— protection of the health of workers and of the general public against ionizing radiation;

- protection of the environment, particularly against the effects of thermal discharges from nuclear power stations and by processing and immobilizing radioactive waste;
- operative reliability of the actual plant components;
- transport of radioactive materials;
- supervision of fissionable materials used in non-military nuclear installations in the Community.

II. The Community powers and their limits

Nuclear facilities for peaceful purposes are generally built by undertakings, whether public or private. 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.

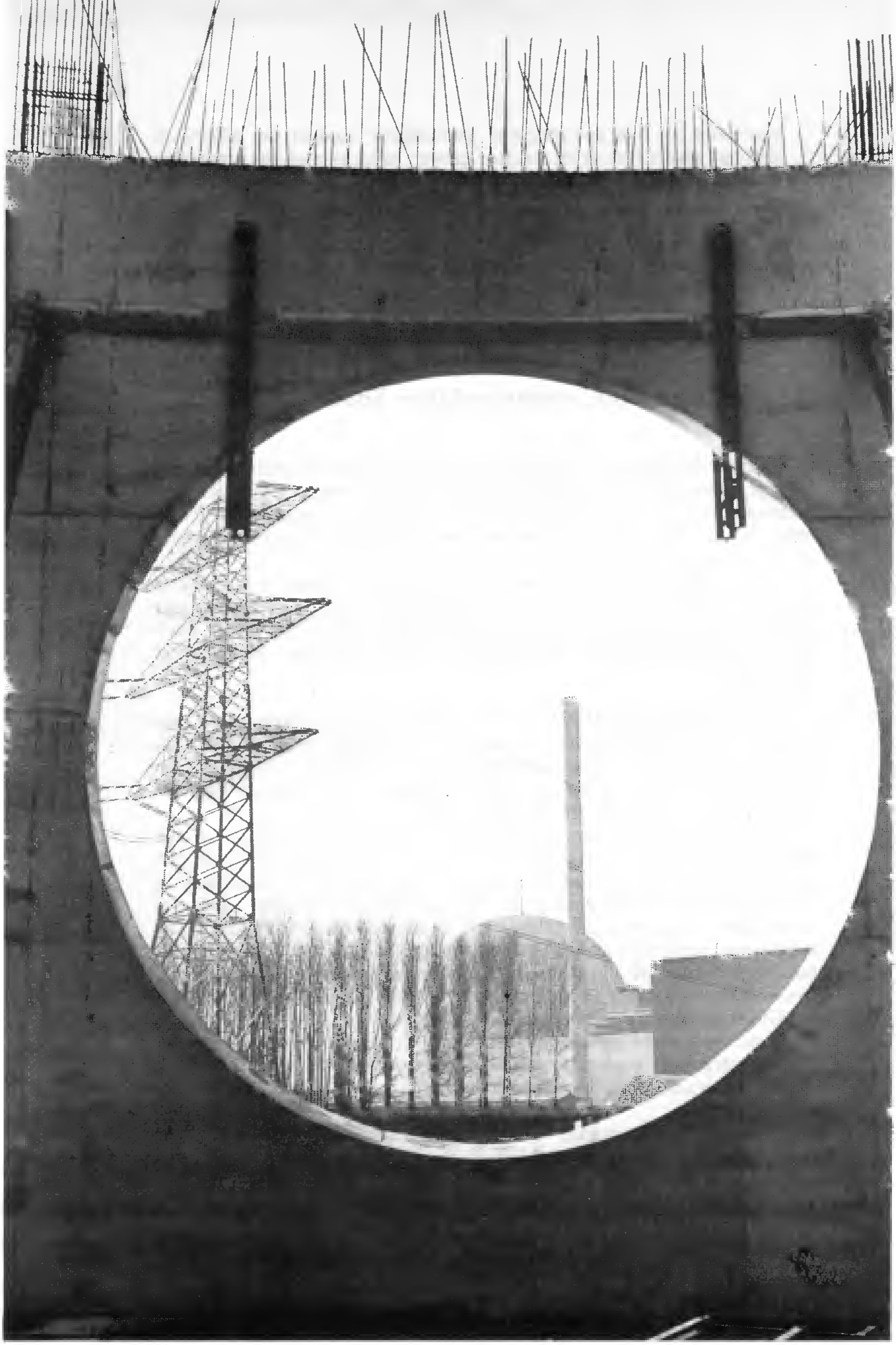
Of course, the investment involved must have the prior authorization of the governments, who have the final say on the installation of nuclear power plants and the rate of development of nuclear energy in each country, often after consulting regional or local authorities or with their agreement.

Signed by the nine Member States of the European Economic Community, the Euratom Treaty 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 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.

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, 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.

The 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.

The Commission's tasks do not end once the nuclear plant is in operation. 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.

"Permissible" radiation levels for workers and the general public, with a wide safety margin have been set. 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:

- epidemiological studies 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;

- extensive interdisciplinary research—encompassing human biology, ecology, soil science, agronomic science, dietetics, and so on—in the widely varying natural regions 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;

- 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;

- 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.

- studies on the primary effects of radiation on living matter and work on microdosimetry have been made. The initial and local stages, which are critical in the deterioration process triggered off by ionizing radiations, are of primary importance.

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.

b) Community radiation protection standards

Under the Euratom Treaty, the Commission is responsible for working out radiation protection standards. 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.

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.

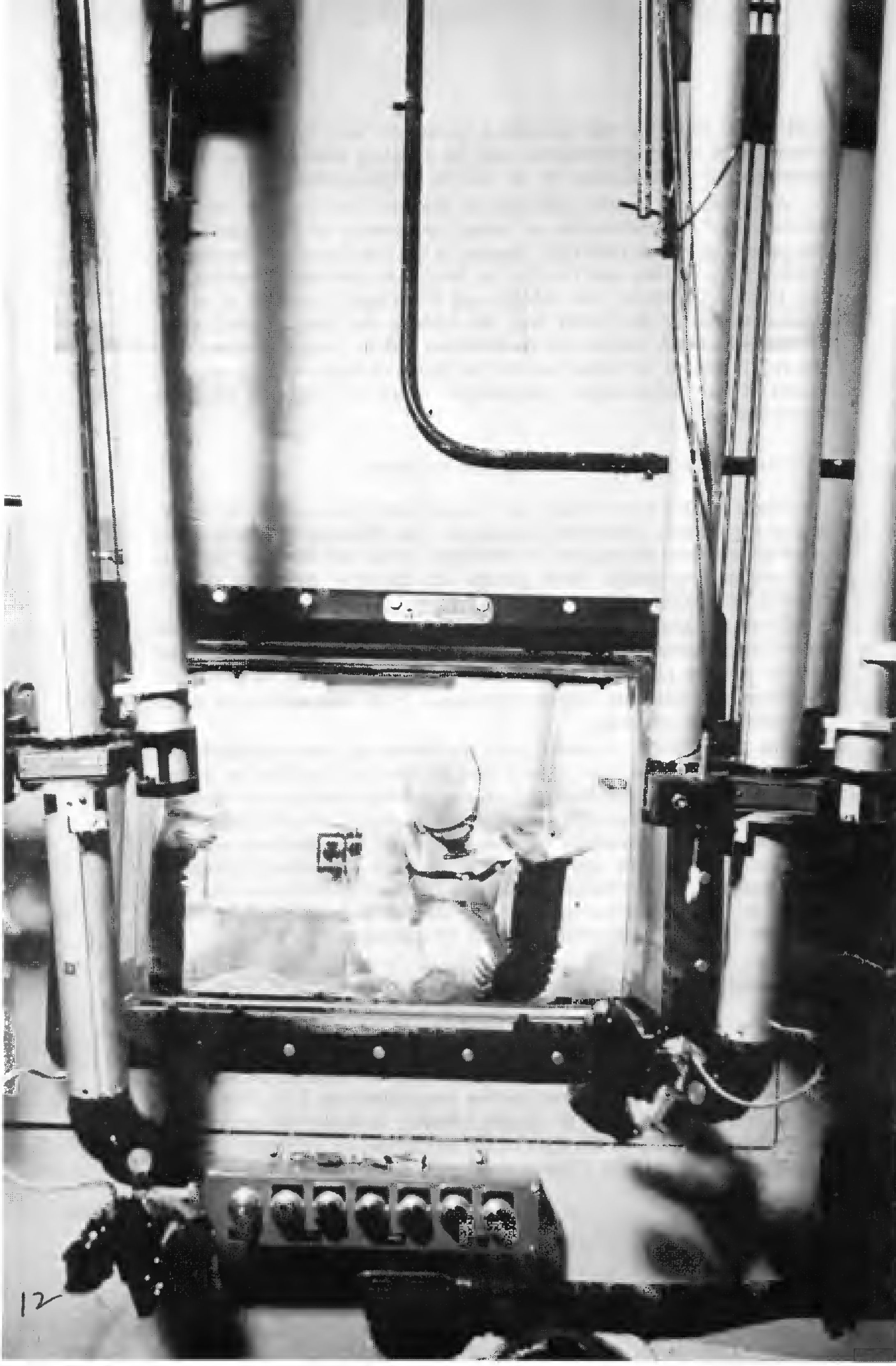
These standards are obviously reviewed from time to time as scientific knowledge develops.

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 side of industry and nuclear plant managers to inform them of the standards adopted and how they will be applied in practice. 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

When the setting-up of a facility involving the disposal of radioactive waste is being planned, the government concerned must inform the European Commission. 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 consulted the Commission could assess the amount of radio-



active waste discharged from nuclear power plants between 1969 and 1972. From this assessment it emerged that, generally speaking, waste imparts doses which are only 1 per cent 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 1 percent of 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 [1] 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. Environment protection

A nuclear facility can affect the environment not only through its radioactive effluents but also 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.

a) THERMAL DISCHARGE

While all electric power stations give off heat, thermal generating stations discharge the most heat to the atmosphere. A conventional

[1] 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.

power station, burning fossil fuel (coal or fuel oil), releases over 60 per cent of the total combustion energy into the water or the air. This percentage reaches about 67 per cent in nuclear power stations, even the most recent concepts. Thus a 1 000 MWe nuclear power station cooled by the total-loss system gives off 40-50 cubic metres of water per second approximately 10° above its normal temperature.

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. Nuclear plant constructors have also 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 1 000 MWe nuclear plant would need two towers each about 140 m high and cover about 7 ha. The wet towers also evaporate off huge quantities of make-up water: about 1.1 m^3 per second in a 1 000 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.

Work is under way to give national authorities—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. 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.

In addition, 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.

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 to thousands of years?

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).

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.

The Commission has therefore undertaken a study on large LWR power stations (900-1 300 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:

— the plant could be left in such a condition that it could be entered safely, without dismantling the equipment maintaining the leak-tightness of the containment;

— 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;

— 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 contructors 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 European Commission 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.

Secondly, the Commission uses in its Research Centre, 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 Commisison also gives technical support to 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 working parties on the various reactor types.

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. 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, 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 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 about £105,000.

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:

— solve economic and safety problems caused by the large increase in traffic;

— harmonize approval procedures and transport formalities;

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

— give all handlers of radioactive consignments the necessary health and safety training;

— 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.

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.

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 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 thus exercised on the peaceful use of fissile materials use techniques and methods developed in the laboratories of the Community Research Centre, especially at Ispra. 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. Commission expenditure on nuclear safety

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 [2].

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.

[2] Approximately £10.5 million.

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.

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.

In the laboratories of the Community Research Centre at Ispra, 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.

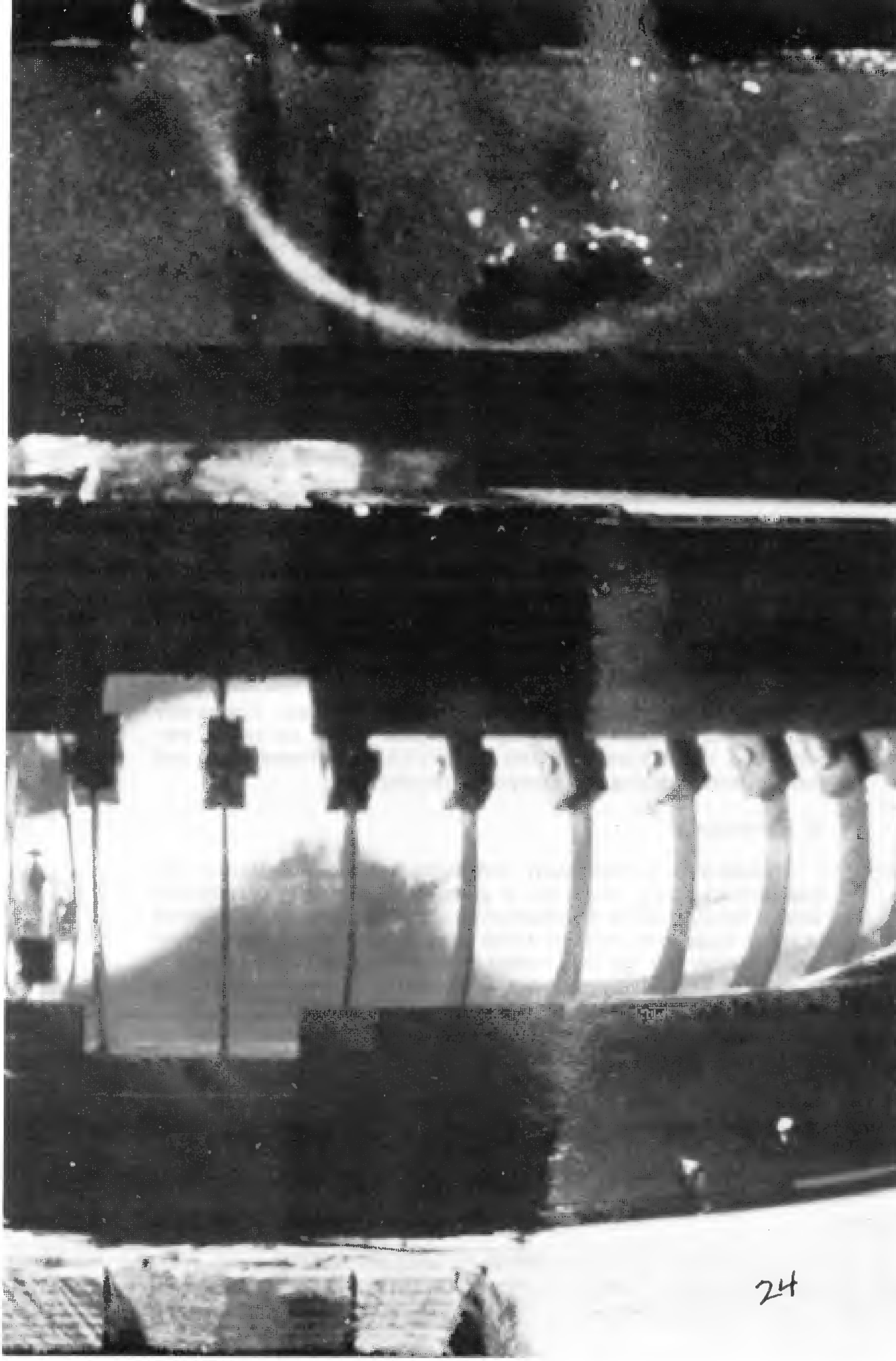
The research programme developed by the European Community should by 1978 improve surveying techniques, perfect the use of hot-water and steam sources, collate the available geothermal data and provide better training for European specialists.

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 has been investigating the production of hydrogen by the thermochemical decom-



position 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 European laboratories.

Community reference documents on nuclear safety

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4.	Second illustrative nuclear programme for the Community	EUR 5011
5.	1974 Annual report on the Biology and Health Protection programme	EUR 5332
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
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