COMMISSION OF THE EUROPEAN COMMUNITIES

environment and quality of life

Environment and site problems in the Uranium ore mining and processing industry

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ENVIRONMENT AND SITE PROBLEMS IN THE URANIUM ORE MINING AND PROCESSING INDUSTRY

SUBJECT OF THE CONTRACT

The uranium mining industry of the European Community has to cope with problems arising from the pollution of the environment and harmful effects of operations on the localities in which its facilities are sited France, currently the only producing country in the Community, has considerable experience in this field and has already taken a number of measures to reduce environmental pollution and to conserve sites. As we must expect an expansion in ore mining and processing operations in the Community, with the industry tending to exploit lower-grade ores and to use new extraction techniques, problems relating to the protection of the environment and site conservation are certain to acquire greater urgency. This study sets out to provide a survey of protection and conservation measures and monitoring methods applied and of costs. It also deals with the means envisaged to protect the environment with the predictable introduction of new extraction techniques. The final aim of the study wille be to prepare a practical guide to the protection of the environment and site conservation, for use by uranium ore mining and processing undertakings in the Community. The radiological protection of workers and the public is covered by the work of DG V (Directorate-General for Employment and Social Affairs).

AIMS OF THE STUDY

The aims of the study are as follows :

- to analyse environmental and site problems associated with the extraction and processing of uranium ores,

- to analyse the technical means and the economics of reducting pollution of the environment and improving sites in the uranium mining industry,

- to compare measures already taken pr planned by uranium-producing countries and by site operators to reduce pollution levels and to dispose of mining waste,

- to subject to a critical analysis problems of the environment, and possible solutions to them, which will be raised by the application of new extraction methods and by the exploitation of ores having low or complex contents,

- to prepare a pratical guide for the use of site operators in environmental protection and site conversation in the uranium mining industry.

FRAMEWORK OF THE STUDY

The study will consist of several parts :

- environmental and site conservation problems in the uranium mining industry,

- the technical means and costs of pollution control,

- a comparison of measures taken and existing legislation in the main producing countries in regard to the environment and site conservation,

- evaluation of environmental and site conservation problems due to the application of new extraction methods and to the exploitation of with low or complex contents,

- a pratical guide for use by site operators in the protection of the environment and site conservation.

1. INTRODUCTION

Public opinion has been made particularly sensitive of the risks attributed to nuclear power stations by extension to the nuclear industry as a whole. Because of this, it becomes necessary, even at the stage or applications for licences to conduct mineral explorations, not to speak of applications for concessions or exploitation rights, to take into account the questions legitimately posed by the public, questions which, only of few years ago never arose.

It is also to be noted that the anti-nuclear groups are organized at European level by people of high political and scientific standing, who feel that all these problems should be dealt with together, with the result that Europe's entire energy policy is called into question, right down to the level of mining operations. All these factors tend to bring uniformity to the conditions met with by industrialists from one region to another in the European Community and constitute an incentive to adopt technologies ensuring the hughest level of protection for the environment. However, we must realise that this trend, if it continues, could lead to the very opposite of the results desired. Excessively stringuent constraits imposed on nuclear energy through the action of irresponsible pressure groups would lead in practice to a preference for other forms of energy, none of them wore readily available in our regions, and all much more harmful to the environment.

Principles followed in the drafting of this document

It is necessary, in the light of what has been said, to collect into a single document all the available scientific and technical knowledge on the externalities of the uranium mining industry and on the means of controlling them.

This document has been prepared with the twofold aim of leaving nothing unsaid with regard to the externalities - short and long term, local and global - of the uranium mining industry, and of reducing each of them to its proper proportions, staling clearly what is of significance and what is not.

In so multidisciplinary a field as that of environmental protection, it has been found necessary to develop a certain number of basic concepts, without which readers not necessarily versed in all the scientific fields concerned might grasp the while matter.

The document comprises two parts.

The first is an exhaustive listing of scientific and technical concepts and principles without which clear comprehension of the subject woudl not be possible.

The second is a pratical guide describing measures which might be recommended to site operators to assist them in evaluating and minimizing externalities and in establishing relations and exchanges of information with the populations concerned.

Estimated reserves and ressources in the territory of the European Community (réf. 1.)

	Uranium metal in tonnes Cost below $ 30/lb of U_3O_8
Federal Republic of Germany	2 000 (ref. 2)
Belgium	
Denmark	16 000*
France	95 000
Ireland	
Italy	1 500 (ref. 3 and 4)
Luxembourg	
Netherlands	
United Kingdom	
Total	114 500

* Greenland

Outside the European Community, the reserves of Spain are estimated at 210 000 t and those of Portugal at 10 000 t (ref. 2) ; these values, added to those in Table 4, would bring the total to 335 000 t.

We shall return to this figure of 335 000 t subsequently, when an estimate has to be made of the impact of the uranium ore mining and processing industry at European Community level.

We felt it would be of interest to include in an annex the personal comments of an expert on the data contained in the above table.

CONCLUSIONS

The figure of 335 000 t, indicated in the previous paragraph, represents thirty times the annual consimption for 1980, ten times that for 1985 and only one and a half times that for the year 2000. On the other hand, it again accounts for twenty times the figure for the year 2030, if fast breeders are brought into service in good time. It must be noted, therefore, that the Community's own resources can only have significant economic weight either in the relatively short therm or in the very long term. Over the period 1990 - 2010, the implementation of the nuclear programme envisaged in the European Community will involve large-scale recourse to resources available in non-Community countries.

Such resources do indeed appear to be potentially available. Nevertheless the uranium mining industry is a heavy industry and its reaction time is of the order of some ten years. Bearing in mind the fact that for various reasons, notably environmental ones, some of the countries with the biggest deposits are slowing down the development of these deposits and are planning to restrict their exports within a quota system, supply difficulties could be experienced. This could delay the nuclear programme envisaged in the European Community.

Whatever the outcome, even if the nuclear programme is slowed down considerably, there will be a strong incentive in Europe to resume the prospection effort, which has been at a considerably reduced level for the past two decades and has only been showing signs of recovery since the oil crisis. It is to be hoped that this effort will not be without success ; increases in demand and increases in reserves of raw materials are generally observed to run parallel.

Whit regard to the rate of development of European resources, varying hupotheses can be adopted depending on whether the emphasis is laid on the short term or the long term, but new mines will certainly be brought into production over the next few years. Since the establishment of fast breeder reactors means better utilization of the ore extracted, the user value of uranium will increase and lower-grade deposits will be worked. The volume of exploitable uranium reserves will then no doubt increase substantially

It is likely that an attempt will be made in Europe towards the end of the century to exploit low-grade deposits, where necessary by new methods. At present, uranium contained in mine tailings with contents in the order of 100 ppm is being recovered. It may be noted that the energy content of a given weight of uranium ore with a content of 70 ppm would still, even with present technology, be of the same order of magnitude as that of the same weight of coal ($2.5.10^6$ tonnes of coal $\sim$ 170 tonnes of uranium).

References

(1) Luciene THIRIET (1976) - L'énergie nucléaire. Quelles politiques pour quel avenir ?. (Nuclear energy. What policies for what future ?).

(2) Information obtained from the Commission of the European Community.

(3) Uranium deposit of Novazza (Bergamo), AGIP Publication, april 1977.

(4) Uranium occurrences in the Rendena Valley and Dalgone Valley area, AGIP Publication.

2. THE EXTERNALITIES OF THE URANIUM ORE EXTRACTION AND PROCESSING INDUSTRY

The effect of the activity of a commercial undertaking is to change the socio-economic environment in which it functions. These changes, whether favourable or unfavourable, to which micro-economics has given the name 'externalities" or "external effects", can in theory have assigned to them costs which are either positive or negative and which do not normally enter into the accounts of the undertaking, except in specific cases in which compensation systems are established or taxes imposed in order to internalize them. Among these external effects, hazards to the environment and to health are taking on increasing importance in the eyes of the public. In other words, their social cost in increasing relative to production costs. The threshold of economic viability of uranium ore extraction and processing operations may thus be shifted by taking into account the detriment caused by them ; the true value of this detriment must therefore be determined. Its evaluation gives rise to both methodological and pratical problems.

In this section, we shall catalogue the externalities created by the extraction and processing of uranium ore and shall then evaluate the relative importance of these effects.

We show briefly that, at a level which transcends, the purely local framawork, i.e. at the regional of Community level, there are, compared with the economic advantages afforted at this level by the production of yellow cake, no hazards which are statistically significant or even measurable - at this level of course.

On the other hand, the socio-economic impact, at the local level, while it is not negligible, is still slight but at the same time there are potential hazards of many kinds. A detailed list is presented. The absolute extent of the potential hazards varies considerably in relation to local factors, which will be examined in detail.

2.1. Consequences which could go beyond the purely local framework

2.1.1. Socio-economic effects at European Community level

In view of the overall inadequacy of the energy resources of the Community Member States, there is a case for exploiting all existing resources. The indications given in Section 1 show that known uranium resources already constitute a very significant asset for certain Member States and a not inconsiderable fraction of the overall requirement. The use of these resources will therefore tend to improve significantly the Community's overall trade balance. At $ 30 per pound of U_3O_8*, the reserves referred to in Section 1 (335 000 tonnes of uranium) represent a value of 23.10^{-9} dollards.

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* in 1975.

In addition, they will help to reduce the Community's dependency on energy exporting countries, particularly once fast breeders have started to give back the energy which they required to begin operating.

2.1.2. Environmental consequences at regional or Community level

2.1.2.1. Psycho-sociological consequences

If we accept that the psycho-sociological context forms part of the environment in its vroadest sense, the hostile reactions that the use of nuclear energy arouses among a certain fraction of the population, whether justified or not, manifest themselves as a moral detriment suffered by that population.

The development of uranium mines, which is the first link in the nuclear chain, thus finds itself facing organized opposition at levels transcending the local framework.

It is scientifically established that the risks associated with the use of nuclear energy are lower than those associated with accidents in general or with natural disasters and are wholly negligible in relation to the risks accepted daily by each and everyone in his work and even more in his private life. A split nevertheless persists, however paradoxical that may seem, between the correct evaluation of the risks made by scientists and the view of them prodained by the various social groups. It emerges that, while for the scientists or technologist the term "nuclear energy" denotes a system of energy production characterized by certain specific technologies and economic conditions, the same term in the mind of the public acquires a secondary grafted-on meaning : the term "nuclear energy" thus becomes what modern communication and language theory calls a myth. The results of a recent survey[1] show that this myth varies from one individual to another ; it is a "multimyth", the meaning of which for some is drawn from negative connotations (people killed, mankind threatened) It has already been pointed out that these fears have no rational basis where the peaceful use of nuclear energy is concerned. For others, the secondary meaning relates to a hypercentralized form of social organization which they feel would be brought about by the development of nuclear energy. Again according to Agrafiotis et al[1], this latter argument correlates closely with others concerning issues of the day or ideological problems (the birthrate, censorship, capital punishment, the family, work, the nuclear strike capability, Larzac, God). It might be pointed out that this attitude amounts to confusing the tool with the way in which it is to be used. There are no technological constraints which would prevent nuclear energy from being integrated, for example, into a highly decentralized society, using in direct proximity to the centres of consumption small power generators adapted to pwely local economic and environmental conditions. It is thus a question of a decision as to policy, which it would be wise to tackle in a more direct manner, rather than a question of nuclear energy as such.

Since we have to evaluate the extent of the indisputable psychological detriment suffered by those who really are frightened, we must point out that it would not be possible, according to the experts [2-3], to bring about an improvement in the situation solely by rational argument, which is powerless in the face of a myth.

However, it is possible that gradually as the public sees nuclear power stations set up and finds that the disasters predicted to not occur, the power of the myth will weaken. We may conclude that the detriment suffered at the psycho-sociological level is merely transitory and that common sense will prevail in the long term over an inconsistent myth, as has haggened in the past with the introduction of major new technologies.

2.1.2.2. Consequences for environmental contamination

The operations involved in the extraction and processing of uranium and thorium ores structly speaking to not introduce any new radioactive elements into the environment, for these elements have always been there in dispersed form and indeed account for roughly half natural background radiation to which living organisms have had to adjust themselves. It should be recalled that the average concentration of uranium in the earth's crust is 4 grammes per tonne. The quantity thus dispersed through the territory of the European Community over a thickness of 100 m, at concentrations which are unfortunately not suitable for exploitation, mounts to 8.10^9 tonnes, i.e. 3.10^4 times the quantity which could be handled at extraction facilities. The fact remains, however, that during extraction and processing the chances of transfer to man of uranium and its daughter isotopes are increased. The quantities of radioelements reaching the atmosphere and discharged into surface waters are increased. Analysis shows that the contamination of air by radon and its short-lived daughters and the contamination of surface waters by radium might need to be considered at local level.

In view of the fact that, at he regional level, quantities discharged from extraction facilities will already be in very diluted form, the excess concentrations in the air and waters under consideration wille be very low, as will the dose absorbed by the public. The problem then arises of calculating the effect of extremely low doses. Such experimental data as epidemiology has provided on the effect of ionizing radiation relate to doses in excess of the dose limits laid down for workers. In the case of

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1 D. AGRAFIOTIS, E. DELARMINAT, G. MORLAT, J.P. PAGES
l'énergie nucléaire et l'opinion publique : émergence d'un mythe.
IRPA Congress, April 1977, 4, (Nuclear Energy and Public Opinion : Emergence of a myth).

2 D. AGRAFIOTIS, G. MORLAT, J.P. PAGES
Le public et le nucléaire, (The public and Nuclear Energy) International Conference on Nuclear Energy and the Fuel Cycle, Salzburg, May 1977.

3 R. BARTHES
Mythologies
Edition du Seuil, 1970.

workersn their exposure is kept below the dose levels for which effects have been detected, and a cautions method of evaluating the risk is to accept the hypothesis of linearity between the dose absorbed and the effect, expressed for example in terms of shortening of life expectancy. So the man-rem concept is introduce, the abstract result of a multiplication process the practical value of which is questionable outside the context of medium or heavy doses, but convenient and acceptable as long as the consequences drawn are not absurd. On the basis of the results obtained at high doses, the coefficient of risk characterizing the linear law, of the number of cancers in excess of the normal rate observed annualy, in respect of a population of one million inhabitants having been exposed to a dose of 1 rem. Some experts accept, for instance, that this figure is 6.10^{-6} per (man-rem) per year, for whole-body external irradiation (Section 5). It has been verified that the risk coefficients arising for nuclear workers, in the case of the pessimistic evaluation which consists in considering these coefficients as true at the low doses, are no different from those encountered in other occupations.

In the case of populations exposed to very low doses - of the order of one thousandth, or less, of the doses for which effects begin to be detected - the same man-rem concept, vased on the hypothesis of dose-effect linearity, loses any biological meaning. The excess concentrations in the environment in question are negligible in relation not only to average levels of natural contamination, but also to their fluctuations of those levels in time and space. Exposure to natural radiation is only one biotic factor among many others, such as UV radiation, oxygen concentration and temperature. It is known that living organisms flourish when the biotic factors in their habitual environment are maintained within a very narrow band of fluctuation. If one of the biotic factors becomes too high or too low, the organisms go into decline. In all probability, this is also true for the biotic factor "ionization radiation", which must not only be not too high but also apparently, not too low, as some experiments have tended to show. The conclusion is that, if ecess contamination is of an order well within the usual bands of fluctuation of the natural contamination, to the characteristics of which living organisms have adjusted themselves, we do not outside the acceptable range and we have to regard the effect of this excess contamination as zero. If we adopted a different attitude, we should have to induce populations to leave areas of peak natural contamination. It is easy to imagine that this would give rise to both absurd and comical situations and that the public would not comply.

Case of radon contamination of the air

In view of the fact that the half-life of radon is 3.8 days and bearing in mind the speeds at which masses of air move, it may be supposed that the radon found in Europe basically arises in Europe itself. The total flux of radon emitted by

European land masses is of the order of 5 Ci/s, adopting as a basis the value of 5.10^{-13} Ci/s.m^{-2} accepted in the literature for the mean specific terrestrial flux, and assuming the geographical area of Europe to be 10 000 000 km^2.

Assuming that the cumulative quantities of uranium extracted on Community territory may be as high as 335 000 t, representing $1.1.10^5$ Ci of radium, the production of radon from this radium, 99 % of which is contained in the wastes from processing facilities, would for thousauds of years* be 0.2 Ci/s** ; experience has shown that a maximum of 10 % of this output may reach the atmosphere. This additional radon flux of industrial origin would thus be less than 2.10^{-2} Ci/s. The excess concentration resulting at European level will therefore be less than 4 % of the natural value. The average values for radon concentration observed in Europe are of the order of $1.5.10^{-10}$ Ci/m^3, the instantaneous values, however, may vary by a factor of 100 from one day to the next (cf. subs 5.2.2.3.). There are considerable variations betwenn sedimentary rock and crystalline rock.

It may thus be seen that the excess due to European extraction and processing operations would be of the order of 6.10^{-13} Ci/m^3 on average. This value is substantially smaller than the amplitude of natural fluctuations and is 1/1700 of the maximum value for radon concentration permissible for the general public (10^{-9} Ci/m^3) which can be deduced from the ICRP standard for workers (30.10^{-9} Ci/m^3). The dose at which effects begin to become discernible with regard to the frequency of lung cancer would be that absorbed over 66 years by a person living constantly in an atmosphere with a concentration of 10^{-8} Ci/m^3.

Out of academic interest the risk can be calculated on the hypothesis that the linear law is valid at very low doses. In epidemiological studies carried out on uranium miners (who had unwittingly been exposed to high doese in the past showed**, that among a population of 10 000 miners having been exposed to a dose of 100 WLM (he WLM is a dose unit which will be explained) the researchers statistically observed six lung cancers each year in excess of the number of lung cancers recorded in an identical control population. Se we introduce a risk coefficient equal to siw additional cancers per year per 10^6 inhabitants who have absorbed a dose of 1 WLM ; this coefficient is only of interest is we accept the linear law hypothesis. A population living in natural conditions which air containing radon at $1.5.10^{-10}$ Ci/m^3 for a period of 66 years absorbs an individual dose of 1.5 WLM**, to which, according to this coefficient, 9 cases of lung cancer per million inhabitants can be assigned. For the 300 million inhabitants of the European Community, there would be 2 700 cases of lung cancer attributable to radon. Similarly, the radon excess

* Although ^{226}Ra has a half-life of only 1 600 years, it must be remembered that it remains in radioactive equilibrium with ^{230}Th, which is also contained in processing facility wastes, and has a half-life of 80 000 years.

** $1.1.10^5$ Ci $2.1.10^{-6}$ s-1 = 2.10^{-1} Ci/s^{-1}.

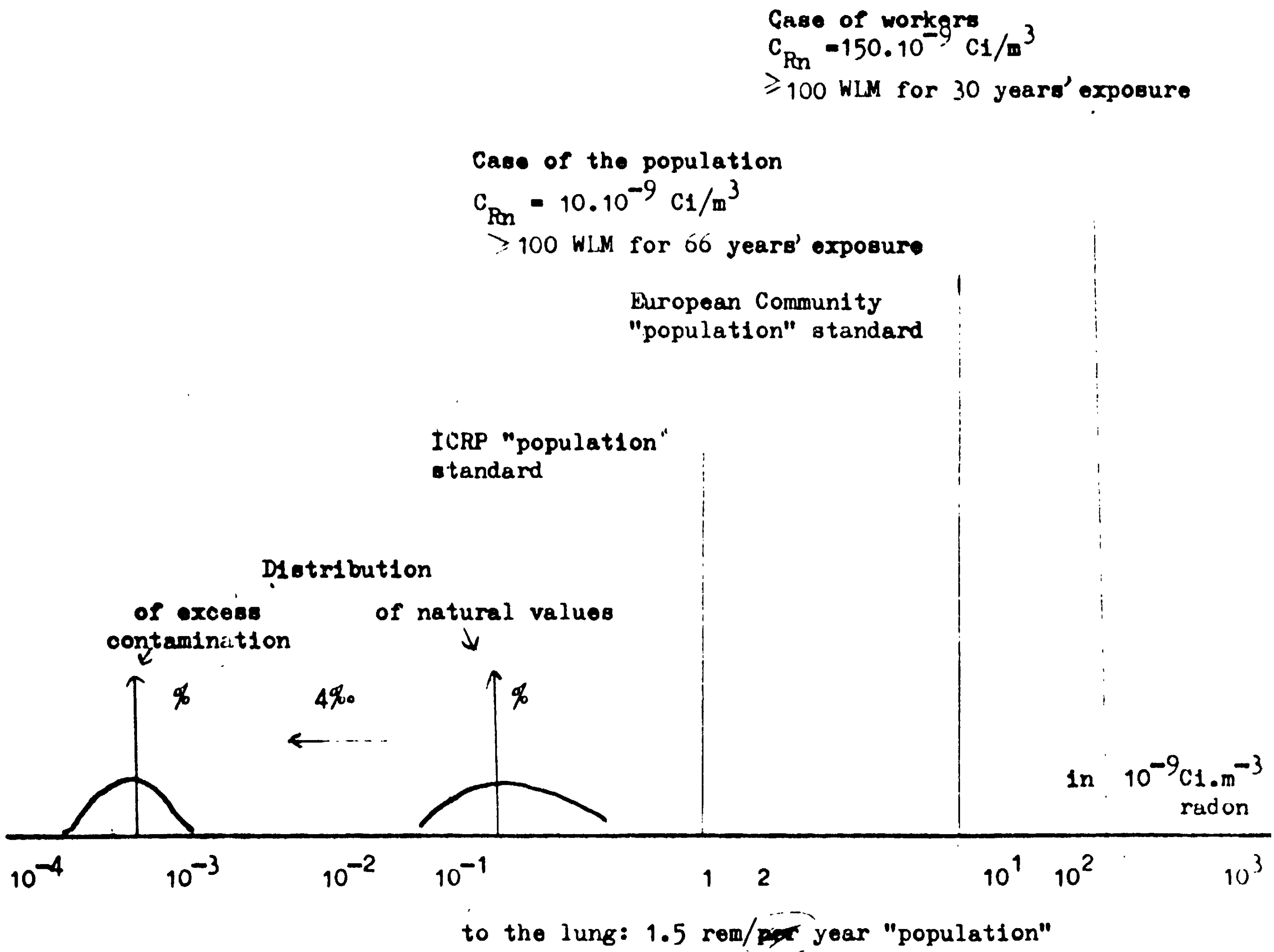
of 6.10^{-13} Ci/m^3 contributed by discharges from processing facilities at the natural concentration of radon would give rise to 11 additional cancers each year per 300 million inhabitants. Even if an epidemiological study were extended to the entire Community population of 300 million, an increase of 11 in the number of lung cancers recorded each year, which is of the order of 60 000, would not be detectable. In fact, if we accept the additivity of attacks, it is probable that a 4 % radon excess would be more likely to reduce by a few days or weeks the lifetime of those destined to die of lung cancer than to create additional lung cancers in people whose lungs will have withstood natural radiation doses but who will die of something else.

Case of the contamination of waters by radium

Using present methods of purifying radium-contaminated waters, less than 1 % of the radium handled will be deposited in surface waters, i.e. less than 300 curies, hence less than 300 g, or if extraction continues for 30 years, an average of 10 curies per year. The quantity of water precipitated over Europe is of the order of + 10^{15} litres per year. The average contamination of surface waters during the operation of European Community mines over a period of 30 years could therefore the increased by an average of 2.10^{15} Ci/litre, not taking into account reserves of fresh water. The content of radium in rivers is in the order of 10^{-13} Ci/l, but may frequently reach 10^{-12} to 10^{-11} Ci/l in the rivers of crystalline formations. Here, again, additional contamination on the European Community scale is low in relation to natural contamination and its fluctuations. It should be noted in passing that the quantity of radium contained in the sea is estimated at 10^9 Ci.

2.2. Local consequences in the short or long term

Observations made in France show that the public is in actual fact primarily concerned over the possibility of disturbances of its work, daily life and surroundings ; the anxieties associated with any change of whatever kind are, moreover, felt at the level of private interests vefore they are felt at Community level. Nevertheless, pollution of the natural environment and especially radiological hazards, although vaguely perceived, are mobilizing themes. They make it possible to group, into, Defense Committees for example, people whose interests are very varied or who are not directly concerned at the economic level. This explains why anly trouble due to ionizing radiation is given great prominence in the literature published locally and discussions organized locally. As radioactivity is still a lighly mysterious phenomenon for the public and is in any case associated with dangers that are the mone grossly overestimated because pooly understood, harmless or even fortunate consequences of mining activity tend to be automatically disparaged by at least part of the population.



Comparison of natural radon concentration levels and possible excess levels due to the extraction of 300 000 tonnes of uranium in Western Europe.

Calculation bases: 1 WLM › 5 rem

equilibrium factors: 0.5 outside

0.2 on mining establishment sites

In these circumstances an objective and complete inventory of all the local consequences has provede to be necessary. The difficulties of assessing their real importance are examined below. The consequences of prospecting operations are covered in Section 4.3.

2.2.1. Inventory of local consequences

How is such an inventory to be tackled ? Various methods for the systematic identification of the externalities of regional development or industrial siting have been proposed (1 to 6/4/). After examining them, we felt that these methods, in the particular case of uranium mines, were unnecessarily cumbersome and technocratic in practice.

We prefered, in a more pragmatic way, to base our considerations on the observations that can be made at existing uranium extraction facilities.

Four categories of effects may be distinguished :

- effects on socio-economic activity,
- effects on the setting of people's lives,
- effects on the natural environment,
- effects on health.

Effects on local socio-economic activity

- Acquisition of land by the Company, either by private agreement or by exorioriation. Abandonment of activities and jobs associated with this land.

- Alteration of the social and occupational structure : creation of new jobs, either directly or indirectly, for the duration of operation of the facility.

- Expansion of communications routes and electricity transmission lines.

- Taxes and dues levied by the local authorities either directly or indirectly (increase in local purchasing power).

- Deterioration in tourist potential.

- Drop in the value of houses and land, except in the case of speculation.

- Reduction in the fish yield of watercourses.

- Increase in the costs of upkeep of pumping stations for irrigation water and in the chemical burden of drinking-water purification plants.

Effects on the setting of people's lives

- Increase in noise : shot-firing, drilling, excavation, mine compressors and ventilation plant. Crushing and grinding. Site machinery.

- Congestion of the road system by heavy plant and lorries.

- Disfigurement of the countryside : surface installations, open-cast mining, site excavation works, storage of solid wastes, visible pollution (foams and slurries) of surface waters. Impairment of the cultural and archeological heritage.

- Reduction in amenities for leisure pursuits : walks, fishing and hunting zones.

Effects on the natural environment

- Physicochemical and radioactive contamination of the air. Radon. Dusts. SO_2.

- Alteration of the hydrographic system. Diversion of water courses. Creation of collecting ponds. Physicochemical and radioactive contamination of surface and grount waters.

- Degradation and contamination of the soil.

- Degradation of biotopes : effects on aquatic fauna and flora. Changes in biotic indices.

Effects on public health

- Effects of external radiation from products in storage or discharges to the environment.

- Chemical and radioactive contamination by inhalation.

- Chemical and radioactive contamination by ingestion.

2.2.2. Methodological and pratical problems raised by the evaluation of externalities

Once existence of externalities, many of which constitute nuisances, has been established, various attitudes can be adopted : one ean prohibit or restrict exploitation, impose better technologies, or "laisser faire". In order to decide which of these attitudes to adopt, it is first necessary to assess the magnitude of the nuisance. However, the evaluation method adopted exerts an influence on the decision and a preliminary question arises : are there techniques for evaluating the extent of the nuisance which are rational and absolute ? If so, the decision could be taken on objective bases which are not subject to criticism.

In micro-economics, it is considered possible to assign to externalities a cost which can be expressed in monetary units. According to this thoery, it is for example possible to calculate the effects on the setting of life on the basis of the fall in prices of land and property, effects on health by the cost of medical care, effects on life expectancy on the basis of life assurance premiums. It is thus principle possible to calculate the cost of the nuisance constituted by the exposure of an individual to a certain radiation dose.

It was calculated that the cost of having on indivdu getting one rem was in the range of 10 to 1000 dollars for the case of the external irradiation of the whole body.

3. RECOMMENDATIONS FOR COMMUNITY REGULATIONS TO DEAL WITH ENVIRONMENTAL PROBLEMS CREATED BY THE EXPLOITATION OF URANIUM DEPOSITS IN THE EUROPEAN COMMUNITY

In view of the difficult financial situation, particulary in the field of energy supply, with which the European Community will be confronted during the coming decades, no Community resource should be overlooked. A particular effort must be made to discover and exploit all the uranium deposits available on the territories covered by the Community. This mining activity must of course remain compatible with care to safeguard the environment, the qualtiy of life and the health of the people. It is also desirable in the interests of both site operators and the public that the constraints and restrictions imposed upon exploitation as a result of such care should be brought into uniformity at Community level.

First the the Community should lay down the basic philosophy and the rules of procedure wich Member States must adopt with regard to uranium ore extraction activities. This applies in particular to measures designed to protect populations from the radiological hazards whichare likely, as we have seen in the preceding sections, to have a real incidence at local level on health and for which there is no reason to adopt a different attitude from on region to another.

Secondly, wide decision-making power should be left to the regional level, for many of the externalities in the socio-econmic field or of concern to the quality of life or the environment will be assessed very differently by local populations and the local authorities.

3.1 Recommendations covering externalities as a whole

A general framework may be proposed making it possible to deal uniformly with contentious situations resulting from the exploitation of a uranium deposit.

A distinction is made between the of preliminairis to operation and the operating phase proper.

3.1.1. The case of preliminaries ot operation of an extraction facility

It is proposed that the adversary procedure of public inquiry based on the critical and public examination by the various parties involved of an impact dossier prepared by the operator, be adopted at Community level.

This impact dossier, the content of which will be examined in the following section (guide for the use of operators), must include a section describing the projected mining activities and the means to be applied in order to reduce adverse effects before, during and after operations and a section in which the extent of residual adverse effects is evaluated in the light of specific studies carried out on the various local factors mentioned in section 4. During the inquiry, additional dossiers may prove to be necessary. If, at the end of the enquiry, authorization to exploit the deposit is granted by the administrative authority, it will be subject to variously stringent environmental constraints.

This procedure seems to be readily adaptable to the different regulatory situations existing in the Member States, particulary in those States which have adopted similar procedures. Specialists in administrative and legal questions will have to harmonize the Community provisions and those of the Member States and to specify how the various interested parties, are to be consulted, how the various national and Community bodies are to intervene, and who is to take of final decisions.

3.1.2 Case of extraction facilities in operation

During the public enquiry, the operator will have to submit a description of system monitoring the quality dans quantity of all his discharges and for cheking a number of parameters considered representative of the physical and biological environment. During the operating phase, it is to be recommended that the corresponding measurements - the cost of which would be borne by the operator - be effected or at least confirmed by a specialist laboratory independent of the facility and approved by the administrative authority. These measurements will, in particular, be designed to reveal disturbances in the contamination of the natural environment, which presupposes that the radiological "zero" state of the site, which will be mentioned in the following section, has previously been established. The data collected during this phase must be used to verify whether the conditions for the transfer of radioelements to man have been correctly evaluated during the public inquiry, and whether the health of the population is being affected by inhalation or ingestion of radioactive or nonradioactive toxic products.

The particular cas of radiological hazards is to be assessed in relation to knowledge gained by biologists dans physicians in the effects of ionizing radiation, particulary at low doses. It was felt that this subject deserved a special section.

3.2. Recommendations on the particular case of radiological hazards

The intentions is to indicate the principles on the basis of which standards for absorded doses and concentrations in the environment, food and discharges need to be laid down to ensure the protection of the public.

In regard to radiological hazards the reader should refer to the work of the International Commission on Radiological Protection (ICRP), particulary publication n°26 (1977).

Analysis unfortunately shows that the complex and sometimes contradictory considerations set out this document, which is of high scientific standing, do not make it at all easy to decide in pratice what needs to be done in this or that specific cas, for example, in the cas of a uranium or extraction facility. In some secyions, reference is made to standards of exposure, in others, in order ot determine whether a risk is acceptable, analyse of the "cost-benefit" or "cost-advantage" type are used; we have drawn attention in section 4 to the technocratic and - in pratice - illusory nature of these crtieria. Reference is also made to irradiations due to natural radioactivity.

If people have taken the trouble to propose a standard, they must have thought it necessary and intented it to be applied. On reflection, it may be observed that in fact the basic standards envisaged, which relate - it should be noted - only to effects, may have the following four different meaning :

Below the limit recommended :

1. There is no risk and therefore no effect.

2. The risks and their consequences to health, if any, are of a lesser degree than those normally accepted at work ("workers" standard) or in everyday life ("population" standard).

3. The risks and their consequences to health, if any, are of a lesser degree than those caused by natural radioactivity and its fluctuation in space and time.

4. The risks, if any, have consequences to health which can no longer be measured statistically because it would be necessary to wait too long and to work with samples of disproportionate size.

Whether trough the wish to avoid taking responsibilities or through scientific scruple this ICRP document does not make it possible to decide which of these meanings should be taken as a reference in practice.

It is at all events clear that, taking advantage of the ambiguity of these texts, the opponents of nuclear energy seek to secure a very restrictive interpretation according to which any additional dose absorbed by an organism, however low it might be, is dangerous and should be prevented. Consequently, all discharges of radioelements to the biosphere should be completely stopped. Hypothetical effects on health, the reality of which could only be ascertained by epidemiological studies covering thousands of millions of individuals or extending over hundreds of thousands of years, are regarded as unacceptable.

Rich countries abundantly endowed with energy resources, such as the USA, Canade and Australia, can afford the luxury of delaying the exploitation of known deposits and of devoting careful attention to considerations of this type.

We think that the European Community, in its own particular situation of energy dependency, cannot afford this course of action : delays in the supply of uranium would bring upon the public more disastrous social and economic consequence the environmental consequences which could be avoided by imposing constraints at the outset.

We feel that an attitude which is both reasonable with regard to the radiological hazards - employing measures which are capable of pratical application in the field - dans above all simple to explain to everyone, is to require that the consequences to health of the hazards, if any due to extractive operation be of a lesser degree than the wholly identical hazards that could arise from natural radioactivity in the region concerned. It is possible to determine experimentally the radnge of doses absorbed under natural conditions by the populations through external irradiation from the ground and from buildings, inhalation of airborne radon daughters and ingestion of the radium present in water and foods from the local soil. The increase in dose levels originating in mining activity must be comparable at most to the fluctuation in space and time of natural dose levels. If the conditions for transfer between the environment and man are known for a given site, this amounts to proposing for radon, a maximum value for radon concentration in the air and, for radium, a maximum value for the concentration of soluble radium in drinking water, and consumption quotas for certain critical foods : fish, cereals, milk.

On the basis of the observations made on natural radon contamination of French mining sites, the excess concentration of radon should on these terms be limited to a value situated between 5.10^{-3} and 5.10^{-2} WL (standard based on potential alpha energy of radon daughters) or between 10^{-9} and 10^{-8} Ci/m3 (standard based on radon gas). It will be observed that these values correspond precisely to the standards proposed for radon by the ICRP and the IAEA respectively.

In the same way, in view of the concentration of radium in drinking waters derived from a supply system or local springs and welles, not to speak of mineral waters which may have high levels of radium, it may be observed that quantities ingested annually from this source may commonly be between 100 and 1000 pCi, values approaching 8000 pCi the value derived from the ICRP recommendations as a maximum permissible limit being sometimes obtained in uranium bearing regions. On the terms postulated, discahrges of radium into surface waters must not increase the radium concentration in water drunk by the population in such a way that the additional quantity of radium ingested is greater than 100 or 100 pCi, depending on site. Similar considerations are possible for each transfer by the alimentary route.

The limits thus proposed are in conformity with the directive of the Council of the European Communities of 1 June 1976 laying down revised basic standards for protection of the health of the general public against the dangers of ionizing radiation. It is worth pointing out that the philosophy proposed here is more stringent than that adopted for non-radioactive toxic substances emanating from industry : for sulphur compounds, for example, concentrations in the air are permitted up to 10, 100 and 1000 times higher in absolute values than those found under natural conditions.

It must also be pointed out that we advise laying down standards of emission in an arbitrary and uniform way. This practice, adopted by certain Statesboth within and outside the European Community, does not take into account the capacity of the site to take up discharges and absorb them. Discharge standards are necessary, for they make it possible in practice to monitor the conduct of the operator. But they have to be set site by site on the basis of standards for concentration in the environment or in foods, which in turn are derived from standards on the effects of irradiation.

European Communities — Commission

EUR 6586 — Environment and site problems in the Uranium ore mining and processing industry

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The anticipated increased demand for uranium in the EEC over the next 25 years will prompt industry to step up exploration for and exploitation of deposits in those territories which are economically or politically dependent on the EEC. Potential recoverable reserves of uranium could be as high as 300.000 tonnes. This paper makes an exhaustive review of all the environmental implications, the short and long-term and at local and regional levels of the extraction and processing of uranium ore.

Account is taken of the impact of possible new extraction and processing methods for low-grade ores. At local level, effects on socio-economic activity, the quality of life, the natural environment and health are discussed. An important chapter reviews the radiological effects on man : irradiation routes are dealt with in detail using bibliographic data and experimental results recently obtained in France internal irradiation due to the inhalation of daughter products of radon and internal irradiation due to the ingestion of radium.

Recommendations are made with a view to the implementation of Community regulations on operating licences for mines and processing plants and the application of protection techniques and environmental safeguards. It is suggested that emission standards be set by case in such a way as to utilize the capacity of the site to receive waste in the light of an impact study establishing the critical population and the importance of the main transfer routes. Protection techniques are also reviewed.

The last chapter is devoted to the compilation of a guide for companies wishing to exploit a uranium deposit.