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COMMUNICATION FROM THE COMMISSION TO THE COUNCIL

SITUATION OF THE TESTING REACTORS IN THE COMMUNITY

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INTRODUCTION

During the 1950s there was felt to be a need to have Materials Testing Reactors (MTRs) in Europe. By their contribution to studies on safety, these reactors proved to be an indispensable tool in the pursuit of all programmes for the development of nuclear power.

The reduction, slowing down or phasing out of these programmes had important consequences on the operation of these reactors which are also used for other purposes -such as the production of radioisotopes for medical use (diagnostic or therapeutic)- which have become a more significant factor in the exploitation of MTRs, without providing in themselves an optimal work load.

The decision to close down the two oldest reactors, DIDO and PLUTO at Harwell, was taken in 1988 for essentially economic reasons.

Faced with that situation and with requests from certain Member States, the Commission conferred a technical study in 1988 on Dr. J. Williams, ex-Director of the Harwell research establishment. The conclusions arrived at in the study were communicated in February 1989 to the Council and the Euratom Scientific and Technical Committee (STC).

It soon appeared necessary to extend and deepen this technical study by an analysis taking into account all the pertinent scientific, technical and economic elements and with a longer forward projection.

Such an analysis was conferred on the Chairman of the STC, Dr. Jules Horowitz, but to carry through so ambitious a mandate required a relatively long time scale in particular because of international uncertainty fuel supply and fuel cycle especially on research reactors.

Nevertheless, to get clear ideas on questions dealing with their exploitation, the Commission decided to establish a Coordination Group set up with operators of the four Materials Testing Reactors still operating in the Community, in parallel with the completion of Mr. Horowitz's report as quickly as possible.

Research Ministers took note of this decision at the Council of 29 April 1992 when adopting the Multiannual Research Programmes of the Joint Research Centre.

I.

TEST REACTORS

IN THE COMMUNITY

Test reactors were the starting point and the basis of the peaceful utilization of nuclear energy and are older than the technical employment of this energy source. The classical uses of research reactors worldwide extend over many and varied fields of application: examination of reactor-geometries, studies of the behaviour of materials and nuclear fuels, isotope production by neutron irradiation, application of techniques using neutron diffusion in the field of the science of matter and of biology and the education and training of physicists and reactor technicians.

The concept of a MTR reactor in general is a compact core with enriched uranium with a U_{235} assay equal to or greater than 19,75 % enabling high neutron flux to be generated. In Europe, the most important reactors are either of the "open swimming pool" type or "closed-tank" reactors but there are also many other types of research reactor. Thermal power of test reactors ranges from some hundreds of kilowatts up to somewhat more than 100 MW.

Finally, an important point is that the irradiation process itself is but the main element in an experiment which also requires preparation beforehand and examination after irradiation. The proportion of the cost of irradiation in the total cost of an experiment is very variable and in certain cases that of the additional equipment needed to perform an irradiation can be much greater.

Historically, test reactors in the Community fall into two categories: the first and oldest, were general purpose machines intended to satisfy numerous different requirements; the rest were designed to respond to more specific needs and in general were more powerful. This distinction is less clear today. Under economic pressure, the more specialized reactors are often used for work of a very general nature. However, the most difficult projects need specific equipment, and thus the most costly experiments, may be associated with one rather than another reactor.

These considerations somewhat modulate the notion of overcapacity. There is little effective duplication of means between test reactors in terms of irradiation experiments are currently undertaken or might be undertaken in the future. A possible excess availability of neutrons in test reactors does not necessarily mean that there is an excess capacity available for using the reactors for particular irradiation experiments. In fact such capabilities cannot be easily or cheaply moved from one reactor to another.

Table 1 shows the salient points of MTRs. The two reactors DR3 at Risø and FRJ2 at Jülich are shown for information.

TABLE 1 : Testing Reactors in the Community

Reactor	Located at	Exploiter	Started up	Nominal Power	Moderator	Fuel *(1)*	Main experiments carried out or characteristics
BR2	Mol (B)	CEN/SCK	1961	80 Possibility of up to 125	Be/H_2O	HEU	Loops using a high fast flux. Instrumented capsules.
HFR	Petten (Nl)	JRC *(2)*	1961	45	H_2O	HEU	Measurements of mechanical properties. BNCT Installation. Instrumentedcapsules.
SILOE	Grenoble (F)	CEA	1963	35	H_2O	HEU/LEU	Small loops, instrumented capsules. On-line fission product laboratory.
OSIRIS	Saclay (F)	CEA	1966	70	H_2O	LEU	Big loops. Instrumented capsules. Easy accessibility to the core. Large experimental volume
DR3	RISØ (Dk)	RISØ	1960	10	D_2O	LEU	Instrumented capsules.
FRJ2	Julich (D)	KFA	1962	23	D_2O	HEU	(Reactor Stopped)

HEU (High Enriched Uranium) (up to 98 %) in U_{235}
LEU (Low Enriched Uranium) (19.5 %) in U_{235}

(1) Current situation
(2) The high flux reactor in Petten is entrusted to the Commission of the European Communities by Council Decision (supplementary programme), but its technical operation is assured by ECN (Energie Centrum Nederlands).

Requested by the Commission and focused on the utilization of MTRs by Community programmes and the future requirements of the latter, Dr. Williams' 1989 study clearly showed that the mix of capabilities, available in the Community for carrying out irradiations, cannot be matched elsewhere in the western world. If this situation can be maintained the Community's potential future needs would be covered.

Reciprocally, the viability of the Materials Testing Reactors is determined by national and industrial programmes as those coming from Community programmes only contribute in a minor way.

Finally, regarding the potential availability of MTRs in the Community over the coming 10 years, Dr. Williams drew the Commission's attention to the fragility of the situation and to the fact that a reorganization of the system might be imposed by failure of the reactors one by one rather than as a result of any balanced consideration of the overall situation.

II.

THE COORDINATION GROUP ON TEST REACTORS

In the letter of 24 April 1992 addressed to Permanent Representatives of each of the Member States concerned with the exploitation of a Materials Testing Reactor, the Commission announced the creation of a Coordination Group, under the guidance of the Director General of the Joint Research Centre, comprising operators and with the aim of promoting greater consistency in the operation and use of these reactors and the examination of possible means of intervention for the preservation of these materials testing reactors in the Community, particularly in those sectors where they are essential. The Council of Ministers (Research) which met on 29 April 1992, took note in this respect of the Commission's Declaration joined to the Decision on the HFR Supplementary Programme. One Delegation stressed what was to be expected from the exercise; in particular underlining problems linked to the recent attitude of the American Administration on the fuel cycle of these reactors, and with reference to the worrying situation in the Eastern countries, together with the essential role of these reactors with regard to nuclear safety.

I. The Exploitation of Testing Reactors: Economic Aspects.

In his technical study, Dr. Williams had noted: "In these circumstances it is to be expected that specialist skills needed to undertake particular types of experiments, associated with the particular irradiation capabilities of each reactor, have grown up on each reactor site. It follows that these specialist capabilities are not easily transferred from site to site, if in fact they are transferable at all." (annex 4, paragraph 3).

Each operator (CEN/Mol, CEA, IAM of the JRC) of testing reactors in the Community contributed to the establishment of a global view by presenting the means by which the various exploitation costs are charged; the Coordination Group conferred the examination of such questions on a working group which has been asked to prepare a report.

The conclusion of the Williams' report was rapidly recognized by members of the Coordination Group, where it became clear that each operator calculated prices for irradiation services on the basis of criteria intimately connected with the specificity of each reactor which rendered the comparison of prices extremely difficult. The Group decided to focus its attention on cost evaluation and in the way different parameters are included, with the objective of finding possible distortions. Table 2 follows the conclusions of this work. It presents the following arguments:

- concerning the depreciation indicated in Table 2, the exploitation of the High Flux Reactor (HFR) at Petten is the subject of a supplementary programme by a Council decision every four years. This decision must follow closely the budgetary rules of the Community: inscription of all expenditures in the budget in the year of their commitment.

- operations for refurbishement vary according to the reactor concerned. Such an operation should be undertaken on the reactor BR2 on the occasion of the replacement of the beryllium matrix. Other reactors have been, to a greater or lesser extent, subjected to such operations. The HFR reactor was completely refurbished in 1984, for OSIRIS and SILOE, refurbishement is a permanent feature of operation.

- the question of the provision made for the reprocessing of fuel and storage of waste is intimately connected to fuel supply which is examined later.

TABLE 2 : COMPARATIVE COST STRUCTURES

	BR2	HFR	OSIRIS / SILOE
DEPRECIATION:			
Refurbishment	(*)	Foreseen in the budget of the year of financial commitment	yes since 1991
Reactor	no	no	no
Buildings	no	no	no
Projects	yes	Foreseen in the budget of the year of financial commitment	yes
New investments	yes (*)	Foreseen in the budget of the year of financial commitment	yes
PROVISIONS :			
Reprocessing	yes	(*)	(*)
Storage	yes	yes	yes
Decommissioning reactors	no	no	yes
Decommissioning of new installations	yes	yes	yes
OVERHEADS:			
Reactors	yes	yes	yes
Organization	no	yes	yes
CONTINGENCIES :	no	no	no

(*) cf. see specific annex for this reactor

Conclusions of the Group:

Based on Table 2 and complementary information, the Coordination Group did not find any significant distortion in the calculation of exploitation costs of any reactor.

II. Financial Instruments

The Coordination Group has examined all possibilities offered by the financial instruments available in the Community for construction, operation or in-depth refurbishment of Testing Reactors.

The Council Decision N° 77/270/Euratom of 29 March 1977 (JO L88, 6.4.77) stipulates in Article 1 that the purpose of Euratom loans is the financing of investment projects relating to the industrial production of electricity in nuclear power plants. With reference to article 2c of the Euratom Treaty, the 4th recital recalls that the Community must "facilitate investment and ensure the establishment of the basic installations necessary for the development of nuclear energy in the Community".

As has already been underlined, testing reactors are an indispensable element, notably in their contribution to the safety of nuclear installations. Therefore, they would eventually conform to criteria set out by the Council for the attribution of Euratom loans.

The Commission will continue to examine, in close liaison with operators, application modalities of the Council Decision to these reactors, as well as the possibility of intervention by the European Investment Bank.

III. Materials Testing Reactor Safety

The safety of MTRs and more widely that of research reactors has been a topic of international cooperation for years. More than 320 research reactors are operational worldwide in 54 countries: more than twice the number of countries with power reactors. A number of these are "developing countries" and benefit from the assistance of the International Atomic Energy Agency (IAEA).

Very early, the IAEA attached great importance to all safety aspects of these reactors: the establishment of criteria and standards for safety; assistance with research and setting up a structure for the exchange of technical information and of experts.

Thus, the safety of research reactors is based on IAEA publications which are the result of a large international consensus covering all aspects (radioprotection, waste management, and safety itself).

- "Safety Fundamentals" constitute a presentation of safety concepts, safety objectives and fundamental principles or requirements;

- "Safety Standards" establish the essential requirements which must be satisfied to guarantee safety. These requirements are formulated in regulations accompanied by recommendations;

- "Safety Guides" contain recommendations to fulfil requirements or principles set out in the above-mentioned documents; they are written in an obligatory format because they are consequential requirements tied to those in a safety standard or they recommend ways to implement these requirements;

- "Safety Practices" give practical examples and detailed methods on how to implement certain safety requirements.

Other safety-related documents which may contain additional topics and which are not predominantly written to ensure safety are collected in Reports or Technical Documents (TEC DOC).

The first two types of document treat design and operation of reactors. They cover matters concerning safety authorities, the site, quality assurance, etc. Safety Guides deal with safety assessment, utilization and modifications, commissioning of reactors, emergency planning and decommissioning. Safety Practices address topics such as instrumentation and control, radioprotection services, maintenance and surveillance, operational limits and conditions, as well as operating instructions.

Table 3 shows the hierarchical organization of these publications.

At the same time, since 1972 the IAEA has carried out missions concerned with the safety of research reactors (INSARR: Integrated Safety Assessment of Research Reactors) which places high importance on design, on operational aspects as well as on radiological protection. For the last two years, particular interest has been focused on research reactors in Eastern European countries and in 1990 an INSARR was organized in Russia.

Members of the Coordination Group underlined that at a European level, the European Atomic Energy Society (which includes research establishments in Community Member States) created in 1988, a Research Reactors Operators Grouping (RROG) comprising representatives of Germany, Belgium, Denmark, Finland, France, Norway, the Netherlands, Portugal, the United Kingdom, Sweden and Switzerland, together with the IAEA and the Commission of the European Communities. The Grouping in particular decided to reinforce cooperation on the safety of research reactors.

In conclusion, the Coordination Group expressed particular satisfaction about the quality of international collaboration which exists in the fundamental field of nuclear safety. It considered that increased support should be given to the work of the IAEA and of the RROG and to this end a close coordination should be established between operators to prepare their contributions together. The Commission agreed to provide the framework for this collaboration.

IAEA RESEARCH REACTOR SAFETY PUBLICATIONS (Schematic)

Safety Series Categories:

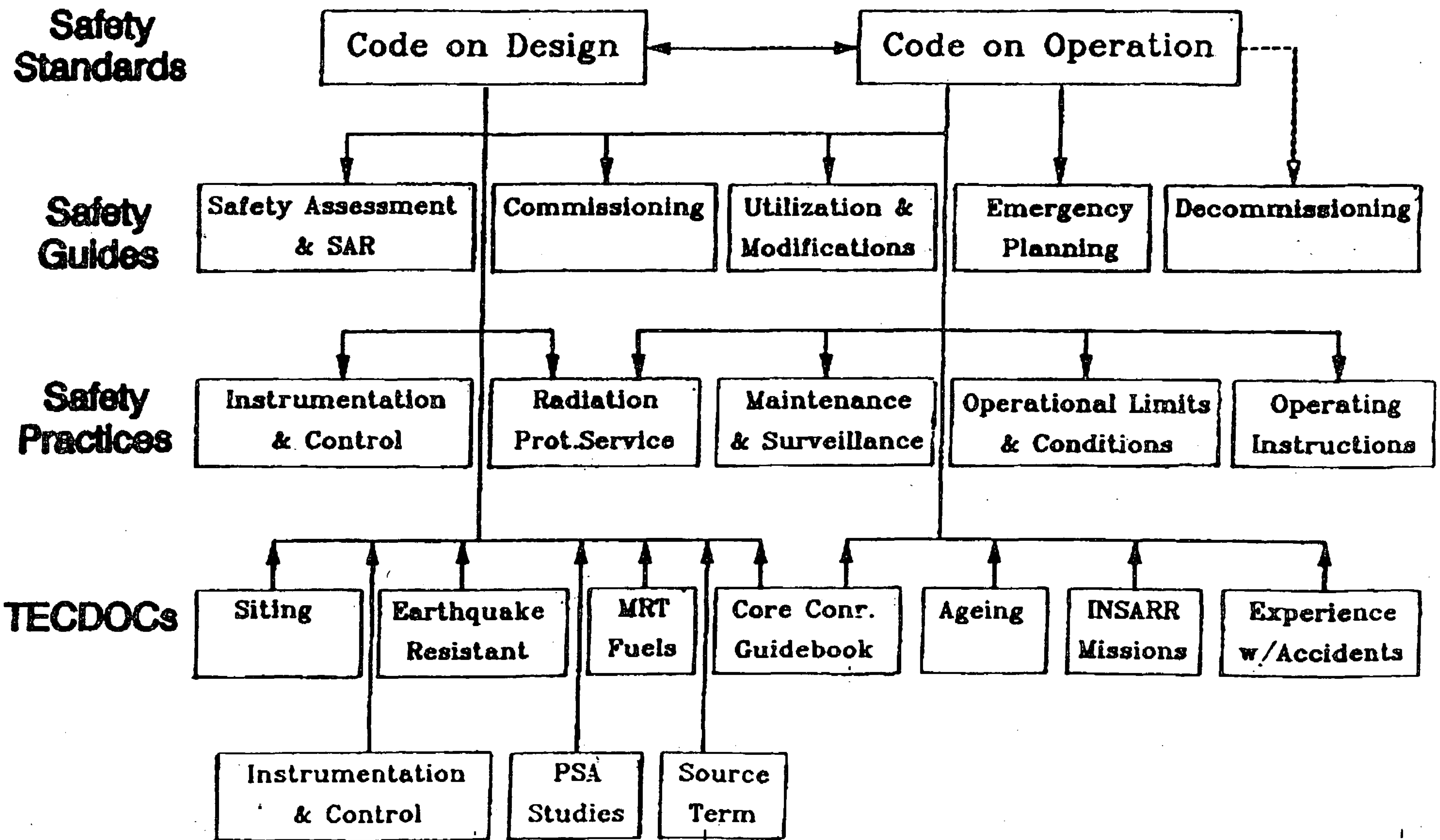

TABLEAU 3-

VI. Fuel cycle of testing reactors

1.- Fuel evolution.

In the beginning of the 50s, the American authorities encouraged the development of peaceful utilization of nuclear energy through the programme "Atoms for Peace" launched by President Eisenhower in December 1953. This programme led to the transfer of until then secret information, from the United States to Europe and the first test reactors were built, in the United Kingdom and then in the rest of Western Europe.

At the beginning, U235 assay in the fuel was generally of the order of 20%. At the end of the 50s, it was increased to 93% to allow higher neutron fluxes.

The United States have always been and officially still are the only supplier of highly enriched uranium (HEU). Until 1974, this HEU could be leased from the former Commission of American Atomic Energy (AEC). Operators of testing reactors had to pay only rather low leasing charges in the order of 5% per year on the basis of the consumption of the uranium, including burn-up and losses.

Around 1974, the American commercial policy changed and operators of testing reactors had to purchase the material. However, the procurement of American HEU was relatively easy and was not encumbered by administrative obstacles. The particularly attractive prices offered by the DOE and the conditions proposed (see paragraph 3) eliminated competition. But in 1977, President Carter declared himself to be concerned about "the wide spread of weapons-usable material" in testing reactors.

He took the initiative to start an International Fuel Cycle Evaluation (INFCE). Working Group N° 8 of this new action was charged with investigating how to avoid the utilization of HEU and to promote fuels having a reduced U235 assay.

As a result of this working group, it was decided that the ideal U235 assay was 19.75% ±0.2%. In order to maintain fuel element geometry, an increase of fuel density was necessary. Development of such a high density fuel was the subject of the RERTR (Reducing Enrichment in Research and Test Reactors) programme of the Department of Energy (DOE) and of an international cooperation involving many organizations and enterprises of the Community. In September 1990, the annual meeting decided that the RERTR programme had achieved its objectives because the majority of research and testing reactors could be converted to low enriched fuel (LEU) to below 20%. Consequently, the development of high density fuel for certain high performance reactors, has ceased: these reactors continue to use highly enriched fuel.

2.- The supply of highly enriched uranium and the fabrication of fuel

The preceding paragraph showed that the United States has established and developed a monopoly on the supply of enriched uranium used for peaceful purposed with U235 assays from 10 to 98%.

The supply of uranium by the Department of Energy (DOE) is carried out under a contract which generally specified that the material would be delivered as the hexafluoride (UF_6), but made provision for conversion to the metal as an extra service available on request. This was temporarily suspended from mid 1989 to mid 1990 and the French firm COGEMA met needs during the period.

The export of enriched uranium of American origin is covered by the "Nuclear Non-Proliferation Act" (NNPA) of 1978 and by the "Atomic Energy Act" as amended. Consequently, export licences can only be given on a case by case basis and not as a general authorization. To obtain such a licence for highly enriched uranium requires the establishment of a detailed inventory of materials present on the reactor site and the justification of new requests together with a declaration of use. The transport of HEU to Europe has considerably decreased in the last few years and the cancellation of certain means of transport has increased its difficulty. Nevertheless, there still exist enough stocks in the Community to cover the needs, at least in the short term. The fabrication of fuel for MTRs (and for research reactors) is carried out in the Community by the Atomic Energy Authority (AEA) at Dounreay and above all, by the French company CERCA which, since its amalgamation with the relevant department of the German firm NUKEM, has become the largest producer of research reactor fuel in the world.

Other fabricators exist, such as the Danish national laboratory at Risø, which produces elements for use in its own reactor DR3, however, the principal factory outside the Community is that of Babcock and Wilcox in Lynchburg in the United States.

3.- Reprocessing and Waste Disposal.

Until recently, the United States were not only the supplier of highly enriched uranium to Europe but also carried on the reprocessing of spent fuel in two plants belonging to the DOE: Idaho National Engineering Laboratory (INEL) and Savannah River Site in South Carolina, also used for irradiated fuel from military reactors. The DOE took charge of the waste and the plutonium, the reactor operator receiving a credit in highly enriched uranium against his following order. In fact, the plutonium was not separated but treated with the waste. This policy began with the "Atoms for Peace" programme and was pursued up to 31 December 1988.

Effectively, at that date, the DOE had to elaborate a study on the environmental impact of its policy ("Environmental Assessment"). The long environmental administrative procedure necessary for the exercise already introduced considerable uncertainty in the pursuit of the DOE's policy, also criticized on economic grounds. The decision taken in February 1992 to stop the reprocessing of spent fuel from the U.S. Navy as soon as possible, has only served to reinforce the uncertainty.

Questions concerning the tail-end of the MTR fuel cycle are being posed ever more sharply not only for the Community but for those operating research reactors throughout the world, except for American ones for which the DOE's policy is still valid.

Solutions which might be envisaged in the Community framework are already being examined in Member States possessing the necessary technology; essentially France and the United Kingdom.

Questions relating to the tail-end of the fuel cycle may have consequences on the supply of HEU. The constraints weighing on American material and the expected intentions of the DOE regarding prices may render that source of supply less attractive and encourage the search for other potential suppliers. The number of possibilities offered is limited because only the Community (France and the United Kingdom) and the Russian Federation are in a position to offer highly enriched uranium.

4.- Special Fuels.

As a reminder, certain special fuels, at the end of the cycle have to be treated individually. Their original characteristics make it impossible to reprocess them with other research reactor fuels. Reprocessing possibilities should be examined as should other options such as treatment to prepare for permanent storage.

5.- Conclusions.

Questions relating to the fuel cycle of materials testing reactors are, among others, one item in the mandate conferred on the Chairman of the Euratom Scientific and Technical Committee (STC) Mr. Horowitz, and his study should allow the examination of technically and economically possible ways. These will be the subject of a special attention by the Commission which will not fail to make a report to the Council when the conclusions of the Scientific and Technical Committee become available.

Nevertheless, the Coordination Group wished to underline the present incoherence of American policy. It considered that all possible solutions should be examined.

V. The special case of medical applications.

As has already been said, the utilization of testing reactors for medical purposes for the production of radioisotopes, necessary for the diagnosis and therapy of certain illnesses (notably cancer) has been financially marginal until now. The necessity of maintaining a production in Europe of these radioelements, whose future is tightly connected to testing reactors, had led the Commission to finance an in-depth study on this question and to consult with the principal organizations and industries concerned.

1.- A discipline particularly important for public health.

Medical use of radioactive isotopes is today part of normal medical practice and permits highly specialized examination or therapy to be carried out. Although it involves specialist techniques, the number of patients concerned is large.

For diagnosis, there exist about 3,500 gamma cameras in Western Europe, located in 1,800 specialized centres (generally hospitals). In total, more than 5 million examinations of this type are carried out each year on about 4.5 million patients.

In the area of therapy, current applications, apart from cobalt-therapy, are strongly targetted: classical radiotherapy concerns approximately 300,000 patients in Western Europe. As for metabolic radiotherapy (for thyroid, rheumatism of the joints, polyglobulins, etc.) some 30,000 to 50,000 patients per year are treated.

During recent years, the rate of development of nuclear medicine has reached approximately 6-7% per year, expressed in the volume of products used and the the sale of gamma cameras.

2.- Radioactive isotopes use in medicine.

Rays emitted by radioactive elements find medical applications in *in vivo* diagnosis, as measuring signals and in therapy, as a means of very local destruction. Reminder: very small quantities of iodine 125 are also used as tracers in *in vitro* diagnosis.

Choice of isotopes: a difficult compromise

The choice of elements used depends on several factors:

- the type of rays emitted (γ rays are used for diagnosis and γ and β in therapy);
- the period of the radioactive isotope (very short to limit undesirable secondary effects in the patient but sufficiently long to permit production and transport, the best compromise being, in most cases, in the order of 3 days);
- eventual affinity with an organ or a tissue type, tropism for a function or a particular metabolism;
- energy adapted to application: level compatible with sensitivity range of gamma camera in diagnosis, total energy delivered which permits destruction of tumors or cysts in therapy;
- chemical properties of isotopes (ability of association with vectors).

These different parameters are shown in Figure 1 and have allowed the identification of more than 20 radioactive isotopes of medical importance.

Double origin of isotopes

Radioactive isotopes use in medicine are produced in two types of installation: nuclear research reactors (mainly MTRs) and cyclotrons, with the exception of cobalt 60, an element of long lifetime, which is mostly produced in thermal nuclear power plants, when irradiation time is of the order of 3 years. However, except in exceptionally rare circumstances, this means of production is not an alternative: isotopes in use can in general only be produced in a single type of installation.

The principle vocation of **research reactors** is to test materials used in nuclear power plants. However, the most powerful of them (essentially MTRs) can also produce the isotopes needed in medical applications. These are extracted from a target irradiated by the reactor's neutron flux.

RESPECT OF CONSTRAINTS
(Medical purpose, Protection of patient, Isotope logistics, Required radiation intensity)
CONSIDERABLY REDUCES THE POSSIBLE NUMBER OF ISOTOPES OF MEDICAL INTEREST

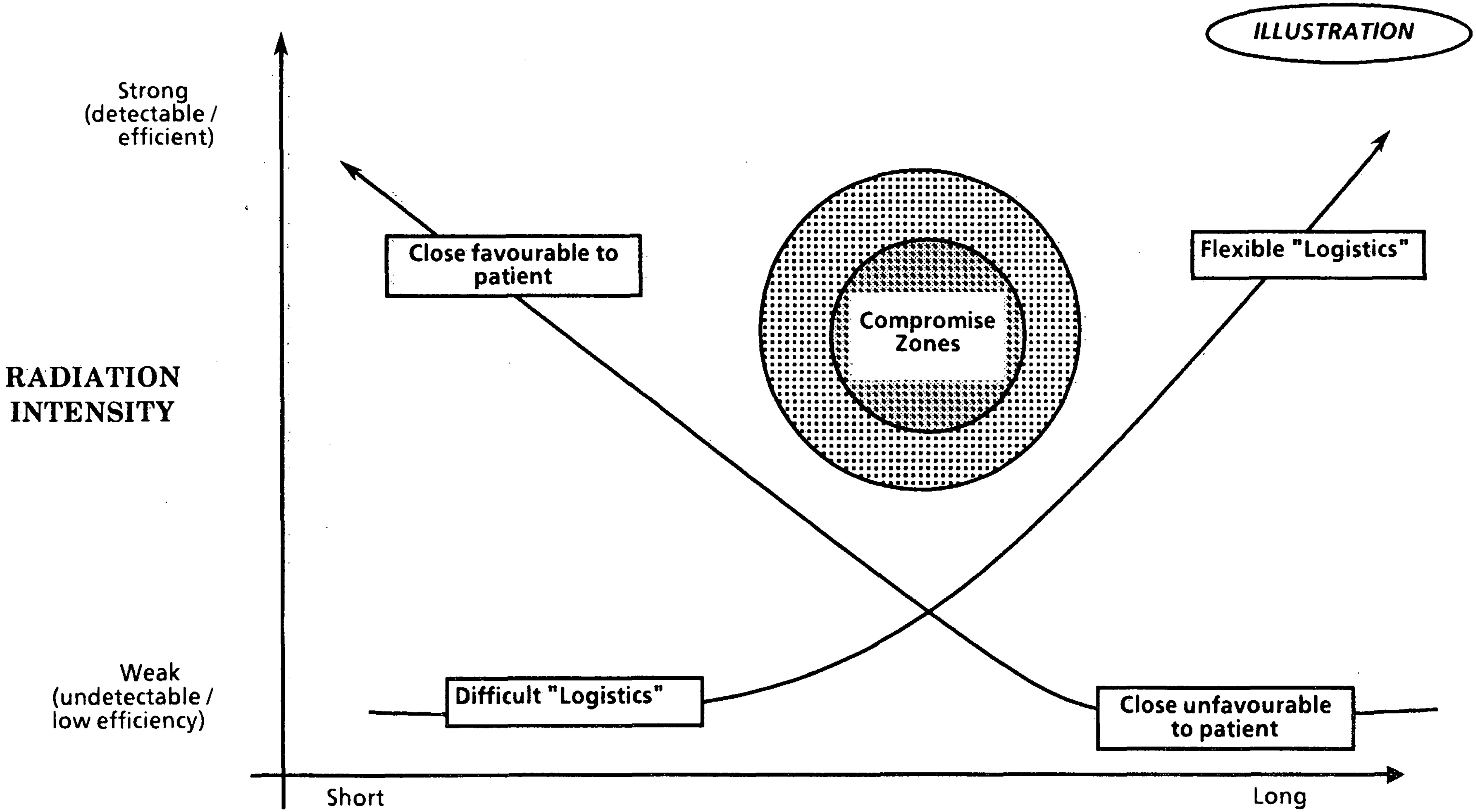

FIG. 1: PERIOD OF ISOTOPE
(or length of patient exposure)

This target is made either from enriched uranium from which fission products are extracted (molybdenum 99, xenon 133, iodine 131, etc.) or from stable isotopes, sometimes enriched, close to the one which it is wished to obtain (cobalt 60, iridium 192, rhenium 186, etc.). **Cyclotrons** on the other hand, are installations specially conceived for medical use.. The principle production is different in that cyclotrons generate fluxes of electrically charged particles.

Radioactive isotopes produced by **research reactors** cover:

- **a great majority** of **diagnostic** applications. Those most often used are technecium 99m (obtained from the decay of molybdenum 99) and iodine 131, but at the same time there are other isotopes for particular applications (iron 59, chromium 51, xenon 133, etc.);
- **all** isotopes used in **therapy** at present, notably, iodine 131, iridium 192, rhenium 186, ytrium 90 etc.;
- products coming from **cyclotron** irradiations are only applied in diagnosis and are principally thallium 201, iodine 131 and gallium 67. Table 4 and Figure 2 illustrate this situation.

3. Problems with the production of radioactive isotopes

A situation which could become critical.

European needs in medical radioactive isotopes supplied by R & D reactors represent an added value resulting from irradiation, of between 5 and 6 Mioecu in 1992. This figure probably does not represent the real cost because operators of these reactors consider medical irradiations as being a marginal business which is not taken into account when planning future activities. Currently, irradiation costs represent some 30% of the price of an isotope that can be used directly but may drop to under 10% if intermediate equipment is necessary (a technecium generator for example). There is no doubt that the part consisting of irradiation services making up the price of medical products will rapidly grow, which in turn will result in an increase in prices themselves.

Because of the slowing down of civil nuclear programmes, the medium-term future of four European reactors (BR2, Belgium; OSIRIS, SILOE, France; HFR, Netherlands) most concerned with medical applications may be put in doubt. Any reduction in the number of these reactors and thus the capacity available for medical applications could lead to a serious rupture in the supply of radioactive isotopes. In general, these radioactive isotopes cannot be stored and reserve stocks with producers only represent at the most, one or two days of consumption; continuous production is therefore necessary. This problem is even more critical since the isotopes concerned have a short lifetime.

In case of a shortfall in capacity in Europe, the European doctor would find himself dependent on Canadian production, which already covers certain European needs. Apart from dependence on what is in fact a monopoly, security of supply cannot depend on a unique and distant producer (lifetime too short for certain elements, risk of limitation or prohibition of international transport of highly radioactive substances, risk of interruption of supply by unforeseen occurrences, risk of possible breakdown of installations). this situation would prove critical for the greater part of the isotopes in use at present.

TWENTY ISOTOPES ARE FREQUENTLY USED IN MEDICINE

ORIGINE OF ISOTOPE	MEDICAL PURPOSE	Isotope	Period
CYCLOTRON	DIAGNOSIS	- Gallium 67	3.2 days
CYCLOTRON	DIAGNOSIS	- Indium 111	2.8 days
CYCLOTRON	DIAGNOSIS	- Iode 123	13.3 hours
CYCLOTRON	DIAGNOSIS	- Thallium 201	3.0 days
CYCLOTRON	DIAGNOSIS	**Product from generator :**	
CYCLOTRON	DIAGNOSIS	- Krypton 81	13 seconds
CYCLOTRON	THERAPY		
NUCLEAR R&D REACTOR	DIAGNOSIS	- Chrome 51	27.7 days
NUCLEAR R&D REACTOR	DIAGNOSIS	- Iron 59	44.5 days
NUCLEAR R&D REACTOR	DIAGNOSIS	- Iode 131	8.0 days
NUCLEAR R&D REACTOR	DIAGNOSIS	- Iode 125	59.9 days
NUCLEAR R&D REACTOR	DIAGNOSIS	- Xénon 133	5.2 days
NUCLEAR R&D REACTOR	DIAGNOSIS	**Products from generators :**	
NUCLEAR R&D REACTOR	DIAGNOSIS	- Indium 113	1.6 hours
NUCLEAR R&D REACTOR	DIAGNOSIS	- Technétium 99	6.2 hours
NUCLEAR R&D REACTOR	THERAPY	- Césium 137 *	30.0 years
NUCLEAR R&D REACTOR	THERAPY	- Cobalt 60 *	5.3 years
NUCLEAR R&D REACTOR	THERAPY	- Erbium 169	9.5 days
NUCLEAR R&D REACTOR	THERAPY	- Iode 131	8.0 days
NUCLEAR R&D REACTOR	THERAPY	- Iridium 192 *	74.0 days
NUCLEAR R&D REACTOR	THERAPY	- Gold 198	2.7 days
NUCLEAR R&D REACTOR	THERAPY	- Phosphore 32	14.3 days
NUCLEAR R&D REACTOR	THERAPY	- Rhénium 186	3.7 days
NUCLEAR R&D REACTOR	THERAPY	- Strontium 85	64.8 days
NUCLEAR R&D REACTOR	THERAPY	- Yttrium 90	2.7 days

(*) The patient is only temporarily exposed to the source of radiation classical radiotherapy and transcutaneous radiotherapy

TABLE 4-

ALL THERAPY AND MOST DIAGNOSTICS (Number treated) USE NUCLEAR R&D REACTOR-PRODUCED ISOTOPES

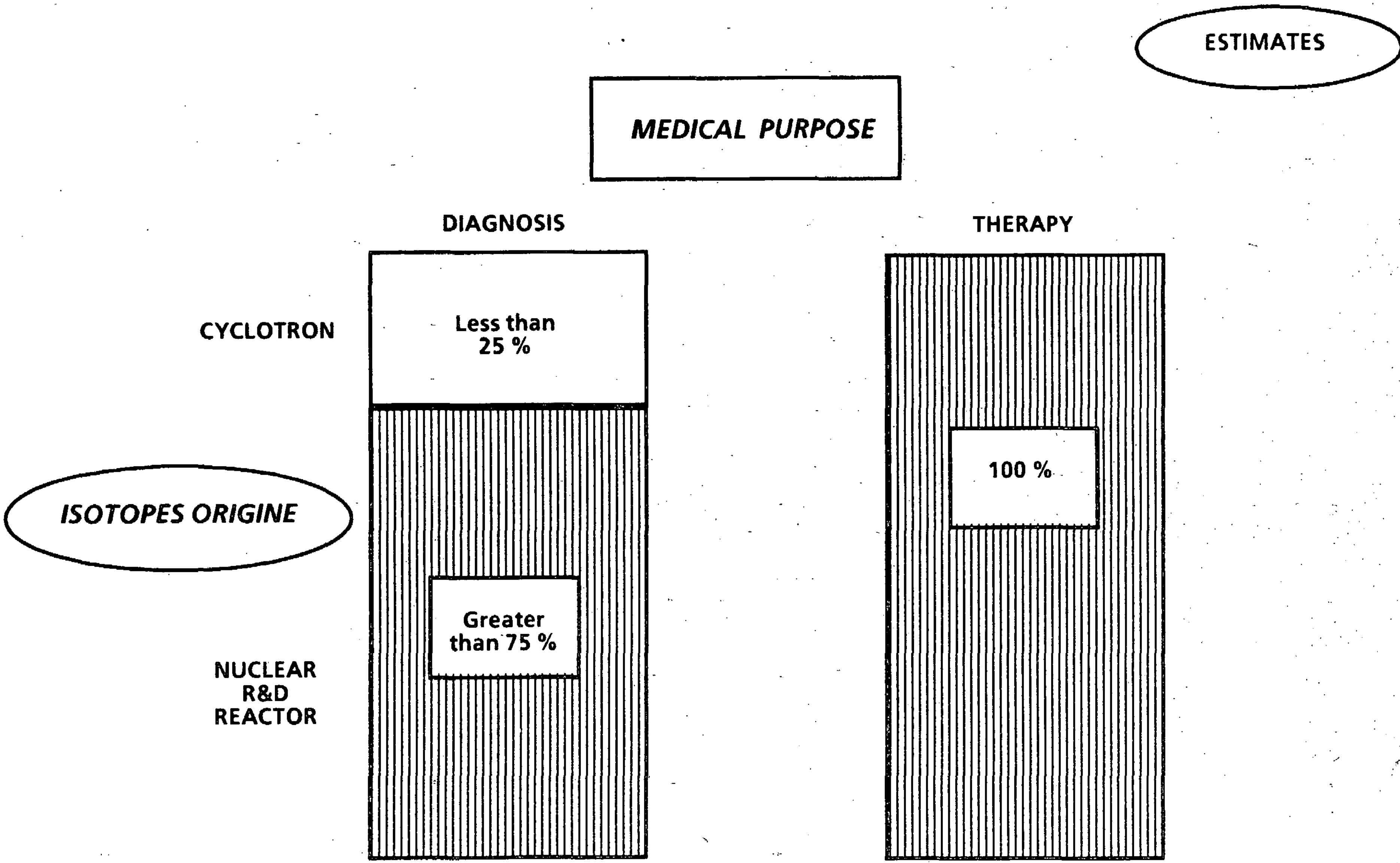

FIG. 2 -

In conclusion, the Coordination Group states that in view of the importance for public health of medicine using isotopes produced by nuclear research reactors and mainly MTRs, the Community cannot allow serious ruptures to their supply. Only a "local" production can serve to cushion any risk of this type. Taking into account the necessary delays and financial consequences tied to any long-term solution, the problem, solutions and the resulting consequences have to be resolved immediately.

VI. Towards a reinforced concertation on the use of MTRs

The Coordination Group made a detailed examination of all aspects relevant to the irradiation services market offered by materials testing reactors in the Community. Participants unanimously underlined their concerns regarding the development of the international market. The possible emergence into this market of reactors sited in Eastern countries and meeting only uncertainly criteria established in the Community for the operation of MTRs could lead to problems later. On the other hand, it is apparent that existing contacts between operators are insufficient to be certain of being able to meet the exigencies of the market on a permanent basis.

The operators present recognized the interest of profound exchanges they had in the various meetings of the Coordination Group and wished to continue these in an appropriate framework, in particular with the aim of following the examination of items partially tackled in the limited framework of the Group.

The Coordination Group has thus decided on the creation of an operators' club for MTRs to which other organizations could be associated (notably the reactor at Risø in Denmark and eventually the R2 in Sweden); the organization of the club should be conferred on the Commission.

In addition, the Group returned to an in-depth examination of the situation of medical applications where participants considered that the importance and sensitivity of the subject should lead to the creation of an European Economic Interest Grouping focussing on this very precise activity in MTRs. The Commission is asked to examine in detail all the implications of this. The Commission agrees to give every assistance needed in the constitution of such a grouping.

III.

CONCLUSIONS

The work of the Coordination Group on Materials Testing Reactors in the Community set up in conformity with the wishes of the Council of Ministers (Research) of 29 April 1992 reached the following conclusions :

1) with respect to economic aspects relating to the exploitation of the reactors, based on information provided by operators, the Group was unable to find any significant distortion in the calculations of operating costs for any reactor.

2) concerning the setting up of financial instruments, more particularly Euratom Loans, the Commission will continue to examine, in close liaison with operators, modalities of application to these reactors of the Council Decision N° 77/720/Euratom together with intervention possibilities by the European Investment Bank.

3) with reference to the safety of materials testing reactors, the Coordination Group expressed particular satisfaction about the quality of international collaboration already in existence. It considered that increased support should be brought to the work of the IAEA and to the Research Reactors Operators' Grouping and that for that purpose a close concertation between operators should be established to prepare their contributions together. The Commission agreed to furnish the framework for this collaboration.

4) questions relating to the fuel cycle of materials testing reactors are, among others, one item in the mandate conferred on the Chairman of the Euratom Scientific and Technical Committee (STC) Mr. Horowitz, and his study should allow the examination of technically and economically possible ways. These will be the subject of a special attention by the Commission which will not fail report to the Council when the conclusions of the Scientific and Technical Committee become available.

   Nevertheless, the Coordination Group wished to underline the present incoherence of American policy. It considered that all possible solutions should be examined.

5) The Coordination Group's attention was drawn to medical applications and it considers that in view of the importance to public health, of the use, in medicine, of isotopes produced by nuclear research reactors and mainly MTRs, the Community cannot allow serious ruptures to their supply. Only a "local" production can serve to cushion any risk of this type. Taking into account the necessary delays and financial consequences tied to any long-term solution, the problem, solutions and the resulting consequences have to be resolved immediately.

6) The Coordination Group has thus decided on the creation of an operators' club for MTRs to which other organizations should be associated (notably the reactor at Risø in Denmark and eventually the R2 in Sweden). The organization of the club has been conferred on the Commission.

In addition, the Group returned to an in-depth examination of the situation of medical applications where participants considered that the importance and sensitivity of the subject should lead to the creation of an European Economic Interest Grouping focussing on this very precise activity in MTRs. The Commission is asked to examine in detail all the implications of this. The Commission agrees to give every assistance needed in the constitution of such a grouping.

IV.

ANNEXES

Commission of the European Communities

JOINT RESEARCH CENTRE

Institute for Advanced Materials

The Director

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Petten, 10 July 1992

JA/gp/92.0537

NOTE

Re : **Additional comments on the cost structure of HFR Petten**

The technical subgroup on pricing policy of the co-ordination group on material testing reactors has arrived at a comparative table on costing structures for BR2, HFR, OSIRIS, SILOE.

The following additional comments are given to the related lines of the table.

DEPRECIATION

Refurbishment

Investments into refurbishment and purchase of new equipment required for reactor operation, as well as major refurbishments and maintenance of the building complex are included in the costs; they are budgeted in year of commitment.

Reactor/buildings

Depreciation of investments into the HFR complex (reactor installation and buildings) is not included in the operation costs.

Product related/projects

All investments into ancillary equipment for executing the exploitation programme, as well as investments into dedicated facilities is included into the operation costs and budgeted in year of commitment.

New investments

Addressed under refurbishment.

Visiting address: Westerduinweg 3 - 1755 LE Petten, The Netherlands

PROVISION

Reprocessing

Until end of 1988 the full costs of the back end of the fuel cycle were included in the HFR irradiation tariffs, i.e. the costs of reprocessing were fully taken into account. These costs were more than balanced by the credits for unburnt uranium in the spent fuel. Since the beginning of 1989 the return shipments of spent fuel to the USA were suspended and no expenditures for reprocessing were made. At the same time the full price for fresh uranium had to be paid without compensation for uranium credits resulting from the return of spent fuel. Last month the US-DOE announced that the DOE reprocessing plants will be phased out. As a consequence reprocessing in the USA can no longer be regarded as an option. In view of this new situation the Commission decided to include a provision for reprocessing in the HFR operation costs as per June 1992.

Storage

All expenditures for temporary on-site storage of spent fuel elements are included in the operation costs.

Dismantling reactors

No provision is made for dismantling of the HFR.

Dismantling new installation

Dismantling of experimental equipment and related waste disposal is included in the project costs.

OVERHEADS

Reactor/organization

All reactor operation related overheads as well as exploitation related overheads, including administration and infrastructure and JRC headquarters are included in the HFR operation/utilization cost.

COMMISSARIAT A L'ÉNERGIE ATOMIQUE

DIRECTION DES RÉACTEURS NUCLÉAIRES

9.07.92

COST OF AN EXPERIMENT

1 - COST OF AN EXPERIMENT

The cost of an experiment in a reactor comprises :

A/ Studies and realizations related to the rig and measuring and control systems and their associated informatics.

B/ Experiment engineering : preparation, surveillance, analysis of the results accompanied by calculation of nuclear characteristics, the dosimetry campaign possibly using a mock-up, surveillance of parameters with adjustments to conditions mainly at the start of the cycle, data treatment, the measurement of neutron detectors, preparation of the report ...

C/ Neutron costs. The latter are only treated in terms of the operation of the reactor concerned, in all cases the following are also taken into account :

- surveillance of experiments by shift operators, the analysis of alarms with or without consequences on the operation of the reactor,
- manipulations of the rig concerned for its transfer to and from hot cells and/or to and from various positions in the pool for non-destructive examination,
- recuperation of samples and sending them to specialized laboratories,
- safety analysis of each experiment,
- providing the interface with the Safety Authorities, the operator having responsibility for the safety of the reactor and its experimental load.

The service under points A and B having been defined, the group of charges included in the neutron costs will be shown, these being the result of the weighting between the operational budget and the experimental load.

2 - BUDGET

The operational budget for the reactos OSIRIS and SILOE comprises :

. LABOUR CHARGES

These consists of the overall labour charges to which is added :

- Technical and administrative support from the Department of Experimental Reactors,

- Logistic charges for the Nuclear Reactors Directorate,
- CEA headquarters charges,
- Early retirement charges to which certain reactor operating staff have a right (manipulation hall, hot cells, ...)

. OPERATION

This consists of all orders connected with reactor operation and includes renewal of items and replaceable components, not forgetting contracts between supporting units of the Centres (effluent treatment, decontamination, staff transport, medical surveillance, heating, ambulance and fire services, entry control ...) and maintenance contracts signed with enterprises.

. BASIC NUCLEAR INSTALLATION TAX

In France, every basic nuclear installation (I.N.B.) is subject to taxation by the Ministry of Industry. The tax is to cover operational costs of the Safety Authorities.

. FUEL

The item comprises :

. supply and conversion costs,

. fuel element fabrication and inspection costs,

. transport costs of irradiated elements,

. reprocessing or storage costs in dedicated facilities such as PEGASE (in the pool) and CASCAD (dry storage) at CEN, CADARACHE.

. ELECTRICITY AND WATER

This item differs considerably between OSIRIS and SILOE because the latter uses the river DRAC as a source of cooling water whereas with the cooling towers used by OSIRIS water consumption is very high.

. WASTE

The item consists of a part of the services rendered by the Centres in treating liquid effluents, preconditioning the residues and conditioning the solid waste. To that is added transport within each Centre as well as extra-mural transport for storage managed and charged for by ANDRA.

. HEALTH PHYSICS

Staff for the surveillance and measurement of ionising radiation who are present at reactors is not managed by the Reactor Department but by a support unit at each centre. Services are thus billed annully pro-rata with the staff deployed, in agreement with the Safety Authorities.

. REFURBISHING

Refurbishing carried out before 1991 did not appear in bills for irradiations. Since that time, depreciation for expenditures of this nature is included (change of the control system presently in course at OSIRIS and the installation of new heat exchanges in "SILOE").

. DECOMMISSIONING

In the same way, since 1991, the year in which agreements between the CEA and its partners EDF and FRAMATOME were signed, a provision for decommissioning the installations has been included when establishing neutron costs.

3 - **REMARKS**

- Dosimetry and neutron calculations associated with reactor operation are included within the relevant neutron cost envelope. Services related to an experiment itself appear under point B above, in the first paragraph.

- Depreciation of investments connected with the construction of the two reactors (in 1960 and 1966) is not taken into account.

ADDITIONAL COMMENTS ON THE COMPARATIVE TABLE ON COST STRUCTURE OF BR2

DEPRECIATION

* Refurbishment: the BR2 cost model does not incorporate any depreciation for the refurbishment of BR2, since it has not yet taken place .
  Normally, in the event that refurbishment will take place, these costs can be taken into account for pricing purposes.

* Reactor/buildings : depreciation charges related to past investments in buildings or general reactor equipment are not included.

* Product related / projects : the only exception was made for specific product related investments that were made in the past. In the BR2 model, the impact on total cost is rather small.

* New investments: new expected investments until replacement of the Be-matrix (within 3 to 4 years) are taken into account but are kept at minimum. It is expected however that real investments in the next coming years will be higher than those considered for the model.
  If is was certain that BR2 would be operational after a Be-matrix replacement, these additional investment (estimated at some 20 MBEF per year) should be taken into account for pricing purposes.

Storage : in the waste costs there is a small portion that is related to temporary storage of waste and a provision for final burrial. These amounts are paid on an annual basis to the official institute NIRAS in Belgium. Costs for the storage of fuel elements, however, are yet not included in the cost model.

Dismantling BR2 reactor : no provision is made for dismantling the BR2 reactor.

Dismantling new installation : for the new installations which will operate until the replacement of the current Be-matrix, provisions are made for dismantling and waste management; they are spread over the remaining life-time of the current matrix.

OVERHEADS

BR2 Reactor : only specific BR2 related overhead is taken into account in the cost model.
These costs are :
- porters BR2 building
- BR2 radiation control
- cleaning BR2 buildings
- maintenance
- accounting fissile materials
- emergency plan
- quality control on BR2 products
- dosimetry
- nuclear insurance
- CPU time
- management BR2.

Organisation : general SCK overhead costs are at present not taken into account in the BR2 cost model.
These costs are :
- cost for medical service
- cafetaria, library
- marketing and communication
- general and analytical accounting
- costs of central workshops (technical services)
- data processing department
- cleaning of buildings other than BR2
- general administration (telephone, fax, car rental)
- infrastructure works
- purchasing department
- personnel administration
- general security and safety other than BR2 related.

In order to recover the full exploitation costs a portion of these general overhead costs should be attributed to the BR2 products.