COMMISSION OF THE EUROPEAN COMMUNITIES

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REPORT FROM THE COMMISSION TO THE COUNCIL
INTERNATIONAL NUCLEAR FUEL CYCLE EVALUATION (INFCE)

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CONTENTS

		Page
I	INTRODUCTION	1
II	INFCE : ITS ORIGIN, AIMS AND WORK DONE	2
III	MAIN RESULTS OF THE WORK	4
IV	FINAL CONSIDERATIONS ON INFCE AND COMMUNITY ACTION	8

ANNEX 1 : LIST OF PARTICIPATING COUNTRIES AND ORGANIZATIONS

ANNEX 2 : LIST OF THE INFCE WORKING GROUPS AND OF THEIR CO-CHAIRMEN

ANNEX 3 : SUMMARY OF THE TECHNICAL RESULTS

I INTRODUCTION

1. The Commission of the European Communities participated in the work of International Nuclear Fuel Cycle Evaluation (INFCE), which took place between October 1977 and February 1980.

2. It feels that it is its duty to forward, for information, to the Council, the European Parliament and the Economic and Social Committee a report summarizing the origin and aims of INFCE, the work done and its main results and presenting certain considerations on Community action in the nuclear field in relation to this international exercise.

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II INFCE : ITS ORIGIN, AIMS AND WORK DONE

3. International Nuclear Fuel Cycle Evaluation (INFCE) dates back to the change in the United States's nuclear policy, which was prompted by fears that the peaceful uses of nuclear energy in a growing number of countries might increase the risk of the proliferation of nuclear weapons.

4. In April 1977, President Carter declared :

"Among other things, we will explore the establishment of an international nuclear fuel cycle evaluation programme aimed at developing alternative fuel cycles and a variety of international and U.S. measures to assure access to nuclear fuel supplies and spent fuel storage for nations sharing common non-proliferation objectives".

5. The Western Summit held in London on 7 and 8 May 1977 accepted President Carter's initiative "in principle".

6. The inaugural Conference of INFCE was held in Washington on 19 - 21 October 1977.

The final communiqué from this Conference gives an accurate picture of the aims and nature of INFCE and of the way it was organized.

The following passages deserve to be quoted in extenso :

"The participants are conscious of the urgent need to meet the world's energy requirements and that nuclear energy for peaceful purposes should be made widely available to that end. They are also convinced that effective measures can and should be taken at the national level and through international agreements to minimize the danger of the proliferation of nuclear weapons without jeopardizing energy supplies or the development of nuclear energy for peaceful purposes".

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"The participants recognized that special consideration should also be given to the specific needs of and conditions in developing countries".

"The participants agreed that INFCE was to be a technical and analytical study and not a negotiation. The results will be transmitted to governements for their consideration in developing their nuclear energy policies and in international discussions concerning nuclear energy cooperation and related controls and safeguards. Participants would not be committed to INFCE's results".

"The evaluation will be carried out in a spirit of objectivity, with mutual respect for each country's choices and decisions in this field, without jeopardizing their respective fuel cycle policies or international cooperation, agreements and contracts for the peaceful use of nuclear energy, provided that agreed safeguards measures are applied".

As regards the organization of the work, the Washington Conference decided to set up eight working groups, laid down their terms of reference and assigned to certain countries the responsibility of co-chairing them. All the participants (countries, the Commission of the European Communities and other international organizations) were able to contribute to the work of these groups on an equal footing(*).

The Washington Conference also decided to set up a Technical Coordinating Committee (TCC), composed exclusively of the co-chairmen of the working groups, with the task of coordinating the work of the groups from a technical standpoint.

7. After more than two years of intensive work, for which the International Atomic Energy Agency (IAEA) in Vienna provided a large part of the secretarial services, eight

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(*) See the list of participating countries and organizations at Annex 1, from which it emerges that the only noticeable absence was that of China and the list of working groups and their co-chairmen at Annex 2.

reports (one by each of the working groups) and a Summary and Overview were drafted.

8. The INFCE Final Conference was held in Vienna on 25 - 27 February 1980. It took note of the eight reports and of the Summary and Overview and decided to officially communicate them to the governments of the participating countries, as well as to put them at the disposal of all governements and international organizations concerned with the field of peaceful uses of nuclear energy.

Lastly, it declared the INFCE programme finally closed.

III MAIN RESULTS OF THE WORK(*)

9. The main results of the work can be summarized as follows :

The role and development of nuclear energy

a) INFCE has confirmed that nuclear power is playing an increasingly important part in meeting the world's energy requirements ;

b) INFCE has recognized that, in view of the grave uncertainties of various kinds affecting uranium supply, it is in the interests of the industrialized countries and regions of the world which import large quantities of this energy source to develop nuclear strategies enabling it to be used as efficiently as possible. Fast breeder reactors could in the long term play a major role in this respect ;

Resistance to proliferation

c) INFCE has underlined the fact that a governement's decision to equip itself with nuclear weapons is essentially political and prompted be reasons of national security, and that the peaceful use of nuclear energy is neither the easiest nor most economic method of manufacturing nuclear weapons ;

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(*) A more detailed summary of the technical results is given at Annex 3.

d) INFCE has demonstrated that the implementation of new technical processes can contribute in only a limited measure to non-proliferation policy and consequently that the United States' attempt to employ radically new methods (alternative and futuristic nuclear fuel cycles) for futur nuclear development is not at all likely to produce the hoped for results ;

e) INFCE has recognized that the risks of proliferation inherent in the various cycles cannot be compared in an abstract manner but depend on a number of specific factors, which for the most part are subject to change ; hence there are neither cycles that are totally free from risks nor cycles that are per se incompatible with the objectives of non-proliferation ;

f) INFCE has emphasized that there is no universal model for a fuel cycle, the choice being conditioned not only by the need to minimize proliferation risks but also by economic, industrial, ecological and especially energy requirements, which vary greatly as between different countries and as between regions of the world ;

Nuclear safety

g) INFCE, while making it clear that its terms of reference did not consist in either a comparison of nuclear power with other energy sources or a thorough analysis of the consequences of the large-scale use of nuclear energy on the environment, health and safety, came to the conclusion that :

- the contribution ot the collective radioactive dose commitment from normal nuclear fuel cycle operation is small when compared to the annual exposure to natural background radiation ;

- although the radiological impact of waste management is mainly correlated with uranium demand and is

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largest for the once-through fuel cycles and smallest for the fast breeder reactor cycles, the difference in the impacts of waste management and disposal as between the various fuel cycles are not in themselves sufficient to be decisive in choosing among them ;

Possible action to be taken

h) INFCE has underlined the importance to gradually implement measures leading to a more stable and more uniform nuclear materials supply system that should be nevertheless compatible with the aims of non proliferation ;

i) INFCE has observed that the present non-proliferation system can clearly be improved and that therefore measures can and must be taken to minimize the risks inherent in the points identified as sensitive without thereby jeopardizing the development of the corresponding fuel cycles ; these measures can be classified in order of importance and effectiveness as follows :

- institutional measures : for example, the introduction of systems such as International Plutonium Storage (IPS) and International Spent Fuel Management (ISFM) ; limitation of the number of so-called "sensitive" installations (reprocessing plants, mixed uranium/plutonium fuel fabrication plants, enrichment plants, etc...) and, if possible, design and construction of these installations on a multinational basis ;

- measures to improve current safeguards ;

- technical measures : for example, the use of uranium with a medium or low enrichment factor instead of highly-enriched uranium in research reactors ; the adoption of processes to reduce or eliminate the existence in pure form in the various phases of the

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fuel cycle of materials that can be used of explosive purposes ; and the use of physical barriers to protect this type of material ;

The needs of the developing countries

j) INFCE has recognized that nuclear power can play an important role in the supply of energy to a number of developing countries provided that their infrastructures, which are still weak in the majority of cases, are reinforced ; hence the need for increased technical assistance from the industrialized countries, channelled in particular through the International Atomic Energy Agency (IAEA) ;

The role of the IAEA

k) INFCE has emphasized the growing role that this Agency is going to play in the nuclear field on a worldwide basis.

10. In the light of the foregoing, it can be stated that :

a) INFCE has fostered a better understanding amongst the experts of participating countries and organizations, concerning a wide range of aspects of the peaceful utilization of nuclear energy ;

b) INFCE has also fostered a dialogue between the experts of the industrialized countries and those of the developing countries. This dialogue has permitted a better understanding of each other's approach concerning nuclear energy ;

c) INFCE has offered a more objective or, if one prefers, a less emotional, framework for debating non-proliferation, by extending and comparing the knowledge concerning the proliferation resistance of different technologies ;

d) Lastly, INFCE has produced results which reflect the points of view of different countries in a balanced fashion.

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IV FINAL CONSIDERATIONS ON INFCE AND COMMUNITY ACTION

11. First, it is heartening to note that Community cooperation, under the Council presidency, in preparation for the plenary Conference and the most important meetings of the Technical Coordinating Committe has been satisfactory.

12. The results of INFCE have by and large confirmed that the Community position(*) is justified in not confining itself to recommending that thermal reactors be operated but also aiming at keeping open the option of recycling plutonium in thermal and fast reactors ; this in turn implies the reprocessing of irradiated fuels.

13. As regards the implementation of the measures suggested by INFCE, we shall confine ourselves for the time being to pointing out that :

a) the Commission has already adopted its standpoint on the possibility of setting up an International Plutonium Storage (IPS) system in the initial communication which it sent to the Council on 5 March 1980(**).
The aim of this communication is to facilitate, should the need arise, a consensus between the Member States on the conditions under which the Community would take part in the IPS and on the detailed operation of the system itself, which can without difficulty be integrated with the nuclear policy put forward by the Community provided that it does not prove discriminatory or hinder the legitimate activities of the Community's nuclear industry ;

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(*) See the three Commission communications to the Council on the reprocessing of irradiated nuclear fuels, the management and storage of radioactive waste and the development of fast reactors, which the Commission forwarded in 1977 and the Council approved on 18 February 1980.

(**) COM(80)94 final.

b) the Commission has taken part from the outset in the discussions which are being held within the IAEA on the possibility of setting up an International Spent Fuel Management (ISFM) system ;

c) the Joint Research Centre (JRC) programme in the field of safeguards, which was recently approved by the Council, is in line with the indications supplied by INFCE ; steps should be taken to increase cooperation between the Community and the IAEA (as the Council, moreover, explicitly recommended when adopting the JRC programme). An agreement on this point is being negotiated.

14. The Community must certainly follow closely whatever action may be taken on the results of INFCE, since this exercise has shown that the peaceful use of nuclear energy at world level can in the future be envisaged only in the context of increased international cooperation both in terms of securing supplies in the wide sense and in terms of minimizing the risks of proliferation.

Nevertheless, this orientation cannot be translated into practical terms without a wide-ranging political consensus between the parties concerned.

While INFCE has made it possible to gain a better understanding of the underlying attitudes on all sides, it would be an illusion to imagine that this consensus can easily be reached, INFCE not having succeeded in allaying fears that trade in the nuclear sector would continue to be distorted, or even disrupted, by the unilateral action of certain governments.

In addition, the risk that certain technologies (for example, plutonium recycling in thermal reactors) would be subject to discriminatory treatment is still with us.

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The Community, which is based on the principle of equal access to resources and non-discrimination in the peaceful uses of nuclear energy, cannot be indifferent to these risks.

Accordingly, its course of action in the forthcoming bilateral and multilateral negotiations must steadfastly uphold the principle of non-interference in the free choice of technologies, provided, of course, that the latter are utilized with due regard to the non-proliferation obligations that have been entered into.

ANNEX 1

LIST OF PARTICIPATING COUNTRIES

Algeria
Argentina
Australia
Austria
Belgium
Bolivia
Brazil
Bulgaria
Canada
Chile
Colombia
Cuba
Czechoslovakia
Denmark
Ecuador
Egypt
Finland
France
German Democratic Republic
Federal Republic of Germany
Ghana
Greece
Guatemala
India
Indonesia
Iran
Iraq
Ireland
Israel
Italy
Japan
Kuwait
Korea
Liberia
Lybia
Malaysia
Mexico
Netherlands
New Zealand
Niger
Nigeria
Norway
Pakistan
Panama
Paraguay
Peru
Philippines
Poland
Portugal
Qatar
Romania
Saudi Arabia
Senegal
South Africa
Spain
Sweden
Switzerland
Thailand
Tunisia
Turkey
USSR
United Kingdom
United States
Venezuela
Yugoslavia
Zaire

ANNEX 1 (2)

International Organizations

Commission of the European Communities

International Atomic Energy Agency

International Energy Agency

OECD's Nuclear Energy Agency

United Nations

ANNEX 2

LIST OF THE INFCE WORKING GROUPS AND OF THE CORRESPONDING CO-CHAIRMEN

1. Fuel and heavy water availability	Co-chairmen: Canada, Egypt, India
2. Enrichment availability	Co-chairmen: France, Federal Republic of Germany, Iran
3. Assurances of long term supply of technology, fuel, heavy water and services to cover national requirements that are compatible with non-proliferation objectives.	Co-chairmen: Australia, Philippines, Switzerland
4. Reprocessing, Plutonium handling, recycle	Co-chairmen: Japan, United Kingdom
5. Fast breeders	Co-chairmen: Belgium, Italy, USSR
6. Spent fuel management	Co-chairmen: Argentina, Spain
7. Waste management and disposal	Co-chairmen: Finland; Netherlands, Sweden
8. Advanced fuel cycle and reactor concepts	Co-chairmen: Republic of Korea, Romania, USA

ANNEX 3

SUMMARY OF THE TECHNICAL RESULTS

1. Availability of resources (in particular uranium) in relation to estimates of the future installed nuclear generating capacity

In view of the uncertainties of various kinds affecting the uranium supply, INFCE clearly shows that it is in the interests of the industrialized countries and regions of the world that import large quantities of uranium to develop nuclear strategies for using it as effectively as possible. Savings of approximately 15% can be achieved by improving current light-water reactors (in a 5-10 year outlook), a saving of approximately 35-40% can be obtained by recycling plutonium in LWRs (in an outlook of a few years only), and the commercial operation of fast reactors can in the long term (at the beginning of the next century) enable these countries and regions to free themselves from the constraints inherent in the importing of uranium.

INFCE also points out that heavy-water reactors offer advantages in this respect over light-water reactors. This also holds true for thorium reactors, which will not, however, attain commercial maturity before the year 2000.

2. Degree of maturity of the technologies corresponding to the fuel cycles

The maturity of the technologies used in the fuel cycles currently employed with light-water, heavy-water and fast reactors was recognized. Further research and demonstration are still necessary in particular concerning the recycling of mixed-oxide fuels in fast reactors, temporary storage for more than 20 years of high burn-up spent fuel, the immobilisation of spent fuel ready for ultimate storage, and the ultimate storage of spent fuel or of highly-active waste from reprocessing operations.
Much work remains to be done in order to develop alternative fuel cycles (for example the uranium/thorium cycles).

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3. Availability of uranium enrichment and spent-fuel reprocessing services

No major problem is expected where uranium enrichment is concerned; on the other hand, the delay in commissioning reprocessing plants as a result of a deliberate political choice or of social, ecological and political difficulties will, towards the year 2000, involve an accumulation of a large amount of irradiated fuel (estimated at 300 000 tonnes of heavy metal) pending reprocessing or ultimate storage (the once-through strategy). INFCE considers, however, that the problem will be particularly acute only for countries and regions that have decided to delay reprocessing for an indefinite period.

4. Economic considerations concerning the fuel cycles

Economic considerations cannot be dissociated from either more general considerations concerning energy strategy or other, less quantifiable factors such as the long-term balance of payments, the utilization of capital and manpower resources and the industrial infrastructure.

Countries and regions of the world differ widely in this respect.

It is therefore impossible to assert that a given fuel cycle offers decisive advantages over others in all circumstances.

The importance of reprocessing was nevertheless recognized, since it is an essential stage in a number of fuel cycles.

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The economic arguments for fuel cycles incorporating reprocessing, as against once-through fuel cycles, depend on the price of uranium and on the subsequent use that is made of the separated plutonium and uranium. If they are recycled in light water reactors, the economic advantage is not likely to be large. Nevertheless, some countries see it as a positive contribution to energy independance and assurance of supply. On the other hand, if capital costs and fuel cycle costs of fast reactors can be brought down sufficiently, then the economic and assurance of supply advantages of fast reactor recycle could be considerable. Most countries planning to use plutonium therefore look mainly to its use in fast reactors.

But there is a significant difference in the considerations leading to decisions to proceed with a breeder development programme or to import breeders as a developed system. The decision to develop breeders implies the willingness to accept a substantial economic penalty in the early stages of deployment. Compared with the continued deployment of thermal reactors, a new level of technology is required for breeder development and also a new technological/industrial base.

The differences in the economics of the uranium/thorium cycles in comparison with the other fuel cycles do not appear to be sufficiently great to justify development work on them being either slowed down or intensified.

Lastly, INFCE confirms that the costs incurred in the temporary storage of spent fuel and in the management and ultimate storage of radioactive waste are low in comparison with the cost of each kWh generated and do not vary appreciably from one fuel cycle to another.

5. Environmental, health and safety aspects

It was not within the terms of reference of INFCE to make a comprehensive evaluation of the environmental, health or more particularly, safety aspects of nuclear power programmes.

Nevertheless, working groups made assessments of these aspects generally to determine whether a specific fuel cycle activity could be carried out in conformity with accepted standards, whether it would make a significant contribution to overall fuel cycle impacts or whether there would be significant differences among fuel cycles options in these respects.

The groups came to the following conclusions:

- the contribution to the collective radioactive dose commitment from normal nuclear fuel cycle operation is small when compared to the annual exposure to natural background radiation;

- although the radiological impact of waste management is mainly correlated with uranium demand and is largest for the once-through fuel cycles and smallest for the fast breeder reactors cycles, the differences in the impacts of waste management and disposal as between the various fuel cycles are not in themselves sufficient to be decisive in choosing among them.

6. Measures to make nuclear power widely available in order to satisfy energy requirements

INFCE first observes that the supply of nuclear materials has, generally speaking, proceeded in a satisfactory manner in accordance with normal market rules and that there are no reasons why this situation should change in the future.

Measures to improve the functioning of the market could nevertheless be considered (for example, a Uranium Emergency Safety Network or an International Fuel Bank).[1]

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[1] N.B. INFCE did not carry out an in-depth examination of the ways in which such measures could be implemented.

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On the other hand, the supply of nuclear materials could be seriously disturbed by government intervention (export controls, prior consent clauses, etc.), prompted in the majority of cases by non-proliferation policy considerations.

On this very sensitive political point INFCE only arrived at the finding that: "On the one hand, supplier governments generally place great importance on the achievement of non-proliferation objectives and are not willing to supply, or continue to supply, nuclear materials on terms and conditions that do not adequately respect those objectives. On the other hand, although sharing the non-proliferation concerns, consumer countries emphasize that changes in such conditions inhibit performance of contracts made in good faith and contend strongly that new conditions, even though associated with non-proliferation, should not be applied without mutual governmental agreement to existing contracts with countries not in breach of previously agreed conditions, and in particular not to supplies delivered prior to the change of conditions".

This having been said, INFCE did not confine itself to noting these differences of outlook, but suggested that the following be studied in the future :

- mechanisms for updating non-proliferation undertakings and conditions;

- guarantees regarding continuity of supply during the re-negotiation process;

- common approaches in order to make the nuclear supply regime more uniform and predictable.

Finally, it was stressed that these common approaches, which could be expressed initially through practices of states and bilateral agreements,

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might eventually take the form of joint declarations, codes of practice or other multilateral or international instruments.

7. Non-proliferation aspects

The assessment focussed on the extent to which misuse of the nuclear fuel cycle would assist in implementing a political decision to construct nuclear weapons.

After listing measures that are already in force to reduce proliferation risks (NPT, safeguards and the Tlatelolco Treaty), INFCE has recognized that, taking into account the different stages of development of the various fuel cycles, the extent to which complete fuel cycles are present within individual countries and the evolutionary nature of the technical, safeguards and institutional improvements that may be implemented, no single judgement about the risk of proliferation from the different fuel cycles can be made that is valid both now and for the future. Therefore, the range of possible judgements on proliferation risks must be taken into account when the different arguments (including economics, safety, energy strategy, and proliferation risk) are weighed by national authorities in deciding on whether to introduce a particular fuel cycle. In general, it seemed more important and constructive to identify those points in the nuclear fuel cycles that are sensitive from the point of view of proliferation.

The study of these sensitive points in the nuclear fuel cycle (fresh fuel containing highly enriched uranium or plutonium, uranium enrichment, reactors, spent-fuel storage in the medium/long term and disposal, reprocessing including plutonium storage and mixed-oxide fuel fabrication) clearly shows that any attempt to rank these sensitive points in relation to the corresponding proliferation risks would be arbitrary.

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This also applies to the comparison, from a non-proliferation point of view, of the uranium/plutonium with and without recycle and uranium/thorium cycles.

Lastly, it was recognized - and this is probably one of INFCE's most important conclusions - that measures can and must be taken to minimize the risks inherent in the points identified as sensitive without thereby jeopardizing the development of the corresponding fuel cycles.

8. Minimizing the danger of the proliferation of nuclear weapons - institutional measures.

INFCE considers that pride of place should be given to institutional measures, especially as in certain cases the latter have beneficial effects on not only security of supply, but also economic aspects, the utilization of resources and the environmental impact.

As regards reprocessing and plutonium utilization, the principal institutional measures mentioned by INFCE are International Plutonium Storage and, in the medium and long term, the implementation of a policy to limit as much as possible the number of sensitive plants, to design and construct them preferably in the form of multinational ventures and to group them together in order to create regional fuel cycle centres.

INFCE adds, however, on this point: "However, the practical difficulties in establishing and operating such ventures should not be underestimated" and "negative effects of multinational or international arrangements would be the increased risk of transfer of sensitive technologies".

With regard to the co-location of fast reactors and fuel cycle centres,

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INFCE states: "Taking into account the significant technical problems associated with co-location, when reactors are included within the centre, on issues such as safety and environmental impacts, public acceptance and land and water requirements, it has been put forward as a general conclusion that the co-location of only reprocessing and fabrication plants could be a more acceptable way of improving diversion resistance".

As far as uranium enrichment is concerned, INFCE recommends a policy similar to that mentioned for the back-end of the full cycle, i.e. that the number of plants should be limited and that they should be designed and constructed under international auspices ; here too, however, such a policy is subject to reservations associated with the difficulties and problems involved in the construction of multinational plants.

As regards the management of spent fuel pending reprocessing or ultimate storage, INFCE asserts that "consideration should be given to whether international spent fuel management schemes might improve prospects for storing spent fuel and thereby assist certain countries in the economic and management aspects of spent fuel storage" but it adds that "the fundamental question remains: to what extent would individual countries be willing to offer sites and accept the agreed international conditions? Therefore it seems that for the near future national facilities will be the most realistic solution to avoid a deficiency in spent fuel storage".

As far as the ultimate storage of radioactive waste is concerned, INFCE also recognizes that multinational or international storage sites can offer advantages while remaining compatible with safety requirements and environmental protection criteria.

The scheme aimed at creating more reliable conditions for the supply of nuclear materials* may also be classed among institutional measures.

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* See the closing remarks in section 6 above.

C-22

9. Minimizing the danger of the proliferation of nuclear weapons - Safeguards

Effective international safeguards are seen as an essential feature of the nuclear power industry and a substantial addtional effort involved in safeguards should be regarded as of importance. The study did not identify significant problems with the capability of methods and techniques as applied to existing operating plants. Further development and improvement of existing methods and techniques were foreseen as necessary to meet safeguards objectives at reasonable cost for all stages of the fuel cycle, including uranium enrichment, industrial scale reprocessing of irradiated fuel, and mixed oxide fuel fabrication for LWRs or breeder reactors. This development should in general include taking account of safeguards needs and overall strategies in the design of facilities, enhanced containment and surveillance and improved methods of materials accountancy.

10. Minimizing the danger of the proliferation of nuclear weapons - - technical measures

It was recognized that technical measures have a limited influence as regards reducing the danger of proliferation at governmental level; on the other hand, they can be effective in minimizing the risks of diversion of nuclear materials at the sub-governmental level (terrorism), a sector which is and should remain primarily a national responsibility.

The technical measures considered by INFCE to be the most promising are:

- "co-location" (i.e. the location of different nuclear fuel cycle facilities on the same site);

- "co-conversion" (i.e. the production of mixed oxide from mixed uranium and plutonium solutions);

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- in the longer term and with some reservations co-processing (i.e. a modification of reprocessing in which plutonium does not exist in separated form but emerges from the reprocessing plant in a mixed stream of uranium and plutonium nitrate suitable for co-conversion);

- physical isolation of the reprocessing and mixed oxide fuel fabrication processes by means of structural barriers;

- use of lower enrichment for research reactors fuels.

11. Requirements and conditions specific to the developing countries

INFCE recognizes that nuclear power can play an important part in the energy supply of several developing countries. For this to be achieved, however, these countries must reinforce their infrastructures, which remain for the most part weak; hence the need for increased technical assistance from the industrialized countries, in particular through the IAEA.

The possibility of setting up an International Technology Centre under the auspices of the IAEA is explicitly mentioned in this context.