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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

March 27, 1980

MEMORANDUM FOR: Chairman Ahearne
Commissioner Gilinsky
Commissioner Kennedy
Commissioner Hendrie
Commissioner Bradford

FROM: Edward J. Hanrahan EJH

SUBJECT: SUMMARY OF INFCE OVERVIEW REPORT

We thought you would find useful a summary of the INFCE Overview report.

Since its issuance, you have been asked what the implications of its conclusions will be for Commission positions on domestic reprocessing and recycle. In this connection, many of those who have raised this issue have mischaracterized the results of INFCE, i.e., have asserted that the United States agrees with those statements in the INFCE Reports that may be interpreted as favorable to reprocessing and recycle.

We have prepared for your use the following draft statement, which could be used to respond to such assertions. In preparing it, we drew on the INFCE Overview Report itself, on Ambassador Smith's statement at the Final Plenary Conference in February, and on the NASAP Report "Nuclear Proliferation and Civilian Nuclear Power":

> It must be emphasized that the final INFCE individual working group reports are products of consensus and reflect a wide range of judgments and viewpoints. As Ambassador Smith observed in his Statement to the Final INFCE Plenary Conference, "I do not wish to imply that the United States, or any other nation, agrees with every statement in the report". Ambassador Smith went on to note that the United States continues to believe that it "can prudently defer moves implying a commitment to a 'plutonium economy'".
>
> With respect to reprocessing, the Evaluation concluded that spent fuel can be safely stored on an interim or long-term basis, that terminal disposal without reprocessing appears to be a realistic option for either economic or non-proliferation reasons, and that the economic advantage of plutonium recycle in light water reactors will be, at best, small.

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The foregoing conclusions are not at variance with those contained in the Report of the Nonproliferation Alternative Systems Assessment Program, entitled "Nuclear Proliferation and Civilian Nuclear Power", prepared by the US Department of Energy. That Report states that "the light-water reactor fuel cycle with spent fuel discharged to interim storage does not involve directly weapons-usable material in any part of the fuel cycle and is a more proliferation resistant nuclear power fuel cycle than any other fuel cycles which involve highly enriched uranium or pure plutonium."

Elsewhere, the NASAP Report notes that "Recycle systems would be vulnerable to a wide range of threats, whereas current once-through fuel cycles are susceptable to only the most sophisticated threats".

Finally, the following summary tracks the structure of the Overview Report itself.

Attachment:
As Stated

cc: Leonard Bickwit
Sam Chilk
James R. Shea

I. AVAILABILITY OF RESOURCES AND FUEL CYCLE SERVICES IN THE LIGHT OF PROJECTIONS OF NUCLEAR POWER DEMAND

I-A. Nuclear Power Projections

The high-low nuclear generating capacity projections for world outside of communist areas (WOCA) countries were based on national estimates by IAEA member countries and various studies done by the Nuclear Energy Agency (OECD) and the International Energy Agency. Through the year 2000, these high-low projections for WOCA are as follows:*

1985	-	245-274 GW(e)
1990	-	373-462 GW(e)
1995	-	550-770 GW(e)
2000	-	850-1200 GW(e)

I-B. Reactor Strategies

Requirements for nuclear fuel, heavy water and associated services over the next 50 years will depend not only on nuclear growth projections but also on the types of reactors in operation. Only reactor types and technologies that are presently available, e.g., once-through light-water and heavy water reactor fuel cycles, or likely to be available in the reasonably near future, e.g., large scale fast-breeder reactors, were used in calculating demand for fuel and fuel cycle services.

Using a series of illustrative "mixed strategies" based on combined deployment of LWRs, HWRs and FBRs, the following plausible "range of demand was determined:

> approximately 117,000-208,000 short tons of $U3O_8$ per annum in the year 2000 to approximately [illegible]7,500-559,000 short tons of $U3O_8$ per annum

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* Comparative WOCA projections done by the DOE's Energy Information Administration are considerably lower: (As of July 1979)

1985	-	216-247 GW(e)
1990	-	305-376 GW(e)
1995	-	418-552 GW(e)
2000	-	550-750 GW(e)

I-B-2. Uranium Availability

The supply of uranium over the period up to 2025 will come primarily from deposits of a type that is either currently being exploited or that could be exploited under current technological and economic conditions. Based on a December 1978 NEA/IAEA study, there is also significant potential for the discovery of conventional resources in addition to those in the "Estimated Additional Resources" category. However, with respect to these so-called "Speculative Resources," they may not be discovered and brought into production until after the first quarter of the twenty-first century.

Uranium production capability was about 50,700 short tons of $U3O_8$ per annum in 1978. It could be increased to 63,700 short tons of $U3O_8$ per annum by 1980, and to 117,000 short tons of $U3O_8$ per annum by 1985. A peak level of production of approximately 143,000-156,000 short tons of $U3O_8$ per annum is potentially achievable in the 1990's under optimum conditions. Production would subsequently decline to 26,000 short tons of $U3O_8$ per annum by 2025 as known deposits were depleted.

The achievement of adequate levels of uranium production also depends largely on political and market climates, availability of manpower and equipment, and the resolution of environmental and regulatory uncertainties.

I-B-5. Comparisons of uranium supply and demand

On the basis of Working Group I comparisons of uranium supply and demand, additional sources of production are likely to be needed by, possibly, the early 1990's. The bulk of the required new production will have to be supported by new discoveries. The uranium industry, with the necessary exploration and investment, should not experience undue difficulty in meeting requirements up to the year 2000.

Such factors as the use of various reactor strategies, market continuity and stability, increased uranium ore exploration and improved extraction methods, and improvements in LWR technology, will all affect the uranium supply and demand projections presented by INFCE.

I-C. Fuel Cycle Services

Present enrichment capacities and those under construction would cover projected needs until 1990 while the addition of planned capacities would cover needs until after 1995. Beyond 2000, the capacity that would have to be installed is not seen as a major problem.

However, the situation with respect to the availability of reprocessing services is different. Reprocessing capacity by 2000 is expected to be 9,000-10,000 t UO_2/a. The spent fuel management concepts chosen by countries and the availability of storage space will affect future reprocessing capacity. (NOTE: It is pointed out that the largest proportion of spent fuel expected to accumulate from 1980-1990 will be LWR fuel in countries that have deferred their decisions.

II. TECHNICAL FEASIBILITY: ECONOMIC CONSIDERATIONS: HEALTH, SAFETY AND ENVIRONMENTAL IMPACTS

II-A-1. and 2. - Technical Feasibility of Current and Advanced Fuel Cycle Activities

Enrichment: The technical viability of gaseous diffusion and ultracentrifugation is well established. Other technologies, e.g., aerodynamic, chemical laser, are less advanced but offer good prospects for future industrial application.

Storage and transport of spent fuel:

National interpretations of spent fuel management concepts are dependent on current social, economic, regulatory and political conditions and energy needs prevailing in a country at a given time. However, the national policies of one country can have an impact on other countries.

The storage of spent fuel is an interim step only, which provides flexibility in the selection and use of future fuel cycle operations.

Experience exists with wet storage of LWR and HWR spent fuel for periods of up to 20 years with low-burnup fuel.

The storage of LWR and HWR spent fuel assemblies in water-filled storage pools, including the use of compact racks, can be considered a proven technology. Dry storage might be an alternative for extended interim storage.

Spent fuel transportation is a well-established technology.

Reprocessing: The basic technology is well-established. Large-scale application of the Purex process for FBR fuel will require some technical modifications.

Plutonium handling and mixed oxide fuel recycle in thermal reactors: The basic technology is well-established and substantial experience has been gained in these areas.

Mixed oxide fuel recycle in fast breeder reactors: For FBR fuels some problems resulting from the use of plutonium recovered from nominal burnup LWR or thermal recycle fuel will require attention. The performance of reference fuels in experimental and demonstration FBRs has been satisfactory and experience with statistically significant quantities is now available.

<u>Waste Management and Disposal</u>: Methods fo management and disposal of low- and medium vel wastes are operational and well-proven.

<u>Fast Breeder Cycles</u>: Deployment of a significant number of FBRs using current technology and oxide fuels would be feasible by 2000.

<u>Thorium/uranium recycle fuel cycles and other advanced reactor systems</u>: Commercial deployment probably could not be available until after the year 2000.

II-B. Economic Considerations

Economic aspects of fuel cycle options as well as countries' energy strategy considerations were examined.

After analyzing once-through and plutonium-recycle HWRs and LWRs, and FBRs in the above context, Working Group 4 concluded the no one fuel cycle can be said to have an economic advantage in all cases. nomic advantages <u>may</u> exist in relation to specific energy strategies chosen by i vidual countries.

Reprocessing in itself is important because it is an essential preliminary to many of the possible fuel cycles. The economic arguments for reprocessing depends on the price of uranium and on the subsequent use that is made of the separated plutonium and uranium. If it is recycled in light water reactors, then the economic advantage is not likely to be large. However, some countries nevertheless see it as a positive contribution to energy independence and assurance of supply. On the other hand, if the capital costs and the fuel cycle costs of fast reactors can be brought down sufficiently, then the economic and assurance of supply advantage of fast reactor recycle could be considerable. Most countries planning to use plutonium therefore consider mainly its use in fast reactors.

In addition, the economic considerations affecting breeder deployment will vary from country to country, depending on what alternative sources for long-term assurance of energy are available for that given country.

II-C. Environment, Health and Safety

Although an assessment of environmental, heal and safety issues with respect to various fuel cycle optior- was not a primary task assigned to INFCE, these issues were considered in all of the W rking Groups.

The most far-reaching assessment of environmental and health and safety impacts was performed by Working Group 7, in the context of looking at all waste arising from seven fuel cycles. The Working Group concluded that the difference in these types of impacts of waste management and disposal among the fuel cycles examined does not constitute a decisive factor in the choice among them. Specifically, the FBR cycle compared favorably, from an environmental impact standpoint, to the LWR cycle.

It was further concluded that reprocessing, mixed oxide fuel fabrication, plutonium handling and recycle can all be carried out in conformity with the International Commission on Radi gical Protection recommendations.

III. NON-PROLIFERATION ASPECTS

INFCE's concern in this regard was with the technical aspects of possible misuse of the nuclear fuel cycle in implementing a country's decision to construct nuclear weapons. Those points in the nuclear fuel cycle that are sensitive from the point of view of proliferati n were identified, taking into account that a number of technical and institutional measures have been proposed or are under development that could reduce the risk of proliferation from all fuel cycles.

III-A. Sensitive Points in the Nuclear Fuel Cycles

Fresh fuel: For low-enriched uranium cycles (LWRs, HWRs, and HTRs) and medium-enriched cycles, uranium in the fresh fuel itself would not be weapons-usable without further enrichment.

Uranium enrichment facilities: Most facilities produce low-enriched fuel -- proliferation risk lies in possible diversion for use in other facilities for production of weapons-usable materials. Modifications of enrichment plants producing LEU to HEU are extremely difficult to achieve.

Reactors: In general, the phase when the fuel elements are in an operating reactor was considered a less important area than the other parts of the fuel cycle from the proliferation point of view. On the whole, it appears that an adequate degree of proliferation resistance can be attained, at least in the short and medium term, with present thermal reactors in the once-through mode, provided that appropriate safeguards are applied to enrichment, fuel fabrication and irradiated fuel storage facilities. In this same context Working Group 5 estimates that the diversion risks encountered in the various stages of the FBR fuel cycle present no greater difficulties than in the case of the LWR with the U-Pu cycle, or even in the case of the once-through cycle, in the long term.

Spent Fuel Storage: The high radiation level inherent in spent fuel is an important factor against proliferation.

Working Group 6 determined that the existing legal and institutional framework for spent fuel management is adequate to minimize the risk of proliferation. However, there is no international legal framework to provide states with assurances of access to or management of their spent fuel.

Reprocessing, Plutonium Storage and Mixed Oxide Fuel Fabrication: In the event that reprocessing develops, it will be necessary to adopt the best technical, safeguards and institutional measures to increase the protection of such material against diversion.

In addition, it is noted that the use of commercial-grade plutonium is an unattractive route to the manufacture of nuclear weapons as compared with weapons-grade plutonium produced by a dedicated program. However, it should be noted that the United States government has declared that commercial-grade plutonium can be used for weapons purposes and that this statement has not been challenged by other nuclear-weapons states.

Waste and Spent Fuel Disposal: Waste disposal was not regarded as a sensitive step in the fuel cycle.

IV. MAKING NUCLEAR ENERGY WIDELY AVAILABLE TO MEET THE WORLD'S ENERGY REQUIREMENTS

Working Group 3 investigated assurances of long-term supply of technology, fuel and heavy water and services in the interest of national needs consistent with non-proliferation.

IV-A. Commercial Markets

The following items were identified as means of achieving assurance of supply and demand of uranium:

1. negotiation of long-term commercial contracts, with built-in flexibility to permit adjustment and appropriate sharing of burdens and risks of market fluctuations between supplier and consumer:

2. the existence and maintenance of a sound market for spot transactions in order to cope with short-term fluctuations in supply and demand;
3. diversification of supply, i.e., new suppliers of enrichment services will enter the market in the 1980's and beyond;
4. greater financial participation by consumers on the supply side, e.g., capital or management participation, loans or advance payments.

The following short-or medium-term back-up arrangements were also examined:

1. Uranium Emergency Safety Network, which could build on existing ad hoc arrangements among utilities, primarily in Europe and the US, for swapping or loans of fuel for a limited period of time out of existing inventories; and
2. International Nuclear Fuel Bank, which would be made up of supplier and consumer states and would itself hold a stockpile of natural and low-enriched uranium or claims to such uranium. These assets could be made available to a consumer state whose supplies were interrupted by a contract default that was not the result of a breach of its non-proliferations undertakings.

IV-B. Government Intervention

Although to date, few actual interruptions of supply have occurred as a result of government intervention,(e.g., unilateral changes in agreed conditions of supply),if uncertainties about possible supply interruptions continue, the orderly development of nuclear power programs would be affected.

It was generally accepted that more uniform, consistent and predictable application of national export and import controls by each supplier and consumer country, in accordance with more concrete criteria, would go a long way to mitigate uncertainties and thus strengthen assurances of supply.

Also, the potential for arbitrary exercise of prior consent causes concern to consumer countries. Where a supplier country has a right of prior consent to retransfer or reprocessing, the criteria for its exercise should be established, to the extent possible, before long-term fuel supply contracts are concluded or, for short-term contracts, before fuel is committed to nuclear reactors.

Various international and bilateral mechanisms and other common approaches, are suggested for updating non-proliferation undertakings and conditions when necessary. (See pp. 36-37).

V. MINIMIZING THE DANGER OF THE PROLIFERATION OF NUCLEAR WEAPONS

The following familiar technical measures were identified and described as possible means of minimizing the danger of misuse of fuel cycle facilities:

1) co-location;
2) co-conversion;
3) co-processing;
4) denaturing;
5) pre-irradiation;
6) spiking;
7) partial processing;
8) physical barriers;
9) use of lower enrichment for research reactor fuels; and
10) improved IAEA and other bilateral safeguards

In summary it was concluded that technical measures have a powerful influence on reducing the risk of theft, but only a limited influence on reducing the risk of proliferation. It was also judged that safeguards measures are more important than the technical measures.

VI. INSTITUTIONAL ARRANGEMENTS

Potentially more important than technical measures, in both minimizing proliferation risks and contributing to assurance of supply are institutional measures. In general, it was deemed desirable that the evolution of institutional arrangements should move towards multinational ventures and could eventually result in the development of regional nuclear fuel cycle centers.

Among those institutional arrangements discussed are;

1) multinational enrichment and reprocessing facilities;

2) the International Nuclear Fuel Authority (the nature of which was not yet clear);

3) international storage of plutonium; and

4) international management of spent fuel