第12回 原産年次大会 英語論文

1979年3月

社団法人 日本原子力産業会議

第１２回原産年次大会プログラム

期　日　昭和５４年３月１３日（火）～１５日（木）

場　所　イイノ・ホール〔東京・内幸町・飯野ビル７階〕

基　調　「８０年代にむかって－合意の促進と原子力産業の新展開」

＜総括プログラム＞

	第 1 日 3月13日（火）	第 2 日 3月14日（水）	第 3 日 3月15日（木）
午前	開会セッション （9:30～10:30） 大会準備委員長挨拶 原子力委員長所感 原産会長所信表明 セッション1 「核不拡散と原子力産業の将来」 （前半10:30～11:50） （後半13:30～18:00） 〔国際パネル討論〕	セッション2 （9:00～12:00） 「核燃料サイクルにおける重要課題」 〔講　演〕	セッション4 （9:30～12:30） 「新しい原子力行政と安全の確保」 〔パネル討論〕
午後	レセプション （18:30～20:00） 於　日本工業クラブ	午餐会 （12:30～14:20） 通商産業大臣所感 〔特別講演〕 於　ホテル・オークラ 原子力関係映画上映 （12:50～14:20） イイノ・ホール セッション3 （14:40～17:40） 「原子力開発－自主技術の産業化への提言」 〔パネル討論〕	セッション5 （14:00～17:00） 「原子力論争－安全技術情報と社会」 〔パネル討論〕

第１２回　原産年次大会プログラム

第1日　3月13日（火）

開会セッション　（9：30～10：30）

議　　　　長　中山素平氏（エネルギー総合推進委員会委員長
日本原子力産業会議副会長）

9：30　大会準備委員長挨拶　小林庄一郎氏（関西電力(株)社長）

9：40　原子力委員長所感　金子岩三氏（国務大臣　原子力委員会委員長）

10：10　原産会長所信表明　有澤廣巳氏（日本原子力産業会議会長）

セッション1「核不拡散と原子力産業の将来」（10：30～18：00）

（国際パネル討論）

〔前　半〕

（10：30～11：50）

議　　　　長　平岩外四氏（東京電力(株)社長）

10：30　フランスにおける原子力産業とその展望

M. ペカー氏（フランス原子力庁長官）

11：10　原子力発電の現状と将来－IAEAの見解

R. ショルデブランド氏（国際原子力機関INFCE総括室長）

〔後　半〕

（13：30～18：00）

議　　　　長　大島恵一氏（東京大学工学部教授）

13：30　原子力発電と核不拡散

G. ラスジェンス氏（アメリカ国務省
核不拡散問題担当特別代表代理）

14：00　アメリカの原子力産業－現状と将来

R. シャーマン氏（アメリカ原子力産業会議会長）

14：30　原子力利用の課題と展望－西ドイツの見解

W.-J. シュミットキュスター氏（西ドイツ研究技術省
エネルギー研究開発局長）

15：00　国際秩序の新局面と韓国の原子力発電計画への影響

B. W. リー（李炳暉）氏（韓国原子力委員会常任委員）

15：30 ○日本における原子力開発政策と核不拡散問題

新 関 欽 哉 氏 （原子力委員会委員）

<休　　憩 （10分）>

16：10 〔パネル討論〕

上記発表者のほかに矢田部厚彦氏（外務省科学技術審議官）がパネリストとして参加。

レセプション	（18：30〜20：00）
日本工業クラブ<3階　大食堂>	

第2日　3月14日（水）

セッション2「核燃料サイクルにおける重要課題」（9：00〜12：00）

議　　長　堀　一　郎　氏　（東京電力㈱副社長）

コメンテーター　D. カウチマン　氏　（アメリカNUS社筆頭副社長）

9：00 世界のウラン資源とわが国の確保対策

今 泉 常 正 氏 （東京大学工学部教授）

9：45 ウラン濃縮技術開発の進展

金 岩 芳 郎 氏 （動力炉・核燃料開発事業団副理事長）

議　　長　田 中 精 一 氏　（中部電力㈱社長）

コメンテーター　角 谷 省 三 氏　（㈱荏原製作所理事）

10：30 ○フランスの使用済み燃料再処理の経験と計画

C. エソベリ 氏 （フランスCOGEMA社再処理事業本部長）

11：15 ○核燃料サイクル確立上の国際協力の現状

W. ハナム 氏 （OECD原子力機関事務局次長）

午 餐 会 （12：30〜14：20）<ホテルオークラ本館1階　平安の間>		
通商産業大臣所感	江 崎 真 澄 氏	（通商産業大臣）
〔特別講演〕	「21世紀の文明と社会」	
	梅 棹 忠 夫 氏	（国立民族学博物館長）

原子力関係映画上映　（12：50〜14：20）　<イイノ・ホール>

自　由　参　加

1. 「明日を考える世界 ─ エネルギーと文明 ─ 」（1978年電事連製作：日本語）
   アメリカ，カナダ，イギリス，フランス，西ドイツ，イランにおけるエネルギー問題や原子力開発の課題を描く（27分）。
2. 「動燃1978」（1978年動燃製作：日本語）
   高速増殖炉，新型転換炉，東海再処理プラントなど動燃の各種研究・開発の現状を紹介する（20分）。
3. 「安全処理への道 ─ 放射性廃棄物 ─」（1978年原研製作：日本語）
   放射性廃棄物の処理処分プロセスの解説と原研の研究開発をレビュー（30分）。

セッション3「原子力開発：自主技術の産業化への提言」（14：40〜17：40）

（パネル討論）

議　長　玉置敬三氏（東京芝浦電気㈱会長）

14：40　わが国の原子力計画と自主技術開発

清成　迪氏（原子力委員会委員長代理）

15：10　〔パネル討論〕

伊藤俊夫氏（関西電力㈱副社長）

瀬川正男氏（動力炉・核燃料開発事業団理事長）

竹内　宏氏（日本長期信用銀行調査部長）

永野　健氏（三菱金属㈱専務取締役）

三島良績氏（東京大学工学部教授）

綿森　力氏（㈱日立製作所副社長）

コメンテーター　W. ブラウン氏（西ドイツKWU社副社長）

第3日　3月15日（木）

セッション4「新しい原子力行政と安全の確保」（9：30〜12：30）

（パネル討論）

議　長　岸田純之助氏（朝日新聞社論説主幹）

9：30　安全確保への基本的考え方

吹田徳雄氏（原子力安全委員会委員長）

10：00　〔パネル討論〕

及川孝平氏	（全国漁業協同組合連合会会長）
木原正雄氏	（日本学術会議原子力平和問題特別委員長）
児玉勝臣氏	（通商産業省資源エネルギー庁長官官房審議官）
白澤富一郎氏	（日本原子力発電㈱会長）
橋本孝一郎氏	（全国電力労働組合連合会会長）
牧村信之氏	（科学技術庁原子力安全局長）
山本長松氏	（全国原子力発電所所在市町村協議会監事 愛媛県伊方町長）

セッション5「原子力論争ー安全技術情報と社会」(14：00～17：00)

（パネル討論）

議長	柴田俊一氏	（京都大学教授 京都大学原子炉実験所所長）
	安斎育郎氏	（東京大学医学部助手）
	板倉哲郎氏	（日本原子力発電㈱敦賀発電所所長）
	都甲泰正氏	（東京大学工学部教授）
	道家忠義氏	（早稲田大学理工学研究所教授）

(Not for publication
in the present form)

Keynote Address by
H. Arisawa, Chairman
Japan Atomic Industrial Forum
before the
12th Annual Conference
Tokyo, Japan
March 13, 1979

I am most honored to have this opportunity to say a few words on the occasion of the opening of this 12th Annual Conference of the Japan Atomic Industrial Forum.

First, I would like to thank Director-General Kaneko of the Science and Technology Agency and the many other distinguished guests for their having taken time out from their very busy schedules to attend this Conference today. I am also most pleased and gratified by the large number of participants which this Conference has drawn both from Japan and from abroad. Allow me to offer all of you my heartfelt welcome.

Next, I would like to offer a brief report on the current state of atomic energy development in Japan. Although Japanese atomic energy development had been under a dark cloud for several years, this has gradually dissipated over the last two years and there are now rays of brightness. Last year, four new power stations with a total generating capacity of 3,500 MW were put into operation. With this additional capacity, there are now 18 atomic power generating plants in operation with a total generating capacity of 11,500 MW, giving Japan the second-largest atomic power capacity in the world. At the same time, of Japan's nine electric power companies' total power generation from July 1978 to January 1979, atomic power provided approximately 316 TWh and hydroelectric power approximately 264 TWh, meaning that atomic power provided more power in the latest half-year than hydroelectric power did. Atomic power has finally come into its own as a base-load power generation source for Japan. The average load factor for atomic power plants, which had been a point of much criticism in the past, recovered from 1977's 47% to 61% last year.

Advantage is finally being taken of atomic power's true value as a petroleum-alternative energy source.

Atomic power is a most important factor in our efforts to ensure stability in Japan's future supplies of energy. Today, more than five years since the outbreak of the oil crisis, the international oil situation is again entering a perilous phase. This state of affairs has demonstrated anew the concern in the Japanese economy over having to rely upon imported petroleum for the bulk of its energy supplies, and it has sounded a loud alarm over the slowness with which petroleum-alternative energy resources are being developed.

Within its overall energy policy, the Government has drawn up plans noting the need to develop atomic power to 26,000 - 33,000 MW by 1985 and to 60,000 MW by 1990 if Japan is to achieve an overall energy supply and demand balance and to secure stable energy supplies. Yet even if all 17 atomic power plants which are now under construction or have been approved by the Electric Power Resources Development Coordination Council are completed as planned and added to those atomic power plants currently in operation, the total capacity in 1985 will still be only approximately 28,000 MW, far short of the upper level recommended. We must hope, therefore, for further private- and public-sector efforts and enhanced public understanding and cooperation for atomic power development.

It was thus fortunate that the Nuclear Safety Commission and the new Atomic Energy Commission were established in October 1978. With its public mandate, this Nuclear Safety Commission is the long-awaited means for restoring the public credibility of atomic power development through concentrating upon assured safety. The primary missions of the Nuclear Safety Commission are to ascertain the safety of nuclear facilities undertaken by administrative agencies and to conduct assessment studies and ensure nuclear safety for the people. Indeed, the public trust of nuclear power safety will be greatly enhanced through the Nuclear Safety Commission's responding to its mandate and exercising its authority to the fullest.

The new Atomic Energy Commission, on the other hand, is to take the initiative in comprehensively promoting the basic policies for research and development on atomic energy which Japan has followed to date. The new Long-Term Atomic Energy Research, Development, and Utilization Program decided upon last September has elucidated research and development approaches for the next decade in the nuclear fuel cycle, advanced power reactors, nuclear fusion research, and other important projects. This long-term atomic energy program indicates, first in Japan's atomic energy programs, that the total funding necessary for the research and development program will be approximately ¥4 trillion (in FY 1977 prices), and it has pointed up anew the requirement of special allowances to ensure adequate capital procurement in view of the need for such funding to increase twice as fast as the total national budget during the first five years of the program. While we in the private sector will do everything we possibly can in cooperation, I am confident that this new Atomic Energy Commission will be the locomotive for systematically advancing atomic energy research and development in Japan.

The basic policy for power reactor development in Japan is a strategy based upon light water reactors and fast breeder reactors. Readying of reactors is calling for to supplement this basic policy in response to such uncertainties as the timing of the fast breeder reactor's commercialization. It is now more than 10 years since independent development efforts were begun in line with this policy, and the results of this research effort are paying off handsomely. The experimental fast breeder reactor "Joyo" attained criticality in 1977 and has since been operating (at 50 MWt output) as planned. Preparations are now under way to increase its output to 75 MWt. Work has also been begun on the prototype fast breeder reactor "Monju" (300 MWe), which is expected to attain criticality in the second half of the 80's.

The first candidate for the role of supplemental reactor is obviously the independently developed advanced thermal reactor (ATR), and the prototype ATR "Fugen" was put into full-power operation (165 MWe) in November and is expected to go into commercial operation in March. This is to be followed by construction of a demonstration reactor of the 600 MW class to be decided upon in the next year or two. The time has come to promote this program as planned and to clarify the place of the ATR in Japan's reactor strategy.

However, such large-scale programs for reactor development and commercialization are irrevocably bound to the issue of the nuclear fuel cycle. This is also tightly linked to the individual nation's energy situation and the issue of energy resources. It is thus inevitable in consideration of Japan's energy circumstances that Japanese energy policy should focus upon promoting the development of atomic power, making every effort to independently develop its own advanced reactors and seeking to close the nuclear fuel cycle in Japan.

In reprocessing, the Tokai Reprocessing Plant constructed by the Power Reactor and Nuclear Fuel Development Corporation (PNC) began test operation in September 1977. However, this Tokai Reprocessing Plant is a small-scale plant, and Japan must still rely upon supplemental contracts with foreign countries to meet its reprocessing needs. Thus we plan to construct a second, private-sector reprocessing plant, and now await only the ordering of the legal framework for this. The enabling legislation has already passed the House of Representatives at the end of February, and been sent to the House of Councillors, and preparations are being made for the second reprocessing plant to be established by the electric power companies and other interests once the legislation is law.

In the field of technological developments for uranium enrichment, the PNC has attained a high level of sophistication in centrifuge technology and preparations are being made for the construction of a pilot plant (approximately 50 tSWU/year) with partial operation to begin early this August. In the Japan Atomic Industrial Forum's January 1979 uranium enrichment technology assessment, it was concluded that the technology for manufacturing centrifuges for commercial use already exists and that it is possible with systematic promotion to begin operation of the first uranium enrichment commercial plant (approximately 1,000 tSWU/year) in 1987.

under this program, Japan will not be totally but about one-third self-sufficient in uranium enrichment. This decision has been made in consideration of the three factors of price, availability, and reliability as they affect nuclear fuel supply security.

Can any one set roadblocks in the way of a country which has promoted and will promote atomic power out of the need to stabilize its energy supplies just when this same country seemingly has it within its reach to achieve that nuclear fuel cycle which would support self-sufficiency? If this path is blocked, where is that country to turn for energy alternatives? Who will guarantee its future energy supplies? Of course, international nuclear proliferation must be prevented, and I doubt if there is any among us who would seriously dispute the aims of President Carter's nuclear non-proliferation policy. The problem, however, is in implementing them so as to pursue the development of peaceful uses of atomic energy simultaneous with international nuclear non-proliferation. It was precisely to examine the technical issues in ensuring that these two ends are compatible that the International Nuclear Fuel Cycle Evaluation (INFCE) was begun. I feel it is most significant for the international identity of interests and consensus on this issue that 53 nations are participating seriously in the INFCE deliberations. The

Nuclear Non-Proliferation Treaty (NPT) states explicitly in Article 4 that the need for non-proliferation should not affect the signatory nations' right to develop the peaceful uses of atomic energy, and we should respect the spirit of this Treaty. At the same time, we must also work for nuclear non-proliferation today when the need for atomic power development is being increasingly felt in all nations.

Within the INFCE deliberations, special attention is now being given to the strengthening of safeguards and the study of institutional measures to removing the incentive to international nuclear proliferation. This issue of international safeguards is one of the original purposes of the International Atomic Energy Agency (IAEA), and I believe Japan can make a major contribution here in the development of safeguard technologies. Among the international mechanisms which are being studied for effectively preventing nuclear proliferation without impeding the peaceful use of atomic energy are those for plutonium storage, fuel banks, spent fuel storage, and fuel cycle centers. The international management of plutonium is of decisive importance, and I strongly hope that research will be done on effective means for such international management, including the physical protection.

In order to promote the realization of such international systems, it is essential that we create responsible regime for implementing these arrangements, which must necessarily entail cooperation and an international division of responsibility among the nations concerned. In this sense, Japan is ready to fulfill its obligations and to contribute as much as possible to the future global development of atomic power as a supplying nation. Accordingly, Japanese commercial uranium enrichment plant could be of an international nature, and we may consider some internationally agreed upon mode for it.

The long lead times needed before any massive systems industry such as the atomic power industry matures mean that ambiguity about the future is the main barrier to the development of the atomic power industry. To be very frank, the issue of nuclear non-proliferation is currently the major factor for ambiguity, and the ramifications of this are especially sensitive for an industry such as the Japanese nuclear industry which has developed the technology and is beginning its commercialization. Our cooperation with international policies to block nuclear proliferation is thus also intended to eliminate this barrier to the promotion of peaceful uses, yet there are obvious limits to how far we can cooperate. Although it goes without saying that nuclear proliferation is a threat to national security guarantees, energy shortfalls are at the same time a similar threat to the state's survival, and we ignore either of these at our peril.

International cooperation is extremely important to overcoming the problems involved in perfecting new technologies in atomic power development. In addition to seeking to strengthen its traditional cooperation with the nations of the West, the Japan Atomic Industrial Forum is also seeking to promote international cooperation with the Soviet Union. For example, the Japan-Soviet specialist seminar on light water reactor fuel manufacture, operational experience, and related subjects will meet this year in Japan and the Soviet Union for exchanges of information on commercial power reactors.

International cooperation on atomic power development should be broadly promoted among all nations, and I feel that Japan, as a member of the pan-Pacific community of nations, should actively promote cooperation with the other nations of this region. I am thus hopeful that this year's JAIF Annual Conference, in having its first speaker ever from the Republic of Korea, will be of special significance for atomic power development in the Asian region.

This 12th Annual Conference of JAIF is being held around the central theme of Nuclear Power Development in Perspective, and I anticipate a full exchange of views among both Japanese and guest authorities on policies for solving the important problems in the atomic power industry's future. This year's Conference is especially fortunate in having such a large number of participants from overseas, and I would like to take this opportunity to express my heartfelt thanks to them and to all the many speakers whose presentations will so enhance the Conference proceedings.

I trust that your presentations and subsequent discussions will make this 1979 Annual Conference one of the most fruitful and meaningful ever, and I look forward to an interesting and informative three days with you.

Thank you.

NUCLEAR ACHIEVEMENTS AND PROSPECTS IN FRANCE

by

Michel PECQUEUR, Chairman
French Atomic Energy Commission (CEA)

I - The World : a changing picture

During two decades, the time for one human generation to fully grow-up, the world was easily divided in three great masses : you had the "western" world grouping industrialized countries, mainly North America, Japan and Europe ; then there was the communist block ; and all the other countries around the planet were aggregated under the recognized denomination "Third World". This time is now definitely behind us for a variety of reasons. In particular, the drastic increase of energy prices of the mid-70s has introduced new and very effective partition : as for the once-third world, since 1974 it has been very artificial to gather in one single entity some wealthy and underpopulated oil producing countries as well as some poor overcrowded other ones.

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This deep evolution has also introduced some degree of segregation among industrialized countries, between those which are well endowed in mineral resources, and over all in fossil fuels, and those which have to import most of their row materials including, as it is our main subject of concern here and now, most of their energy sources. Such is unfortunately the case for France and Japan. (Slide 1)

II - Nuclear Energy : The logical choice for an energy-poor nation

I will now for a few minutes focus on the french picture, not only because I know this subject best, but because the energy situation there is well characterized, almost schematic, which makes it a good example.

Roughly speaking, France's energy picture can be summarized in just three figures :

- The french consume 3 % of the world energy consumption
- We produce 0,7 % of the world energy production (less than 25 % of our own consumtion)
- The french territory contains 0,11 % of the world energy reserves.

(this last figure could be noticeably improved if we were to take for uranium the energy content corresponding to its full use in breeders reactors, but I shall come to it later).

This rather dramatic picture is also a very recent one, as shown on slide 2. Back in 1960, France was still producing 60 % of its consumed energy, and this was not far from the average ratio for the "9" european countries.

In 1976 we reached a bottom 21 percent while the overall european community still produced 42 % ! The resulting strain on our balance of payment is enormous : in 1977 imported energy accounted for 64,8 billions of francs, 19 % of all our importations, and almost twice our commercial deficit (34,6 b.f).

What are the energy choices for us ?

We have little gas and no oil worth mentionning (significant off-shore oil prospection efforts have up to now been unsuccessfull). Our coal seams are thin, broken and deep buried. National coal is then a rather expensive energy source, and its reserves are limited : boosting the production would only exhaust them sooner. Throughout the 50s and 60s, we have heavily invested, up to 5 % of the nation's productive investments, in hydro-electric dams and equipments.

This huge effort has paid off :

Hydro-electricity, in 1978, with 68 Twh, accounted for 31 % of our electricity production. Of course, there is a drawback : we have now equipped most of the sensible sites, and very little increase can be expected from this source.

The first idea was to rely on energy conservation. This is the cheapest and the most reliable, source of energy with no impact on environment and immediate effect on the balance of paiment. But a long tradition of high energy prices has kept the per capita energy consumption in France well below the industrialized world average : every frenchman uses about 3,3 tons of oil equivalent per annum. Similar figure would read 8,1 for the United States, 4,3 for the Federal Republic of Germany, and 6,1 for Sweden. Japan is still better than France with only 3,1 toe yearly per capita. It is all the more difficult to conserve energy in Japan and France without impairing the needed economic growth : all the unnecessary fat has already been removed.

Nevertheless, a big effort has been launched to take advantage of this possibility as extensively as possible.

If we want to limit our energy dependance, and the financial drain caused by energy imports, we just have to develop the "new energies", and to begin with the only one now industrially available : nuclear energy. (Slide 3).

III - Industrial development of nuclear energy in France

We did not discover nuclear energy during the kippour war. As early as October 1945 was created the french atomic energy commission, CEA, with mission to promote and develop all the applications of nuclear energy. In 1946 electricity distribution and most electricity production was entrusted to a single public utility Electricité de France who very soon was to engage, together with CEA and a still embryonnic industry, in a program to produce electricity from nuclear reactors. In the late 60s, in addition to a sizeable park of natural uranium gas cooled graphite moderated reactors (UNGG), we had in operation a small PWR at the belgian border, an heavy water gas cooled small plant in Brittany, and were already preparing the future in building our Phenix breeder demonstration plant, not to mention our work on ship propulsion.

We had at least three projects for big plants : Tihange a PWR being built in common with Belgium, Kaiseraugst, BWR under study with Switzerland, and a 600 MWe Heavy Water project, brother to Candu. We were also rewening our interest for the High Temperature Reactors. Two french industrial companies had acquired US licences : Framatome from Westinghouse and CGE from General Electric. In short, we were developping all the then existing kinds of reactors, but on a rather limited scale.

Given the size of our country and the capability of our industry we would have stretched ourselves thin in trying to pursue the development of too many types of reactors at the same time. By 1974, things had cleared up dramatically : LMFBRs are still actively developped as the only long term solution in view of the limited world's uranium resources ; the sucessful start-up of Phénix in 1974 is being followed by the construction of the 1200 MWe Superphenix prototype now well in progress (Slide 4). Some effort still continues on HTR development but only for non electrical uses (process heat, coal gasification).

But all the french nuclear effort was redirected and focussed on only one type, PWR, to be the basis of our nuclear "quantitative" programme. The real size of this programme is best shown on slide 5. It corresponds to the steady ordering of 5 000 MWe per year and this should, by 1980-81 bring France to the second position in terms of installed nuclear power with 17 000 MWe (and still more under construction).

Faced with this significant, extended and standardized programme which, for the time being includes 32 almost identical 900 MWe 3 loops PWRs followed by 8 1300 MWe 4 loops PWRs, the french industry was indeed in a position to invest in modern and optimized production plants, and to set-up a coordinated quality assurance system, a very important item in reactor safety. This policy of proceeding stepwise has been constant in EdF, and the "step 900 MWe" is the natural successor of the "steps" 125, 250 and 600 in previous fossil fueled plants. Having a sizeable number of identical unit is a key factor in improving plant reliability and is of great help in training the operating staff.

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The Framatome workshops of Le Creusot and Chalon sur Saone can manufacture 24 steam generators and 8 reactors vessels annually (slide 6), while Alsthom Atlantique is equipped to produce turbines and generators for about 10 000 MWe per year.

This is slightly in excess of the purely french requirements, as it would allow for 8 X 900 MWe or 6 X 1300 MWe units annually, but this overcapacity was designed on purpose for exports. The Framatome planning is rather impressive (slide 7), but components standardization is the key. The different plants are spead over the territory as well as possible (slide 8) and use either cooling towers (slide 9), or direct cooling, mostly on coastal sites (slide 10).

IV - An effort well restricted but comprehensive

The 74 decision to retain only one technology for the next 40 power plants was bold indeed, and it was not unlike putting all our eggs in the same basket. But then most people think it is not a bad basket, as today PWRs account for 49 % of the world installed nuclear power, and we took all necessary steps to make this basket a very good one. First, to coordinate public and private effort in that field, CEA was instructed to acquire from Westinghouse 30 % of the capital of Framatome. This had the double effect to insure that the Government had a say in what was becoming a vital component of its energy policy, and to strengthen the link between the industrial supplier and the main R and D organism. (slide 11).

Extensive Research and Development programs are carried out in the CEA in full cooperation with Framatome and EdF to improve the "PWR product" and make sure that its safety and reliability meet the requirements set up by the french Safety bodies.

A common research program has even be decided between EdF, CEA, Framatome and Westinghouse (slide 12) which, together with the invaluable experience gained in building and operating so many plants, should guarantee that by 1982, when the current american license expires, some kind of equal partnership can be set up between Westinghouse and its ex-licensee.

This comprehensive effort extends itself quite beyond the reactor engineering and construction field as it encompasses the whole fuel cycle associated with the reactor programms. (slide 13).

V - The whole fuel cycle

As we have seen on the first slide, our domestic uranium reserves are by no mean negligible, standing around 100 000 metric tons, but they could not possibly fuel all by themselves the nuclear programme we have just described. Lengthy and costly exploration programes have been carried out first by CEA, then by its subsidiary COGEMA in some countries which have historical links with France. This effort has been very successful in Niger an Gabon, and joint ventures have been stablished to exploit in common with the national companies and selected foreign partners the uranium fields which have been discovered. A good example is provided by the Nigerian Society COMINAK, who started exploitation in 1978 and whose associated partners are ONAREM (Niger), COGEMA (France), OURD (Japan) and ENUSA (Spain).

Conversion to uranium hexafluoride is carried-out in the COMURHEX plants of Malvesi and Pierrelatte, whose capacity largely exceeds the internal needs of France, as it represents 25 % of the world conversion capacity.

1979 will be a landmark for enrichment as we are now starting production at the Eurodif plant of Tricastin (slides 14-15). This plant, which will produce 10,8 millions SWU per year in 1982, 25 % of the world total, is the successful result of one of the best multinational cooperation in the nuclear field, grouping France, Belgium, Italy, Spain and Iran together for this mammoth projet. It will, in full swing, serve the needs of more than 80 power plants. The japanese electricity utilities have been the first, and are by far the biggest, external customer of Eurodif.

The back-end of the fuel cycle is not forgotten in the picture. We deem it essential to reprocess the irradiated fuel elements in order both to put the wastes under the physical and chemical form best suited for final disposal, and to recover valuable residual fissile materials.

In particular, plutonium recovery is a prerequisite to full breeder deployment and full use of the energy content of uranium.

Gas graphite elements have been reprocessed on a large scale in France for decades both at Marcoule and La Hague. The La Hague plant has been extended to accomodate for the reprocessing of fully irradiated LWR elements (slide 16).

Further extension is in progress to increase the UP2 plant capacity to 800t per year, and construction of the new UP3 plant will start very soon. I need not recall here that UP3 will reprocess spent fuel elements for a number of foreign utilies, and that a fair share of these elements will come from Japan. Mr. AYCOBERRY will tell you more about reprocessing, so I come to the last stage of the fuel cycle, which is wastes disposal.

I some countries it is still a rather controversial issue, but I think that the case has often been overstated. We do believe that there exist at least one sound solution to this problem, and very probably, several. We have choosen to vitrify the high level wastes produced during the reprocessing, and, after extended tests in the PIVER pilot, built to that effect the vitrification plant of Marcoule (AVM), shown on slide 17 and in full production since June 1979, which will soon be followed by a bigger plant at La Hague. After some cooling time, during which they are stored in very sophisticated, double lined and cooled stainless steel tanks, the fission products and residual actinides become chemical parts of borosilicate glass blocks. These blocks are, during the first few decades stored in concrete pits (slide 18) each pit can store the fission products issuing from 10 months of operation of a 1000 MWe reactor. Total storage capacity of the room shown on the slide is then 100 year reactors for 1000 MWe plants. until their activity has decayed so that natural convection is enough to keep them at low temperature. They will then be transferred to a suitable geologie storage. The overall fuel cycle activity is depicted on slide 19.

VI - Beyond the 80s

It is obvious, and worldwide recognized, that present thermal reactors are "uranium gobblers".

.../...

There are, however, widely varying theses about how long we can go on developping nuclear power without introducing breeders. Most naturally, the feeling of urgency is almost reversely proportional to the uranium reserves of the country where each thesis is developed. It is quite possible that vast amounts of uranium exist somewhere in the world, but this is a rethorical question ; the real point is : will this uranium be extracted in due time and in the required amount ? (not to mention the question of wether it will actually be delivered to a given country ...).

The world amount of uranium makes it necessary to develop breeders and taking into account the necessary development time schedule, it is in our opinion time to start now. Most europeans development is another showplace of multinational cooperation. Superphenix is owned and will be operated by Nersa, whose sharesholders are utilities from France, Italy, Germany, plus Benelux and Great Britain.

French and German have totally integrated their efforts on breeder development, and a joint Company SERENA detains the common licence. (Slide 20). Under this dual leadership we are confident that the LMFBR pool-type design will be a world success. The point is : we do build Superphenix, and no matter how much you spend on elaborate R and D programs, there is nothing like building and operating a full scale prototype to really know and master a reactor design.

We certainly hope that other countries with similar motivations for developping breeders join us in due time.

The associated fuel cycle is also under development : around Rapsodie we had a small fabrication plant at Cadarache and a pilot reprocessing plant, AT1, at La Hague, around Phenix we had an extented fabrication pilot at Cadarache and we build the TOR reprocessing facility at Marcoule ; for Superphenix we have just completed a fabrication plant at Cadarache and we are laying out the blueprints of a specific reprocessing plant, which will service as well the first few breeders to come on line.

Slide 21 shows the expected rate of introduction of breeders in the french nuclear installed power.

VII - Final details of the domestic picture

Having shown that our nuclear effort is well defined an coordinated, I would not leave you with a too idyllic view of the french program. We have not been immune to the problems which have plagued most countries, and have, in some extreme case, brought their nuclear effort to a complete halt.

Important as may look our programm, our initial expectations were higher, and we register a general slippage of around one year : we did certainly underestimate the sheer dimension of the industrial challenge facing us. Still our construction times are shorter than most, and Eurodif was completed inside the original schedule and budget.

Opposition to nuclear power has been very vocal, and sometimes violent, climaxing in the 1977 anti-Superphenix demonstration, but things have rather settled down since then.

In some of the sites local opposition is still strong, but mainly where there was already a ramping problem of a different kind ; in those cases nuclear power acts very much as the scapegoat for much wider discontents. There is a consensus of the majority of the citizens that we have no choice but to develop nuclear ; the french government has always expressed its strong commitment to that choice, and no significant political party has yet choosen the demagogic way of blaming the government for a course of action they would followed themselves, were they in charge.

I do think that this political courage, both from the majority and the opposition, an irreplaceable element of a true democracy, is a key factor of our relative immunity.

VIII - <u>International aspects - Non proliferation</u>

Nuclear Energy, and mostly the fuel cycle, are inherently international matters : In the previous parts of my paper, supposedly focused on one single country, you have heard me mentionning other countries every third minute or so... Only those very few states which have the size of a continent could take their decision in the nuclear field considering the rest of the world picture as only marginal, and I am not certain they still can. No single element in the recent years has made more to internationalize the nuclear debate than the concern about the proliferation of nuclear weapons.

.../...

How can we offer the benefit of the peaceful use of nuclear energy to every country without increasing the risks of proliferation ? Has this dilemma any acceptable solution ?

After eighten months of hard work which has invoked specialists from all over the world, the INFCE working groups are presently drafting their final reports. At this stage I think everybody recognizes that no miracle technical solution will be born from this exercise, which does not mean that significant technical improvements will not be suggested !

Among these technical improvements, we have made three important and constructive contributions :

- In developping the "Chemical Process" for isotopic enrichment of uranium, a technique which drastically limits any risk of misuse of enrichment plants, as it is basically unfit to produce highly enriched uranium : Since the 1977 Salzburg announcement by Mr. André GIRAUD several countries have marked their interest for this technology and progress have been made towards seting up a joint venture to exploit this technology.
- In developping the "Caramel" fuel element to allow the operation of high fluxes irradiation and research reactors with low enriched uranium : We have just converted Osiris, our most powerful irradiation facility to using this fuel and very soon we shall have full scale demonstration of the performances of Caramel. (Slide 22)
- In studying and perfectionning the "Pipex" design for diversion-proof reprocessing plants : we plan to include most of the "pipex" features in the UP3 plant at La Hague.

But technical improvements can only be part of the solution to reduce the proliferation threat. The core of the problem is political, and only a general international consensus can solve it.

It is not the place to discuss in details the french policy in that respect, when most governments are still in the process of trying to harmonize then views, but I may recall the basic principles defined in October 1976 by the president of the french Republic, which are still the bases of our policy. Above all France recognizes the essential, almost vital, contribution that nuclear energy can bring to the development of some countries, and confirms its intention to help developping its peaceful applications, in the respect of its interantional commitments.

On the other hand, true to its peaceful and humanitarian tradition, France will not contribute to the terrible threat of atomic weapons proliferation.

But far from being based only on denials, the french policy is constructive and intends to combine :

- An international organisation of the materials and services market, such as its peaceful use be guaranteed and controled but also such as users be guaranteed to obtain both in due time and without excess contraints.
- The international development of proliferation resistant techniques when they are operational
- The respect of the national choices as far as they have clear economical motivations and are not systematically oriented towards ambiguous technologies.

I feel and hope this can provide the basis of the broad consensus without which non-proliferation concerns could kill nuclear energy.

IX - Conclusion

The world faces a number of very serious and actual problems for the near and medium term future. Demography, is a real problem : our planet can only support a certain number of human beings if they are to live decently. Disparities are real problems : some countries have a per capita revenue ten times or more greater than others, not to mention societal disparities inside any individual country. How long will the poorer endure and do nothing ? Resources depletion is a real problem : over a very short period of time in historical terms, and much more so in geological terms, we have extracted and used a very significant share of the easily available mineral resources. We are already processing lower and lower grades ores - which, by the way, uses more and more energy to the final ton ! It has taken millions of years for the earth to store sun energy under the very elaborated form of liquid and gaseous hydrocarbons, and it will take less than one century for man to burn out must of those precious products.

On the other hand the scientific and technological civilisation which is vastly responsible for this exhaustion of raw materials and energy has discovered and is developping new energy sources and new ways to use more efficiently the old ones. Among these new ways, nuclear energy is both industrially available now, and of an order of magnitude such as to noticeably alleviate the problem if we include breeders in time.

It is such a waste to see this mean to adress one of the real problems which faces our civilisation now impaired and, in some countries, complety stopped by problems which are nonexistent and artificial.

There is no human activity without risk or side effects but both risks and side effects of energy starvation are far beyond those associated with energy production ! To go further in the analysis, the risks and side effects associated with the production of a given quantity of energy by using nuclear power are far smaller than those created in producing the same quantity of energy by burning fossil fuels !

Those people who are in good faith concerned with our responsibility towards our grand-grand-children who will inherit our buried nuclear wastes would do well to think as well about our grand children who will inherit very little petroleum, the price of which I do not dare to predict. Those people who think and say we have time to decide wether we should develop breeders are in effect deciding that we shall not have breeders in due time. All the same we must pursue actively solar and fusion researches now if we want them to produce a sizeable share of our energy thirty or fifty years from now.

As we need now nuclear energy, we shall need breeders and we shall need solar energy : all our ingenuity will be put to the test to supply energy to developping countries without maiming the industrialized economies. But I am confident that if we squarely address the real problems without wasting time and energy on false issues, we can avoid leading our children to a dead-end. As goes the old japanese saying, "Hitsuyō Wa Hatsumei No Haha", necessity breeds inventiveness. (slide 23).

JAPAN ATOMIC INDUSTRIAL FORUM, 1979-03-13

NUCLEAR POWER - A CURRENT IAEA PERSPECTIVE

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It has become a truism to say that nuclear power at present is going through a period of transition, marked by serious uncertainties about its future. This is in spite of the good experience which we have of nuclear power for the production of electricity, proving our present generation of reactors as mature and safe. There were at the end of 1978 228 power reactors in operation in the world with a generating capacity of more than 110 GWe. Some countries already derive a major share of their electricity supply from nuclear power plants. In Western Europe, e.g. Belgium, Sweden, and Switzerland get more than 20% of their electricity from nuclear origin. For further proof of performance we can look at the excellent record of nuclear power plants during the harsh recent winters in New England, Canada and Sweden.

Slide 1

If there is any uncertainty about the future of nuclear power it is not because of past bad performance or lack of need of this energy source. Serious studies, like, for instance, that of the Conservation Commission of the World Energy Conference have shown the need for nuclear power without any doubt. They all also show the increasing demands which in the future will be placed on our energy resources. The realization among the decision-makers that this will pose a problem must be welcomed as must the emphasis on energy conservation and on rapid development of new and renewable energy sources, in particular solar energy. The discussion of the available options is, however, still confused at the public and political levels. It must be recognized that conservation measures are limited by the time lags inherent in the lifetimes or time for re-equipment of the energy consuming objects, such as automobiles, machinery or houses. The present discussion of zero-growth as an objective in itself in industrial countries is also as illusory as a total dependence on so-called "soft energy technologies". Much of this discussion is in fact beside the point. Just to mention one example: To build a house totally dependent on solar energy for heating is entirely feasible now for smaller units and it can be a good demonstration, but it is utterly uneconomical and, of course, not at all possible in urban locations with high-rise, multifamily buildings. It is not a question of choice between mutually exclusive options, but of optimization between all options available.

We must also acknowledge the large future energy needs of the developing world in order to meet the requirements of its rapidly expanding population not to mention the need to increase its standard of living. Thus, even if the industrialized nations through drastic conservation measures and restrictive policies were to achieve a low energy growth, the pressure of demand from the developing countries will cause a substantial increase in the total world's energy needs. Nuclear power is not a viable near-term option for a majority of the developing countries because of their weak infrastructures and because they could not accommodate large nuclear units. It is, however, much more essential that the industrialized world depends to just about 66% on oil and natural gas for energy supply. There is also a trend towards an increased dependence on these resources, which clearly will be exhausted in a near future even with discovery of new deposits. If this continued and if nuclear power programmes are further slowed down or even stopped in the industrialized countries, there is a risk for a most serious impact on those developing countries which have more limited energy diversification options. In this sense the whole world would certainly profit from more nuclear power use in the industrialized countries.

All serious forecasts thus show an increasing rôle for nuclear power

lide 2 in the future world. Figure 2 shows a recent IAEA forecast, modified from the Conservation Commission's study by using the most recent data available to us. It is, of course, true that most forecasts in the last decade have resulted in consecutively smaller values for total energy and electricity supplies and for installed nuclear capacity. The uncertainties in the energy forecasts in general and for nuclear power as part of this have a primary reason in the uncertainty about the economic development in the market economy countries. Thus figure 2 should not be interpreted as a hard forecast but simply as a plausible framework within which the future rôle of nuclear energy may be discussed. It would mean a total installed capacity of some 1,400 GWe by 2000. It should be noted in this context that the centrally planned economies in the COMECON countries were not influenced by the developments in the rest of the world during the 1970s and that their energy demands continued without perturbation as did their nuclear power installation programmes. Most of the following remarks are thus valid only for the situations in the market economy countries.

The problems of the utilities which must consider their possible choices for introduction of a new generating plant have often been referred to. For those who can consider large units the main question is not one of economic advantage. Large nuclear power units are without any doubt competitive with oil-fired units and with coal-fired units in most locations. Experience has amply showed this and in spite of cost increases it would remain true. Any uncertainty about future prices of uranium and enrichment would certainly seem smaller than about the future price of oil. The uncertainties are in other areas, large outside the control of the utility, namely:

1) The investment climate.

2) Changing licensing requirements, which in turn have influenced capital costs and have increased the lead times for nuclear power plants far beyond those normal in utility planning. This is partly true also for coal-fired plants, which have a serious environmental impact. In the USA environmental protection requirements are now leading to steep capital cost increases for coal-fired plants.

3) In this perspective of long project lead times and stagnant demand, many utilities will tend to rely on large reserve margins which have been created by the plants ordered in the early 1970s and now coming on line.

4) Many Government's policies are changing, in particular due to proliferation concerns. They have at least to some extent influenced the international nuclear market and caused concern about the assurances of future supplies.

5) Finally, there is the serious uncertainty caused by antinuclear movements.

It is clear that to make nuclear power a viable option for the future we must decrease these uncertainties. Some of the problems are international in character and they can best be resolved through international action. This is necessary in the case of governmental policies but also in regard to the need for more international harmonization of licensing requirements and, it would appear, the public acceptance problem.

The opposition to nuclear power has gone through an evolution. In the early stages it focussed on issues concerning safety and later waste disposal. It should be recognized that the debate on these issues to some extent has been useful for the nuclear industry and that it has lead to additional precautions and to useful research and development work.

Recently the anti-nuclear movements shifted their emphasis towards more general environmental concerns over the whole fuel cycle and presently to non-proliferation. At the background there is also often a general objection to the industrial development and distrust of authority. The substitution of "standard of living" with the undefined "improved quality of life" as goal is significant. In several countries these movements have also entered actively into the internal political life.

To discuss the impact of the uncertainties on the whole nuclear industry it may be useful to regard the three major sectors of it. At the centre is, of course, the utilities which have as objective and, indeed, in most places the obligation to meet electricity demands as cheaply as possible. Still, as shown above, they have serious difficulties to make decisions for the future, and any uncertainties in this sector will of necessity be reflected in the others, that is, the reactor plant suppliers and the fuel cycle industries. These are, however, of different character. In the fuel cycle industry each stage has only one earlier supplier stage and one customer stage. Future capacities, and some of them are extremely capital intensive and have long development lead

times, depend entirely upon the future power plant demands and on the conditions under which supply contracts can be concluded. The power plant supply industry, on the other hand is usually part of a well-diversified industry for which nuclear reactors are only a part of the production. There are at the present time some 15 nuclear reactor manufacturers in 10 countries in the world. The total manufacturing capacity is some 60 GWe/year, and it has been asserted that a nuclear power plant supplier would need new orders of some 2 - 4 GWe/year in order to remain viable, otherwise capital utilization becomes inadequate and the workload insufficient to give continuity of employment. Against this it is necessary to balance the facts that although there are some 205 GWe under construction,
3 orders have declined very much in recent years (figure 3). It must also be borne in mind that orders have been cancelled for 5.7 GWe in 1978 and for a total of more than 20 GWe since 1975. It thus seems a legitimate and necessary question whether this manufacturing capacity will survive the present lean years, when, with only two or three exceptions, the firms are now working at well below 50% of their capacities. Looking again at the recent IAEA forecast, it predicts some 800 - 1,200 GWe installed in 2000, i.e. additional orders up to around 1992 of some 500 - 900 GWe! It is clear that if we are going to be able to meet what we now think are our requirements the situation in the reactor manufacturing industry will have to change from one which is hardly viable to one of a capacity which must be increased beyond the present 60 GWe/year in the late 1980s. Hopefully, this will be possible.

Looking at the future of the fuel cycle industry there are some features which are essential for our judgements, namely:

- Uranium production is now dominated by a small number of countries, which together with Australia also have more than 75% of the present reasonably assured and estimated additional resources of some 4.3 million tonnes of U at a recovery cost of less than $ 50/lb of yellow cake. A recent estimate of speculative resources would indicate a potential change in that situation, a change which was, of course, to be expected. Of an additional 6 - 14 million tonnes of speculative resources the bigger part would probably be outside the mentioned countries and in the developing world, which could give a very different international market situation. Use of lower grade resources could accentuate this change further.

- For reprocessing on the other hand there do not appear any imminent changes of the situation we already see. Before the mid 1990s no large-scale reprocessing plants are planned outside those countries which have them now plus the Federal Republic of Germany and Japan. The same incidentally appears to be true for enrichment plants.

- One factor of some importance in the fuel cycle industry is the long lead times required for new production capacities. It is necessary to estimate 8 - 10 years from the beginning of exploration until new uranium production capacity will materialize. The same is true for the large capital intensive enrichment and reprocessing plants. This is one of the motivations for the long-term contract and cross-investment arrangements which have been sought by both suppliers and consumers. There are also long lead times for deliveries in the fuel cycle itself from delivery of yellow cake to the delivery of fabricated fuel elements. These lead times, together with the stocks established against normal commercial risks have in the past to a large extent diminished the effects of supply interruptions for uranium.

It is clear that the international interdependence of the nuclear industry will remain. Very few countries can be completely independent from outside supplies and this would, of course, be a goal that in most cases would be economically unattractive. In addition, it is the international interdependence which through international co-operation and supply agreements give us the best possibilities to reach assurances against the spread of nuclear weapons. But this will require a viable nuclear industry with competitiveness over the world.

It is easy to show that the 4.3 million tonnes of uranium, which are estimated to be available on the basis of exploration could suffice more than well to fuel all nuclear power plants built well beyond 2000 over their lifetimes, even if they were all LWRs and HWRs fuelled on a once-through cycle. This assurance has obviously not been adequate for countries depending on uranium supplies from the outside. Over the longer term, the nuclear fuel cycle must be closed for resource utilization reasons and the breeder reactor introduced if nuclear power is not going to be only a brief parenthesis. Several countries, including Japan, are pursuing this path.

Some also regard plutonium use in thermal reactors as an essential option in order to stretch uranium supplies before any commercial penetration of the breeder on a significant scale is achieved, which is not likely before the late 1990s, even in the few countries where its development is now being pursued.

In some countries it is further argued that reprocessing will not only yield a better resource utilization but that it also represents the best way to solve the nuclear waste management problem and indeed to avoid the accumulation of plutonium in spent fuel in large quantities, which with time would become steadily more easily accessible for explosives production. Still, as stated earlier, new large scale reprocessing capacities are unlikely to become available in additional countries for at least 15 years. In fact, most LWRs and all HWRs in the world now use a once-through fuel cycle with spent fuel being stored indefinitely after discharge.

While, in one way, we can see the long-term goals, the present situation is unlikely to change very rapidly. The transition of the present to the future situation is what now has become critical and dominated by concerns over future possible proliferation of nuclear weapons. Although past history does not show one single incidence of a coupling between civilian nuclear power and the use of its materials for nuclear explosives, we must accept that the proliferation concerns exist, in spite of the assurances which the 106 parties to the Non-Proliferation Treaty have given and in spite of the international safeguards which are now applied to all significant nuclear
Slide 4 activities in all but five non-nuclear weapon states (figure 4).

The proliferation concerns are not new. During the 1960s they led to a steady evolution of international safeguards and to the establishment of NPT as the basis for a nuclear co-operation and trade régime. They later led to the safeguards trigger list and the supplier group's conditions for supplies. The present concerns focus on facilities handling or storing large amounts of plutonium and research reactors with large amounts of highly enriched uranium. These concerns are at the basis of the International Nuclear Fuel Cycle Evaluation (INFCE), which was launched in October 1977 and in which 53 countries and 5 international organizations are now participating. INFCE is an impressive effort to clarify the interaction between peaceful nuclear power programmes and the risks for proliferation of nuclear weapons. The work is performed in 8 working groups, there is a Technical Co-ordination Committee (TCC) and a Plenary Conference of all the participating countries.

The IAEA is participating in INFCE in three different capacities. Firstly, we provide the meeting facilities and documentation services for a majority of the many INFCE meetings. Secondly, the Agency provides the secretariats for the INFCE Plenary Conference, Technical Co-ordination Committee and 6 of the eight working groups. Finally, we participate through secretariat staff in the working groups and in TCC to contribute in areas where our normal programme has given us special competence. In this capacity IAEA is providing computer services for fuel cycle calculations for most of the working groups. The Agency has also been requested by its Board of Governors to pay particular attention to the special needs of the developing countries in the context of INFCE. We have contributed information and expertise available within the secretariat in a wide range of subjects, such as waste management, advanced reactor systems, uranium resources, research reactors and institutional arrangements, including multinational fuel cycle centres. The present status of international safeguards application and safeguards development work have also naturally been the subjects of Agency contributions.

During the first year INFCE has gathered an enormous amount of data leading to some 9,000 pages of working papers. It has now entered an evaluative stage and one has the impression that the work is getting more pragmatic. There seems to be a general understanding now that the improvement of existing technologies is more promising than the invention of exotic ones and that there are, of course, no overall technical fixes. Specific technical improvements or single institutional arrangements also do not appear likely to provide overall solutions, although several could be essential elements for the future. It must also be remembered that INFCE was intended to be a technical and economic study and not a negotiation. It is thus more likely to indicate concepts for further study and discussion rather than any comprehensive solutions. It is still too early to speculate about the outcome of INFCE and the areas to which it will give the greatest importance. One result in itself is undoubtedly the development of common international efforts to define problems properly and try to resolve them, an exercise which has already resulted in a constructive dialogue.

One subject which has been discussed at length is the necessity to match improved non-proliferation assurances with improved assurances for international supplies. This would require a number of measures, referred to recently as a "bouquet". These are at present seen to include institutional arrangements for reaching a broader international agreement in the supply area on non-proliferation conditions and some guidelines for what those conditions would be and their matching supply guarantees. They are also likely to include a preference for multinational solutions in the establishment of new sensitive fuel cycle facilities. The IAEA Board of Governors is, of course, explicitly designed to serve as a forum for such discussions.

Some elements are already obvious.

The most important is the Agency's safeguards system which must be a cornerstone and prerequisite for any international nuclear régime. Continuing development work on safeguards methods and procedures is, of course, going on to meet future requirements on the IAEA safeguards applications. One central problem has undoubtedly been the effectiveness of the Agency's safeguards for large reprocessing plants. In these it would seem very difficult to achieve the objective of timely detection of diversion through the basic safeguards measure of conventional materials accountancy, both due to the inherent measurement uncertainties and the long time periods between the closure of materials balances. Recent development work, not least here in Japan, on more timely dynamics materials accountancy in combination with the other two basic safeguards measures, containment and surveillance, would, however, seem to have a potential to change that negative picture. Much development and demonstration work remains to be done before the effectiveness of such combined approaches can be determined but if the claims of those at present developing them are not exaggerated and if the definition of the safeguards objectives remains more or less unchanged, it seems reasonable to be optimistic. It also seems reasonable to assume that the safeguards development work can keep pace with the requirements placed on it, i.e. that the improved techniques can be available when they are needed in future large-scale facilities.

Much of the technical discussions of international safeguards still seem to miss one essential point. It is in the expression of political will demonstrated by the acceptance of international safeguards, that we have a primary barrier against further proliferation. In the present discussions it seems that the parties sometimes lose sight of the basically political nature of the proliferation problem.

It is already clear from the Agency's past study on regional fuel cycle centres that there are incentives both of a technical and economic nature for multinational and co-operative action in some areas of the fuel cycle. The considerable capital investments, long lead times and development work needed for some types of activities certainly would call for closer international collaboration in their establishment. The economic sizes of several facilities, particularly, of course, enrichment and reprocessing, are larger than most domestic markets would be able to support. The other incentives have been stated to be in both improved assurances of supply and increased non-proliferation assurances. This would seem obvious at first but exactly those most desirable characteristics have to be evaluated carefully against actual planning and management schemes. Such studies probably could best be performed within organizations like the IAEA.

Another scheme involving an international arrangement, foreseen in the Agency's statute, is that for international storage of plutonium now under active study in the Agency. Such a scheme could give the participating States the necessary assurances of access to the fuel materials while at the same time giving assurances against unnecessary stockpiles of plutonium. Another element, which has been proposed, is an international fuel bank to assure supplies in case of failures not related to abrogation of non-proliferation undertakings. These schemes could all have a beneficial stabilizing influence and help to restore international confidence. It must, however, be remembered that it takes considerable time to set up and agree on international arrangements of this nature.

One area has perhaps so far not received the attention it merits and that is further work on internationally agreed practices for handling, transport and storage of materials. Studies under both INFCE and under UNSCEAR have essentially shown that whichever fuel cycle options are chosen, they can be pursued safely and without significant risk to populations in normal operation. This is true for LWR and FBR cycles and for disposal of wastes both in the form of unreprocessed fuel and high level wastes from reprocessing plants. These general studies are very reassuring but if would be highly desirable to obtain additional assurances through internationally agreed recommendations for practices. This applies also for the physical protection of nuclear materials against theft. This should be an important field of work for the international organizations in the future.

In this exposé recent and possible future developments have been touched upon mainly from the perspective of the IAEA. Thus specific political developments such as the London Supplier's Group's supply conditions or the policy developments in individual states have not been mentioned. [They will undoubtedly be covered extensively by other speakers today.] The future at present may appear difficult in some areas, in spite of the confidence we should draw from past history and experience. The international relations and the industry are in a transition period. Still, in the present discussions it must not be forgotten that the basis for any future development is the maintenance of a viable industry, competitive and free to compete on the international market. For this we will need a stable international régime with credibility over the long term. In our efforts to achieve this goal it should be of utmost importance that we build upon the international arrangements which have been established through many years, such as the NPT, the Tlatelolco Treaty and the IAEA.

RSKJ/mc

NUCLEAR POWER AND NONPROLIFERATION

An American View

Remarks to Japan Atomic Industrial Forum
March 13, 1979

by

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As a basis for discussion of the problems of reconciling energy and nonproliferation interests, I should like first to state the principal points on which I assume there will be broad agreement among us.

It is conceivable that solar or other energy sources may make it unnecessary that we depend heavily on fission power for most of the next century. I take it, however, that we would agree that it would be imprudent to assume that, particularly for the first half of that period; and that, therefore, we must try to establish a regime that will permit continued and expanding exploitation of fission power, including very probably breeder technology. In this connection, I should point out that the United States, far from opposing breeder development, is in fact committed to a very large effort. It looks with favor on other nations also working in this area, and believes there may be benefit in more extensive cooperation.

From a more immediate perspective, I assume we would agree that the use of converter reactors should be encouraged wherever they can be employed in an economically beneficial way, provided this can be done safely. In including this proviso I have in mind the fact that a serious accident or the exploitation of a power reactor for weapons purposes anywhere could have unfortunate consequences on a world scale.

This brings me to the relation between nuclear power and nuclear proliferation. Any nation sufficiently advanced industrially to use nuclear power could probably develop a weapons capability in a few years - perhaps less. This would not necessarily involve any of the elements of a nuclear power cycle. Indeed, material for weapons could be produced much less expensively and with less effort in facilities dedicated to that purpose. With time, the necessary technology will become increasingly accessible. This suggests to me, and I assume most of you would agree, that our highest priority in dealing with the problem of weapons proliferation at the national level must be in reducing motivations of nations to acquire nuclear weapons. But having made this clear, we must recognize, as I'm sure you do, that the existence of nuclear power and related sensitive facilities could reduce the time required for a nation to acquire weapons, could perhaps tip the balance in favor of weapons decisions in some instances, and could make more likely the acquisition of weapons-usable materials by terrorists. Thus, we do have a problem in assuring that nuclear power will not contribute to the proliferation problem. From a technical perspective the problem will become more worrisome as technology spreads. We must, therefore, look to the establishment of international institutions, as well as to reduction in incentives, to deal with the problem of proliferation.

More than safeguarding will be involved. I would hope that there would be a consensus that we must move toward a regime where, at a minimum, decisions on storage and release of materials that are directly usable for weapons would be taken at the international level. More ambitiously, we ought to be thinking in terms of bringing virtually all of the sensitive parts of the nuclear fuel cycle under international control. This will take time, and, therefore, for most of the rest of this century we will have to rely substantially on other means in coping with the problems of reconciling our interests in exploiting nuclear power and preventing, or at least in limiting, nuclear weapons proliferation.

The problems will come into particularly sharp focus during the next year with the coincidence of the conclusion of the International Nuclear Fuel Cycle Evaluation, the second review of the Nuclear Nonproliferation Treaty and the continuing requirement, under American law, for the renegotiation of agreements for nuclear cooperation between the United States and a number of other countries, the IAEA and EURATOM.

I do not want to sound too much like an alarmist, but I think it likely that if we fail to make substantial progress by, say, the end of 1980, we will see an acceleration in the development of a two, or more, tier structure in international nuclear commerce with different nations trading on different terms; i.e., with some supplier nations being willing to supply, and with some buyers insisting on obtaining, fuel, equipment, services and technical assistance under conditions that others in the world community would regard as unacceptable from a proliferation perspective. The development of such a trading regime could have a number of most unfortunate consequences: irritation between nations; tensions within them, arising from difficulty in deciding in which of the two or more trading blocs a nation wished to be placed; possibly adverse effects from a proliferation perspective; and, perhaps most serious, a diminution in the prospects for the evolution of a single international regime that will meet longer term needs.

This brings me to the principal differences between the United States and some other nations on fuel cycle questions. These derive from different perspective on the waste management question, on access to supplies of fuel for converter reactors, and sensitivity to possible interruption of access. Questions both of uranium enrichment and of reprocessing of spent fuel are involved. Both processes can be exploited to produce materials that might be used to make weapons. At issue is whether additional facilities of either kind are needed for power purposes; if so, why; and how perceived needs can be met safely and economically.

Conceptually, and practically, the enrichment problem is the more easily dealt with. It is perfectly understandable why nations committed to light water reactors would want assurance of access to enrichment service adequate for the expected needs of those reactors, and why, in the light of past experience, they may be considering building their own enrichment plants to meet that need.

However, even aside from proliferation considerations, there are very powerful arguments that should serve to dissuade most nations from building their own plants at this time. First, there will almost certainly be substantial excess world capacity until at least the nineties. This, and the fact that there will be four suppliers eager to provide service -- the United States, the Soviet Union, URENCO and EURODIF -- means that there will likely be a buyer's market. Second, with technology evolving rapidly, costs are likely to drop, and with that, present technologies will become obsolete. Third, more than in any other major aspect of energy, stockpiling could be a realistic hedge against interruption of supply. Presumably, what would be required for most countries would be the maintenance of a stockpile equal to about five to ten year's requirement of separative work, that period of time being what would be required to develop an indigenous capability on an expedited basis in the event of interruption of supply. Maintenance of such a stockpile would add 10 to 20% at most, to the real social cost of generating electricity, assuming constant uranium and enrichment costs. Rising uranium costs and progress in enrichment technology, both of which seem likely, would make an investment in a stockpile less costly --

indeed, probably positively attractive -- compared to the alternative of early investment in an indigenous enrichment facility that would very likely prove to be rapidly obsolescent.

The reprocessing issue is much more complex, in part because, in contrast to the situation with respect to enrichment, there are differing perceptions about why reprocessing may be needed: as a precursor to disposal of high level wastes; as a condition precedent to recycling of uranium and/or plutonium in converter reactors; or to provide fuel and develop experience for breeders.

With respect to waste disposal, the American view is that it should be possible to handle in an equally satisfactory way either unprocessed fuel or high level wastes that result from reprocessing. We believe both alternatives for dealing with spent fuel should be explored, but at this point, although conceding there are differences, do not believe that much of a case can be made for one method of disposal being safer than the other. It is my personal view that the hazards of reprocessing will exceed those of waste disposal, assuming both reprocessing and waste disposal are done with reasonable care, and that, therefore, when considering fuel cycles in their entirety, the "throw-away" cycle will be safer from an environmental perspective, as well as on proliferation grounds. Having said this, we must recognize that we could be wrong, or at least that others may disagree, and that, therefore, some nations will continue to be strongly motivated by waste disposal considerations to reprocess spent fuel. The motivation, or at least the imminence, can be reduced if provision can be made for retrievable storage of spent fuel outside the countries where this is a problem. It is this thought that has underlain both the Administration's proposal to store limited amounts of foreign spent fuel in the United States with the United States accepting title to it and interest in the development of multinational facilities where spent fuel could be stored with the originating nations retaining title. We would hope that developments of this kind could reduce incentives for the development of national reprocessing capabilities in those cases where the motivation is for waste disposal purposes.

However, interest in reprocessing seems to be more generally based on a desire to recover plutonium and unconsumed uranium because of their energy content. Whether or not this will be economically advantageous will depend on the cost of reprocessing, the price of uranium and a number of other parameters about which there is, and will continue to be, dispute.

To the extent that interest in reprocessing relates to breeders, other factors that will be particularly important are the expected differences between their capital cost and that of converter reactors, and the magnitude of investment required to carry the breeder through the commercial demonstration stage. Our analyses suggest that even when development has been carried to the point where we are ready to deploy commercial breeder reactors, such deployment will be economically attractive only at uranium prices two or more times higher than they now are. This suggests that few, if any, nations would find breeders economically attractive until well into the next century, assuming reasonable access to a world uranium market.

But, of course, much of the interest in breeders is based on a fear that we will not see such a market and that prudent planning requires that nations try insofar as possible to minimize their dependence on others with respect to energy matters. Breeders can help in this respect, but I can think of no country that could deploy them so as to achieve really substantial reductions in total fuel imports before perhaps the second decade of the next century. Indeed, when consideration is given to the need to produce plutonium for initial fuel loadings, it is clear that, except possibly in the case of France, their deployment will not even reduce dependence on uranium substantially until about the same time. Finally, total independence, including independence with respect to technology, will be beyond the reach of all but a few countries for many decades. And even for most of those few, it will be attainable only at such a high cost that they could very likely achieve a greater degree of energy independence at lower cost by acquiring and carrying large stockpiles of uranium for coverter reactors for many years, expensive as that may be.

All of this suggests that not much of a case can be made on either economic or energy security grounds for nations getting into reprocessing within the next decade or so in anticipation of early breeder <u>deployment</u>.

Some plutonium will be needed on a shorter time scale for breeder <u>research and development</u>. Favoring such R&D, as we do, we believe some reprocessing of spent fuel is justified at this time and over the next few years. In fact, though, the capacity that is likely to be available will greatly exceed the requirement.

This capacity will be used, with the consequent accumulation of stocks of plutonium. With this in prospect, it is urgent that we get on with arrangements for plutonium storage, under international auspices, with conditions for release clearly specified and with an international authority having responsibility for release.

The accumulation of plutonium will, of course, lead to pressure for its large-scale recycling in thermal reactors. Such recycling could result in an increase in risks of loss of plutonium and its possible diversion to weapons purposes. Far more worrisome from a proliferation perspective is the prospect that interest in thermal recycling will lead to the construction of additional reprocessing plants and the accumulation of still more separated plutonium. We are especially concerned that if some of the advanced industrial nations rationalize reprocessing on the grounds that recycling is desirable, other nations that will have no real need for plutonium for many years for breeder R&D will, nevertheless, wish to acquire national reprocessing capabilities.

All of this raises the question of the validity of the arguments for recycling of plutonium in thermal reactors. It is clear that from a narrow economic perspective no strong case can be made either way: the benefits as compared with a once-through fuel cycle will be marginal at best at present uranium and enrichment prices, even assuming the economies of scale of very large facilities. If this is accepted, as it seems to be increasingly, there are strong arguments for delaying reprocessing, even aside from proliferation considerations: (1) the value of the plutonium that can be recovered will increase with time, especially if it is held until such time as it is needed for breeder fuel; (2) aging of the spent fuel will make reprocessing easier and hence less costly; and (3) retrievably storing spent fuel can serve as an economically attractive way of augmenting a stockpile of uranium that might be held as a hedge against interruption of supply. Assuming enough uranium in the stockpile to cover a period of several years that would be required to build reprocessing capabilities, actual investment in a plant could be put off until there were a clear need.

Arguments of the kind I have made suggest to me that deferral of acquisition of national enrichment and reprocessing plants for some years will be in the economic self interest of nearly all of the nations of the world, and further that even if their primary motivations for such acquisition are concerns about assurance of fuel supply, rather than narrow economic advantage, there are acceptable -- probably preferable -- alternatives. These conclusions are almost independent of non-proliferation concerns. When the latter are taken account of, including particularly the importance of nations' recognizing that, however benign their interest in acquiring sensitive facilities, they may trigger suspicions by others, and possible emulation, the case for restraint seems very strong.

It can be enhanced, as we believe it must be, by working hard at building international institutions that can help further in providing nations with greater assurance against interruption of fuel supply, in helping those that have special problems with waste management because of geographical limitations, and in improving safeguards. This is entirely consistent with interest in the establishment of an International Nuclear Fuel Authority. We recognize that in time the world may well need reprocessing on a large scale and probably before that, further substantial expansion in enrichment capability. When that happens, it <u>must</u> be under international auspices that offer better alternatives for meeting energy needs than widespread diffusion of national plants. From a long-term perspective, trying to prevent the latter by the imposition of export controls and externally dictated conditions would continue to be politically costly.

In closing, I should like to make a brief comment on the special responsibilities of the advanced industrial countries to others that are not as involved with nuclear power. One of the lessons we have learned is that new developments in the nuclear field have almost always raised unforeseen problems and have cost more and taken longer than anticipated. This is very likely to happen in the developing countries as well. As a result of overestimating their rates of growth of nuclear power, underestimating the difficulties and costs of developing indigenous fuel cycle facilities, or estimating that breeders will be available for purchase earlier than they will be, they could commit themselves much earlier than need be to getting in enrichment and reprocessing. The result could be the worst of all worlds: a waste of scarce resources on facilities that will be largely irrelevant to the solution of energy problems for many years, but which will be worrisome from a proliferation perspective. We probably cannot prevent all mistakes of this kind but we owe it to the developing countries, and to ourselves, to be scrupulously honest with them in the information we make available which may influence their decisions. This is a challenge of the International Nuclear Fuel Cycle Evaluation which I trust we will agree we should try very hard to meet.

U.S. NUCLEAR INDUSTRY - PRESENT AND FUTURE

by

Roger J. Sherman
Chairman
U.S. Atomic Industrial Forum

March 13, 1979

It is an honor and pleasure to be with you for this 12th Annual Conference of the Japan Atomic Industrial Forum. During the past 23 years, I have been in your lovely country on a very large number of occasions, but this is only my second opportunity to participate in a JAIF conference.

On behalf of the U.S. Atomic Industrial Forum, I extend greetings from the members of the Board of Directors and its Executive Committee who join me in wishing you every success in this conference, as well as in other JAIF endeavors.

On a more personal note, I also wish to extend greetings and warm regards to your Chairman, Mr. Hiromi Arisawa, and to my longtime friend and fellow director of the U.S. Forum, Dr. Ipponmatsu. I note with great pleasure that the Japan and the U.S. Atomic Industrial Forum continue to maintain a close working relationship.

INTRODUCTION

The United States currently has 72 central station nuclear power reactors in an operable state. The combined capacity of these plants, about 55,000 MWe, accounts for approximately 9.5 percent of the total electric generating capacity in the U.S. In calendar 1978, this nuclear capacity produced approximately 12.5 percent of the total amount of electricity used in the U.S.

The real significant contribution of nuclear generation to the U.S. is understated by this total U.S. figure of 12.5 percent. In the northeast region of the U.S. in 1978, nuclear accounted for 20 percent of the capacity and over 33 percent of the generation and during their recent peak load (February 1979) for 42 percent of the generation. In 1978 in that same U.S. region nuclear saved 47,000 barrels of oil and $517,000,000 of foreign exchange (66 percent to the customer). Where would we have been without this fine dependable resource?

The current operating plants are only a partial picture of the U.S. commitment to nuclear power. In addition, 96 more plants with a combined capacity of about 105,000 MWe are under construction and 20 more plants with a combined capacity of about 36,000 MWe are on order. The totals-plants in operation, under construction and on order are 188, of which all but 16 are scheduled to be in operation by 1987. In 1987, the percentage of total installed capacity will be more than 20 percent. As these new plants come on-line, they will, of course, gradually increase nuclear's percentage of total generating capacity. If these coming plants, all of which will be base loaded, operate as well as today's plants, as they certainly should, nuclear will be producing more than 25 percent of our country's electric power needs within another eight years.

I have just gone through quite an array of often quoted numbers, but I wanted at the very outset to document the fact that the U.S. nuclear program has already acquired a very significant momentum. This momentum should be taken into account in any attempt to put in perspective nuclear's future in the U.S. mix of electric generating capacity.

This momentum should also be taken into account in attempting to put in perspective the problems with which the industry has been so occupied during the past few years. This is not to suggest that these problems are not real. Nor is it to suggest that they can be brushed aside. What is suggested is that they must be resolved. Unfortunately the problems are not technical. They are institutional and political - more difficult of resolution than technical problems. However, the nation's already committed reliance on nuclear power permits no alternative other than resolution.

I might make another observation. It is fortunate that some of the key institutional and political problems are international in scope. This means that the combined experience and know-how of the international nuclear community can be brought to bear on resolving them. Over the past two years, Japan has demonstrated exemplary leadership in addressing a number of key issues of vital international interest and concern. For any who have not already done so, I would suggest a reading of the very scholarly article on nonproliferation by Mr. Imai of the Japan Atomic Power Company.

CURRENT STATUS OF THE INDUSTRY

In attempting to assess the current state of the U.S. nuclear industry, one should focus on those segments of the Industry facing the major problems: the utilities, the nuclear steam supply vendors, and the suppliers of nuclear fuel and related services. Each of these segments, along with other elements of the industry, shares a conviction in the merits of nuclear power and a desire to see nuclear power expanded. Each also shares a belief that nuclear power will move forward at an accelerated pace when certain problems have been resolved. The important key here is "when."

THE PROBLEM OF UNCERTAINTY

By far, the most serious problem facing the nuclear industry in the U.S. today is the problem of uncertainty. The symptoms of the problem, as it impacts on the utilities, and in turn on their suppliers, are clearly evident in the record of new plant orders over the last seven years. In 1972, 1973, and 1974, a total of 105 domestic orders for nuclear power plants were placed with the nuclear steam supply system (NSSS) vendors. The total over the next four years was 13. Conversely, during 1972, 1973, and 1974, a total of 14 nuclear plants were cancelled. During the next four years, the number was 34. And further underlining the seriousness of this uncertainty are the large number of nuclear construction deferrals that have been announced over the past four years - 40 plants in 1978 alone.

But to put this record in perspective, it must be understood that the problem is not unique to nuclear. Admittedly, the problem has impacted nuclear power more severely than other types of generation but this is principally because of the long lead-time characteristics of nuclear power plants. When faced with load growth uncertainties and the likelihood that less capacity will be needed than had been anticipated just a few years ago, it is not surprising that utility managements have decided to cancel or defer those units having the longest construction time and the highest construction costs - the nuclear plants.

There is probably no single cause to which this pervasive uncertainty can be attributed. The lack of a definitive, long-range and widely-supported U.S. national energy policy is one major reason. Conservation and inflation are also high on the list. During the last five years, the U.S. has seen electricity for the first time in the history of central station power generation become a price-sensitive commodity. As electric power rates have gone up, growth in demand has gone down, although there certainly is no claim that price is the one cause of reduced growth.

For several decades prior to 1974, the demand for electric power in the U.S. grew at a reasonably predictable rate - at least predictable enough to permit utilities to plan for expansion with a reasonable degree of certainty. At the worst, a plant would come on-line a year early - not the most earthshaking error in a period of low interest rates.

Electric power consumption in the 1950's grew at an average annual rate of 9.4 percent, in the 1960's at 7.3 percent, and in the first four years of the 1970's at 6.6 percent. In 1974, however, there was almost no growth - 0.2 percent. In 1975, it was 2.7 percent; in 1976, it was 6.3 percent; and in 1977, it dropped back to 4.2 percent.

The numbers are not yet in for 1978, but it appears on the basis of the first six that the rate will be higher than it was in 1977.

There is still no clear indication, however, of what the growth will be in the 1980's and the 1990's. This is a problem.

The Department of Energy's current "high" projection anticipates a growth rate of 4.2 percent from now to the end of the century. Its "low" projection is 3.1 percent. Projections circulating within the industry range from 4.1 percent to 5.2 percent. I tend to favor the extreme upper end of this range as being more realistic since I believe as we move into the 1980's and 1990's, increased pressure will be put on certain major users of gas and oil to convert to the use of electricity where such substitution makes economic sense.

NUCLEAR GROWTH

The Department of Energy's projected "high" annual growth rate of 4.2 percent anticipates that installed electric generating capacity in the U.S. in the year 2000 will be 1,420,000 MWe. Of this total, the Department of Energy projects that some 28 percent, or 395,000 MWe, will be nuclear. Its "low" projection of 1,080,000 MWe anticipates a smaller nuclear percentage, about 23 percent or 255,000 MWe.

The industry has made no collective attempt to develop its own concensus growth projection. (As I said, the projections range from 4.1 to 5.2 percent.) What our Forum has done is to look at the nuclear industry's capability to install more nuclear power if it should prove to be in the national interest to do so. To make this kind of assessment, a Forum study group recently studied three questions:

1 - Can the nuclear industry do more than is expected of it in the context of current DOE projections?

2 - How much more? and

3 - Under what circumstances?

The study group took the Department of Energy's "high" nuclear projection of 395,000 MWe as its "reference" case since it felt on the basis of prior studies and its own experience that this target was well within the industry's capabilities. It took as its "expanded" case a total of 550,000 MWe of installed nuclear capacity by the year 2000. The study group felt it should take a target that would not only represent a challenge to the industry but also expose any problems that might be encountered in reaching the higher total.

Time does not permit me to go into the many detailed findings of the study group. For this, I commend to your review the report itself dated February 1979, which is entitled, "Nuclear Power: Its Potential and Resource Needs."

The principal conclusion reached by the study group was that 395,000 MWe of nuclear capacity could be installed in the U.S. by the year 2000 if the federal government were simply to implement, in an expeditious and consistent manner, the policies and programs to which it is already committed, namely, simplifying the licensing process, adding new enrichment capacity, and resolving the waste management issue.

On the other hand, the study group found little likelihood that 550,000 MWe of nuclear capacity could be in operation by the year 2000 unless there were a national determination to make this happen. Such a determination would have to be premised on a belief that nuclear expansion is necessary to the energy needs of the country, to the growth of the economy, and to national security. Given this circumstance and the type of government policy support that prevailed up to 1974, the study group found that a 550,000 MWe goal could be reached. There would appear to be ample uranium reserves and resources to support such an expanded program, provided reprocessing and recycle are permitted to start in the mid-to-late 1980's. There is already sufficient manufacturing capability in place to keep up with the demand of such a nuclear expansion until 1996 and there is plenty of time between now and then to activate idle capacity or build new manufacturing facilities should they be needed.

I would now like to discuss with you a few key problem areas that have been identified by the AIF study group and others in the industry during the past year. The study group identified eight problem areas:

- reactor licensing
- fuel cycle licensing
- closing the back end of the fuel cycle
- proliferation
- uranium supply
- uranium enrichment
- utility financing
- equipment supply.

Further, these eight areas were found to contain a sufficient number of uncertainties to lead to a ninth problem area - erosion of utility confidence.

UTILITY CONFIDENCE

Although the problem of utility confidence appears to be primarily a U.S. phenomenon, I want to say just a few words about it since it is not the type of problem that it may at first appear to be. To the best of my knowledge, there has been no erosion of confidence on the part of U.S. utilities that nuclear power is safe, that it is environmentally desirable, and that it is economically attractive. The erosion of confidence arises from a concern on the part of the utilities that uncertainties now attending the addition of new generating capacity will not soon be resolved. These uncertainties are causing the utilities to be hesitant about adding new capacity - any new capacity, not just nuclear, but the impact on nuclear is greater.

As indicated earlier, future long-term load growth demand for most utility systems is uncertain. Past effective load growth projecting tools do not seem to be working well. The average margin over peak demand across the nation is in excess of 25 percent. The impact of conservation once thought to be a one-time phenomenon, is proving to have a continuing effect, at least up to now. And as indicated earlier, price elasticity is having a greater impact on electric power demand than was thought possible when overall electric rates were lower. There also seems to be a changing relationship between electrical load growth and GNP growth.

Really, little wonder for uncertainty in forecasting when one considers the items I just mentioned (conservation - price elasticity - growth with growth in GNP) with another apparently incongruous fact - in 10 years the percentage of new homes completed annually that were electrically heated has gone quite steadily from 22 percent to over 49 percent!

These uncertainties have caused utility planners to adopt a "wait and see" attitude. Many of them appear to be deferring their own decisions until the federal government takes some kind of definitive position and outlines an action plan for implementing a national energy program. It now appears that such definitive government action may not be forthcoming until there has been more debate among the politicians, certain vocal segments of the public, and the media about such controversial topics as solar, biomass conversion, fusion, and on and on and on. All of this debate is quite peripheral to meeting the needs for central station electric power between now and the turn of the century. The danger, of course, is that the debate will continue until a shortage of central station power is inevitable. In terms of avoiding that shortage by increasing our commitments to long-lead-time nuclear the point of decision is rapidly approaching. If the time of resolution does not approach as rapidly we will be in very deep trouble.

I would now like to turn to some nuclear problems that are more international in scope. I shall limit my remarks to three areas:

- reprocessing and recycle
- waste management
- public acceptance.

REPROCESSING-RECYCLE

Regarding reprocessing and recycle - this is the area around which most of the discussion on proliferation has centered.

The nuclear fuel cycle, particularly the reprocessing of spent fuel and the recycle of plutonium, is now the topic of extensive study among the 52 nations participating in the International Nuclear Fuel Cycle Evaluation (INFCE). It is also the subject of ongoing bilateral discussions between the United States and Japan as well as among other nations of the world having a major interest in civil nuclear power. The objective of all these efforts is to develop a concensus on measures that could be taken to limit the effect of the nuclear power fuel cycle on the international spread of nuclear weapons.

It is to be hoped that INFCE will provide a technological base of understanding upon which to build a concensus of political and institutional arrangements. Although INFCE is not scheduled to be completed until early 1980, efforts appear already to be underway to find an accommodation among nations to support the separation and recycle of plutonium. Such efforts, of course, suggest that INFCE is not likely to identify a fuel cycle that is any more resistant to proliferation than the uranium-plutonium cycle on which most thermal and breeder reactor development around the world is already based.

Such a finding would be in keeping with the conclusion of an AIF Study Group on Technical Deterrents to Proliferation which said in a report issued last fall that

> "in its technical assessment, was unable to identify any cycle which would eliminate or significantly reduce proliferation concerns or which would materially alter the need for institutional controls."

Although it would be contrary to unbiased scientific and technological investigation to foreclose the evolution of a perfect alternative, that likelihood seems quite remote at this time.

Given the absence of a more proliferation-resistant fuel cycle having been identified after a year and a half of intensive INFCE study, other practicalities take on more significance. Civil nuclear power has over the past 25 years invested extensive expenditures of money, manpower and natural resources in uranium-plutonium as the preferred nuclear fuel cycle. It is highly unlikely that a comparable investment would be committed by any country to an alternate fuel cycle except for the most compelling of reasons. And it is also highly unlikely that Japan and certain countries of Western Europe could afford to invest the time that would be required to develop and perfect an alternative fuel cycle even if the investment of money and manpower were not a factor. Their dependence on nuclear to meet their electric power needs is simply too great and too immediate.

Informal consideration is currently being given to the question of whether plutonium recycle should be limited to breeders and what the impact of such a policy would be. Those favoring exclusive recycle in breeders contend that this would, for the near term, limit recycle to the relatively few, proliferation-safe nations that have breeder programs underway. These are the nations that also have the technological know-how and facilities to reprocess spent fuel. The argument goes that in the time that would lapse before additional nations initiated breeder programs and needed plutonium to fuel them, physical and political controls for safeguarding plutonium could be further refined and proof-tested. - I'm not sure I like the idea of "proof-testing" political controls.

Those who take the opposite view, and I count myself among this group, contend that recycle in light water reactors is as a minimum necessary to keep plutonium supply and demand in balance. A country would find it virtually impossible to reprocess just enough spent fuel and separate out just enough plutonium to fuel an evolving breeder program - at least on any basis or schedule that makes economic sense. Such a country would be faced with the question of when should the next increment of reprocessing capacity be brought on-line versus the question of how much additional expense should be committed to storing and safeguarding any plutonium found to be in excess of the fuel needs of its breeder program. Without the option to recycle plutonium in light water reactors, there simply would not exist in the vernacular of the engineer any flywheel mechanism to manage plutonium supply and demand in a logical or economic way.

It has been argued by some that no international policy should be adopted that cannot be applied to all nations without regard to their current nuclear status. The argument goes that giving a country already possessing reprocessing capability and a breeder program access to plutonium recycle in light water reactors while denying that option to other countries would be resented and hence unworkable.

Others argue that the value of plutonium recycle in light water reactors is too important to be restricted. They cite as reasons for their position that plutonium recycle in light water reactors would: (1) confirm the economic value of reprocessing and recycle; (2) improve reprocessing and recycle technology; (3) minimize the expense of storing and safeguarding plutonium; (4) extend the fuel value of uranium reserves; (5) decrease the demand for uranium enrichment; and (6) provide additional options for managing nuclear wastes.

It seems to me that a reasonable middle ground between no recycle and unlimited recycle in light water reactors would be for countries possessing reprocessing capability and a breeder program to proceed with plutonium recycle in light water reactors. Since these countries fall into what I described earlier as proliferation-safe nations, their recycle of plutonium in light water reactors would not add to the threat of further proliferation.

It should, of course, be understood that countries initially foregoing recycle in the common international interest would as their nuclear programs mature to the point of warranting their own reprocessing capacity and their own breeder programs, also have the option to recycle plutonium in light water reactors. In the meantime, their interests could be served by the reprocessing nations whose options give them the maximum flexibility to serve their own needs as well as those of the country looking to them for reliable and economic fuel supply services. Such reprocessing nations could give compensation for the plutonium content of others' spent fuel with enriched uranium fuel or its equivalent. With such an approach, every country would benefit, no country would be disadvantaged, and plutonium utilization would become more widespread only as it makes economic sense.

It is, of course, the responsibility of government, rather than industry, to develop the political and institutional arrangements designed to reduce the risk of nuclear weapons proliferation. However, it is the responsibility of industry, working within government regulation in some countries and working in partnership with government in others, to supply electric power. In either instance, industry should be fully consulted to assure that the political and institutional arrangements developed to prevent proliferation do not defeat the objective of making civil nuclear power a realistic energy option.

The U.S. industry believes that both reprocessing and the deployment of breeder reactors are prerequisites to making nuclear power a full energy option. Although the industry believes that civil nuclear power is an unlikely route to nuclear weapons proliferation, it also recognizes that there is no absolute technical barrier to prevent proliferation from such a route. Accordingly, I believe U.S. industry would accept reasonable constraints against possible plutonium diversion even at an economic penalty and at the risk of compromising proprietary information. Examples of such acceptable constraints might include: (1) the coprocessing of uranium and plutonium; (2) the colocation of new fuel cycle facilities handling plutonium and/or highly enriched uranium; and (3) the placement of resident IAEA inspectors in sensitive fuel cycle facilities.

WASTE MANAGEMENT

The management of nuclear wastes, particularly high-level radioactive waste, has during the past two years attracted the attention of an increasing number of government administrators and legislators. This seems to be as true outside as inside the U.S.

Underlying nuclear waste surfacing as the main problem in the U.S. is the fact that those whose objective is really to change the social order have selected the nuclear issue itself to attack to accomplish their objective. The now most vulnerable aspect of the nuclear issue is waste management.

It is a topic lending itself readily to inflaming public emotions - inflaming emotions to the point where real objectives are completely obscured. Since public controversy of any kind on any subject is fodder for the news media, the subject has received much more attention than the magnitude of the problem warrants. I might add in all candor that since neither the complexity nor the immediacy of the problem warranted any more attention than it was receiving up until recently, neither the government nor the industry was prepared to deal with the public attention that the matter has attracted. I should also add that in the U.S. the problem was exacerbated overnight by the Administration's decision of just about two years ago to defer indefinitely the reprocessing of spent fuel. This policy decision has taken us back to fundamentals. What is high-level waste? Is it spent fuel? Is it waste discharged from a reprocessing plant? Or is it both?

The so-called Deutch report issued last spring indicated that it doesn't make any difference - that spent fuel can be accommodated in a high-level waste repository as easily and with pretty much the same procedures as would apply to the deposition of separated and calcined fission products. The subsequent draft "Report to the President by the Interagency Review Group on Nuclear Waste Management" issued last October restates this conclusion. I know of no industry challenge to this finding, but industry is concerned about any long-term policy that would preclude reprocessing, mainly because the recovery of plutonium from spent fuel reprocessing is a prerequisite to development and deployment of the breeder.

For this reason, the industry is fully supportive of DOE's plans to establish an Away-From-Reactor (AFR) interim spent fuel storage program. The forum, through its Fuel Cycle Services Committee, has during the past two years kept the Department of Energy advised on a current basis on the capability of nuclear utilities to store discharged fuel in their own on-site storage pools. On the basis of such information, the industry has informed the Department of Energy that an AFR must be available by 1983 to accept spent fuel if the risk of reactor shutdowns is to be avoided.

The AIF has followed closely government plans to activate an AFR and to establish a high-level waste repository. At this time, it is reassured that those plans are beginning to take shape in the form of definitive programs and schedules. The industry has urged the Department of Energy to proceed with plans to establish a high-level waste repository at the earliest possible date. The industry has been reassured by one of the conclusions of the Interagency Review Group draft report referred to earlier, namely that repositories can be built with conventional mining technology in a number of different geologic media to isolate radioactive waste from the biosphere for periods of thousands of years. (As an aside, I would point out and emphasize that this is a "draft" report. Possibly sometime in history there has been a difference between a U.S. government draft and final report.)

We would understandably prefer to see a repository in place by 1985, the date formerly established by the Energy Research & Development Administration, the predecessor agency to DOE, in contrast to the 1992-1994 time period now anticipated by DOE. The AIF has committed its assistance to DOE in moving this date forward to the extent possible.

PUBLIC ACCEPTANCE

The subject of public acceptance is so broad in scope, diverse in content, and pervasive in its impact on the nuclear power program that I shall not attempt here to touch on more than two or three recent events. To further make my point, I would remind you that the AIF has been sponsoring two conferences each year for the past several years on this one topic and it is still difficult to stay abreast of all that is going on.

First, you should know that the U.S. public still favors by a nearly two-to-one ratio the building of more nuclear plants. Even among those who oppose nuclear plants, a 53 to 38 majority say it's a good thing that we have them to fall back on if we run short from other sources of energy. The basis of these numbers is the latest survey by Louis Harris and Associates, Inc. that was conducted last October.

The Harris survey pointed out that support for nuclear energy was neither at an all-time high nor at an all-time low. It noted that public opinion "sways back and forth in proportion to public concern over energy supply" and in a fortuitous or possibly clairvoyant observation went on to say: "If the Iranian oil supply were to be cut off, support for nuclear power would likely swell."

Five of the seven leadership groups polled "squarely favored" continued nuclear power plant construction. These were utility presidents, business leaders, utility regulators and political leaders. The two opposing groups were environmentalists and media representatives. But among the media leaders who said they oppose more nuclear plants, about half said they were pleased to have nuclear in reserve.

The AIF has observed that the written media, in contrast to the electronic media, has now become much more objective in reporting nuclear news than it was even as recently as one or two years ago. There has also been a marked increase in interest on the part of the press in becoming better informed. Recent evidence of this was reflected in an AIF-arranged press tour last September in which 17 members of the U.S. working press participated at their own expense in a visit to nuclear facilities in the Soviet Union. No other project in which the AIF has been involved of late has produced more nuclear coverage, most of it favorable. The December issue of Critical Mass Journal, one of the major publications of the nuclear critics, described it as "one of the major public relations coups of the year."

Critical Mass went on to describe the tour in a manner that I would find difficult to improve upon:

> "All of the reporters stressed that their publications paid their way, that the tour was a once-in-a-lifetime opportunity, and that the stories obtained were legitimate news. AIF was consistently praised for its dogged efforts in battling the Soviet bureaucracy for 18 months to set up the tour, and for not trying to slant the copy that reporters sent home.
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> "'They're savvy PR folks,' Fialka (participating reporter from the Washington Star) said.
>
> "So savvy, that AIF managed to keep its promotional self-interest role out of many stories reaching the U.S. Most readers probably did not know the U.S. nuclear industry had arranged for them to find out the Soviets are pushing nuclear exports, breeder technology and plutonium fuel, in contrast to American policy."

As some of you may know, we are currently working with JAIF on setting up a press tour for American journalists to see some of Japan's nuclear facilities and projects. We believe, as we did when we set up a press tour of Western Europe in 1977 and the Soviet tour in 1978, that the more American journalists have a chance to see what is going on in the international nuclear community outside the U.S., the better equipped they will be to put in perspective the scope and direction of the U.S. program.

There is one more activity now under way in the U.S. on the public affairs front that I would like to tell you about. It is gaining momentum and is destined, I believe, to become an increasingly important factor in the continuing energy debate. It is the growing coalition of energy advocacy proponents. Last month, the first National Conference on Energy Advocacy was convened in Washington, D.C.

It was cosponsored by [illegible] state, local and national organizations such as labor unions, consumer groups, minorities, women's groups, and scientists, and hosted by the [illegible] Foundation. Some [illegible] people took part, almost twice as many as originally expected.

A resolution, passed by the delegates at the close of the three-day meeting, noted that "the current energy policies of the United States have been and are being overly influenced by a small, vocal minority, many of whom are motivated by narrow social and political goals. There are a large number of American citizens favoring energy production who are unheeded in the governmental decision process on energy matters." The resolution went on to urge that "federal, state and local legislatures and Administrations give full weight to views on energy expressed by the large number of citizens who support continued energy growth as an essential part of American energy policy."

CLOSING REMARKS

In a brief review such as this, it is only possible to touch on a few of the factors that are currently influencing the U.S. nuclear power program.

I would like to close these remarks where I began. Nuclear power is performing well and, as was observed in an AIF release reporting on the nuclear industry for 1978, *marking time, yet gathering momentum*. As was also observed in that release, in a year that began with a coal strike and ended with a 14.5 percent oil price rise, nuclear energy looked better than ever.

Annual nuclear electric production pushed toward the 300-billion kilowatt hour mark. Average nuclear unit availability, based on the first 10 months of 1978, was 74.4 percent, which topped fossil fuel performance. As an update on this availability number, I might note that in December, 41 of the 65 nuclear plants operating during the month recorded capacity factors of 80 percent or better.

The year 1978 was not much of a year in terms of new orders. But it was not all bad in some other important respects. The good things were (1) In two separate opinions, the U.S. Supreme Court upheld the constitutionality of the Price-Anderson nuclear indemnity and insurance law and it also admonished lower courts not to use judicial review as an excuse for making nuclear policy, which it said was the responsibility of the Congress.

(2) The LOFT test, a simulation of a loss-of-coolant accident, indicated in the first of a series of runs that emergency cooling systems will work better than predicted by computer modeling. (3) The uranium industry continued to expand its exploration, mining and milling activities. (4) And finally, fourteen federal agencies that made up the Interagency Review Group found that the nuclear waste problem is manageable with current technology.

Finally, I remain convinced that a country without an adequate supply of electric power runs the risk of jeopardizing its economic well-being.

And as Chairman of the Atomic Industrial Forum and as Chairman of an architect-engineering-construction firm that is working with the utilities to help build the generating capacity that will be needed to serve America, I am also convinced that we will need more nuclear power along with, in our case, coal to meet those needs for the balance of this century and beyond.

Thank you.

12th JAIF Annual Conference
DR. W.-J. SCHMIDT-KÜSTER

Three years ago, on the occasion of your annual conference it was the last time, that I had the opportunity to explain to you the situation of nuclear power development in the Federal Republic of Germany.

I appreciate the possibility to report today about what has happened in the meantime and to discuss with you problems and perspectives of nuclear power as we view the situation from Germany.

The last three years have been a difficult time for all those, involved in nuclear power programmes in one or the other way in our country and we have to admit, that in most areas the situation did not develop as fast and smoothly as it was hoped and expected three years ago. ...

At that time, two years after the oil crisis the Federal Republic of Germany, as many other countries, had planned to build up nuclear power plant capacity rapidly in order to decrease our dependence on imported oil by 12 % from 55 % to 43 & until 1985. On the basis of the experience gained during the previous 20 years this would have meant an installed nuclear capacity of approximately 45.000 MWe, in 1985.

The economic als well as the political development of the past three years have influenced the overall situation in a way, which has been all but favourable to the development of nuclear energy in many of our countries.

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The worldwide recession of the economy has influenced the energy consumption drastically. So, that at the end of last year we found ourselves in a situation where we seemed to have too much of nearly all the energy raw materials, although we knew, that the limited resources of oil and gas will, within the foreseeable future, be exhausted, or at least have surpassed the maximum of their availability.

For example in Germany we had nearly 30 Mio tons of hard coal piled up in the ruhr area which could not be sold, the oil refineries had to be operated at low load factors because, due to the economic situation, and resulting from conservation measures we have only now again reached the 1973 figures; the

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increase of electricity consumption over the past 4 years have been as low as 3,5 %.

All these facts created an environment in which arguments of anti-nuclear groups and environmentalists found a fertile atmosphere, so that we had to go through a long and difficult series of public debates and political discussions, wich culminated in large and violent demonstrations against the construction of nuclear power plants two years ago.
But at the end of these events, approximately a year ago the Federal Government formulated a revised energy programme, which could then be based on basic decisions of all three political parties representend in the German Parliament.

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The main objectives of this programme are to reduce the growth of the energy demand in the long run and to provide a wider and secure range of supplies to meet this demand.

The measures foreseen aim at:

- reducing the energy consumption by all possible conservation measures,
- reducing the share of mineral oil,
- making use of our only indigenous energy resources coal and lignite with priority,
- developing nuclear energy to the extent absolutely necessary to secure electricity supply,
- to decrease import risks by diversifying delivery sources and international agreements
- and last but not least continuing consequently energy research activities in order to develop all possible energy

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technologies and sources of renewable energy available to us in our geographical situation.

The construction of power plants and not only nuclear plants was more and more influenced by court rulings, which were necessary on the demand of interveners or opponents.

Whereas a number of such court decisions resulted in the interruption of construction work, the tendencies of more recent decisions has been much more positive.

To date we have a capacity of appr. 10.000 MW_{el} inoperation. A capacity of an other 13.500 MW is either under construction or has

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received the first construction permit. Within this group the construction of three stations had been stopped intermediately by court rulings with different arguments.

- One administrative court has annulated the first construction permit for a power plant. The court was of the opinion, that it could not be excluded completely, that a burst of the pressure vessel occured, resulting in a national catastrophe, because the plant - as all other LWR plants in the world - does not have a special burst proof containment.

- One administrative court stopped the construction of a plant because the question whether the operation of the

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plant would influence the products of a nearby pharmaceutical factory could only be answered at a later date. Very recently the next higher court allowed the continuation of construction so that the work will be started again during these days.

- One court stopped construction work for a plant, expressing the opinion, that before granting a construction licence a convincing and reliable solution for the back-end of the fuel cycle had take ensured. Construction will not be permitted to proceed unless geological drilling has been started at the site foreseen for our back end of the fuel cycle center at Gorleben.

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- A few months ago an other court rejected all appeals against the operation of a power plant, ready for operation since more than one year.
  This court came to the conclusion, that the licences for the plant are in conformity with all existing laws and regulations. The plant were equipped with all necessary provisions against mal-fuctions. The remaining risk had to be seen in an order of magnitude, that could be neglected.
  The court finally pointed out, that legislative bodies have expressively excepted such a remaining risk, when deciding the Atomic Law.
  Consequently the plant has now been taken into operation.

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This latest court ruling confirmes the view of the Federal Government that the use of nuclear power will be necessary to meet medium and long term requirements and in view of the high safety standards attained also justifiable.

The political discussions of the last two years resulted in the establishment of one primary demand that would have to be solved, before new licences for nuclear power plants could be issued: a solution to the problem of the back end of the fuel cycle.
And so the Federal Government linked further decisions with corresponding progress in the preparation and construction of this center.

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The Federal Government has developed the concept of an integrated fuel cycle center nearly 10 years ago and has funded the necessary development work. This center has to comprise the intermediate storage of spent fuel elements, a large reprocessing plant and all related facilities for refabrication of the remaining Uranium and the extracted Plutonium into fresh fuel elements for thermal recycling or fast reactors; waste handling and solidification plants and facilities for the ultimate disposal of radioactive waste in salt formations.

When this concept was developed it found full agreement in many other industrialised nations in the world. It is now one of the main points of dispute in the international discussion, especially in INFCE.

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As far as we see things evolving in this exercise,we cannot envisage any new technical safety, or environmental argument against this concept of closing the LWR fuel cycle. There were and are many good reasons for proceeding along these lines. The main argument, however, is, that long term storage of spent fuel in densely populated countries would not be acceptable to the public as a convincing long term solution. In addition, we are still of the opinion, that the safest way to handle Plutonium is to burn it in a reactor, and this not only with respect to the environment but also for non-proliferation reasons.

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A view which was also shared by the responsible administrative courts in our country.

Construction and operation of our fuel cycle centre will eventually be performed jointly by the Federal Government and utilities, who founded a special company, DWK, for this purpose. Both partners are responsible for different parts of the system:

1. Industry will build and operate the reprocessing plant, waste conditioning plants and interim storage facilities.
2. The Federal Government will take care of the necessary research and development and operate the waste disposal facilities.
3. All costs arising from the implementation of the system

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will eventually have to be borne by the industrial partners, either directly or via fees.

To make sure, that everything possible will be done to put this concept into operation the Federal Government decided in March 1977 that the following criteria have to be met as a prerequisite for further licences for power plants:

- a preselection of a possible site for the back-end of the fuel cycle center has to be made,
- the licencing procedure for this center, including the reprocessing plant and the waste disposal system has to be initiated, and
- a positive statement of national the advisory commissions, the

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reactor safety commission (RSK) and the radiation protection commission (SSK) has to be given concerning the feasibility of the concept both from the technical and the safety point of view.

These prerequisits, established by the Federal Government in agreement with the State Governments have in the meantime been fulfilled by the following measures:

- the State Government of Lower Saxony has proposed Gorleben at the site for this center. The Federal Government, accepting this proposal has asked the responsible Federal Agency (Physikalisch Technische Bundesanstalt, PTB) to initiate the necessary administrative procedure.

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- DWK, the German Reprocessing Company, now nearly two years ago has applied for the construction of the necessary facilities of the fuel cycle center, handing over a complete safety report to the responsible licencing authority in Hannover.
- In October 1977 the two commissions, RSK und SSK after thorough investigations of several months have stated, that the construction and operation of the center is feasible in principle from the safety point of view. The two commissions added, that the remaining development work can be carried out accompaniing the progress of the project. They have given a number of recommendations wich will have to be taken into account accompanying the further concretisation of the

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concept. The Federal Government has agreed to this advice in a comprehensive report to Parliament. The Government of Lower Saxony, the Federal State in which the center will have to be built, until to now not yet taken a final decision to start the licencing procedure. They have pointed out, that they wanted to make their own judgement concerning the feasibility of this integrated center on the basis of independent advice, including the opinion of critical scientists, before they would allow any concrete measures to be taken.

Recently negotiations between the Federal Government and the State Government led to a couple of agreements which will form the basis for the next steps to be taken:

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1) an agreement, covering the costs arising from the licencing procedure, including possible damages from demonstrations or similar events and for the necessary infrastructure in the area, including the necessary police forces to guard the following steps,

2) an agreement providing for an information campaign to be carried out jointly between the Federal and the State Governments

3) an agreement to start the necessary drilling operations to investigate the site during the course of this spring. (In effect, these will be started next Monday)

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4) an agreement, to carry out a licencing procedure for our experimental salt mine, ASSE II, to be able to use this during the next decade as a repository for radioactive waste, being produced during this time.

All these steps mark a longer path for the preparation of the first construction licence for the fuel cycle center than originally foreseen, but at the same time mark stepwise progress to pave the way for new power plants.

To bridge the time gap between the needs of today and the full operation of the fuel cycle centre, intermediate storage facilities will be necessary.

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Therefore the Federal Government and the State Governments have agreed to make available one or more sites for such a storage facility and to start as soon as possible with its construction. The first installation of that kind, foreseen for the storage of 1.500 tons of irradiated fuel elements is foreseen to be built at Ahaus in Northrhine Westphalia.
An application for a construction permit has been filed by the future operator, a consortium of DWK and STEAG, which in the meantime has started the necessary preparatory work. Drilling operations to investigate the stability of the ground including hydrogcological studies have already been carried out. It is expected, that the licencing procedure can be finished in time, so that possible intermediate problems with fuel elements to be unloaded from operating plants can be avoided.

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In discussing the back end of the LWR fuel cycle one should not forget the front end, the procurement of fuel. The Federal Republic of Germany had decided to cooperate closely with the UK and the Netherlands in the area of uranium enrichment. URENCO, the responsible joint company of the three countries will carry out the necessary operations.

URENCO, at the same time was one of the first models for close international cooperation in the nuclear field. The positive experience gained so far can be included in all discussions to be held today concerning the internationalization of nuclear fuel cycle facilities.

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URENCO meanwhile is operating two gas centrifuge enrichment plants with a capacity of 300.000 SWU/year at Capenhurst, UK, and at Almelo, Netherlands. The plants will reach a capacity of 450.00 SWU by the end of this year.

This capacity build up has been much slower than originally foreseen, due to the fact, that most of the power plant projects which are foreseen to be serviced by Urenco have been delayed considerably.

On the other hand the advantage of the centrifuge process, was used that capacities can be built with great feasibility and relatively shorst lead times. This allowed URENCO, to

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adjust their plant capacity to their delivery schedules. New investment decisions are being prepared at the moment, to be taken before the end of this year. They are necessary to fulfill contracts concluded. One of the first will be the recently agreed Nuclebras contract.

In addition to the two existing sites of Urenco, preparations are underway, to open a third site in Germany.

The licencing procedure for the third site at Gronau some 30 km away from Almelo has been initiated at the beginning of last year.
Uranit the German shareholder of Urenco, will start the

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construction of a centrifuge assembly plant at that site within the next few months. This plant will produce machines to be installed at Almelo and lateron at Gronau.

Whereas the construction of plant capacity had been much slower than expected, the technical development of centrifuges and the relevant infrastructure as well as operational behaviour of plants has been extremely successful. As far as the single machine is concerned, the separative capacity could be increased by a factor of 15 since 1965. Urenco can now rely on the experience of more than 500.000 centrifuge years. The cascade with the longest lifetime is in operation for more than 80.000 hours with extremely low failure rates. A lead cascade, which

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was built some years ago and which represents an original part of the next plant to be built at Almelo containing some 600 machines has until now be in operation under UF_6 for more than 22.000 hours with a total failure rate of less than 0,4 % including infant mortality. This shows, that the concept of Urenco, to operate their plants without machine maintenance during the total of the calculated 10year life of the centrifuges can be regarded as completely proven.

This means, that utilities in the three countries and others who wish to join them, can be assured, that reliable enrichment services can be made available whenever they are needed.

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Regarding nuclear energy in the long term we are first of all interested in the advanced reachtor systems HTR and FBR which allow the full potential of nuclear power to be made available. Both systems are under development in our country. We see the importance of the HTR especially to produce process heat in combination with coal gasification. This would allow to increase the production of synthetic gas by 30 - 40 % compared to the unit of coal to be processed in conventional processes.

As far as electricity production is concerned, the FBR has an even higher importance, because this system could make

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us practically independent of imports of primary energy sources when by the year 2000 we made use of the large amounts of accumulated uranium tails resulting from light water reactors operated until that date.

It would therefore be irresponsible, if we did not do everything possible to develop the option of such a powerful source of energy.

The development of the fast breeder system was the central issue of a national political debate on nuclear power at the end of last year.

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The debate ended with a great majority in favour of a continuation of the construction of SNR 300 and the licence has meanwhile been granted. In these discussions the Federal Government has made it quite clear that the breeder technology is one of the main long-term options for our energy supply and that therefore this option should be made available on a technical basis to that end. However, before there is a market introduction, an other broad political discussion will take place since the introduction of such an advanced and complex technology in our country is not only regarded as an economic but also a political issue. To prepare such a political debate our Parliament decided to set up an Inquiry Committee which was entrusted with the task to investigate and discuss all problems

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which might develop in connection with a large-scale utilisation of breeder technology in our country.

Our breeder programme is closely linked with the developments of our neighbour countries in Western Europe. The SNR 300 is a joint venture between Belgium, The Netherlands and the Federal Republic. For the further development of this technology our programme was closely linked to France. For this purpose a comprehensive agreement on cooperation was signed in 1977 on the levels of Governments, industries and research centers. The main element of this cooperation is, that future development and market introduction will only be performed jointly. Resulting in only one powerful group in Western Europe in-

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cluding our partners of the SNR 300 to participate in this cooperation as well as Italy the partner of France. The first large project of this wider cooperation is of the Super Phenix in France.

This international group is after URENCO an other example of a broad international venture in the nuclear field in Europe. Other international cooperative projects can be mentioned, like Eurodif in the area of Uranium enrichment and United Reprocessors, URG a collaboration between UK, France and the Federal Republic of Germany, for back end of the LWR fuel cycle, and last but not least, of course, the multinational Eurochemic, which has operated the reprocessing plant at Mol

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and now carries out development work in the area of waste solidification.

Internationalization in the field of nuclear energy has more and more become an issue in international debate, where it runs the danger to be considered a magic tool to resolve every problem related to the worldwide concern about the proliferation of nuclear exposive devices.

However, it is our opinion that we should carefully analyse and discuss all positive and negative results of internationalization before we finally make up our mind on this complex issue. We should take our time not proceed in too a great

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hurry, since otherwise one might too early decide on models which on paper seem to be very attractive but which in reality, later on only hinder the operation of the complicated facilities of the nuclear fuel cycle, and at the same time might also contribute to an unforeseeable pathway for broad proliferation of sensitive know-how and perhaps even material. I would like to recommend, that in further discussions we should try to make use of the experience, the European countries have gained, because there we have the only broad scale practice in this field.

Internationalization is one of the main subjects of the International Nuclear Fuel Cycle Evaluation, INFCE, in which

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both our countries, Japan and the Federal Republic of Germany, are actively involved. This exercise represents the most extensive attempt made to date to clarify the interaction between the economic use of nuclear energy and the principle of non-proliferation, with great political and economic values at stake. We are satisfied that partizipation in INFCE was opened to all interested countries thus allowing a discussion between groups of different status. We likewise wellcome the fact that, also in accordance with our demand, the International Atomic Energy Agency serves at the forum for INFCE so that all those interested in nuclear energy, including those not actively participating, can be informed about the results of the progressing work.

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Since autumn 1977 INFCE has experienced a steadily increasing worldwide interest, a fact that can be deduced easily from the growing number of participating states. In the beginning 40 nations came to the opening and constituting conference in Washington. About 60 nations attended the first plenary conference in the autumn of last year in Vienna, which marked nearly the half-time of INFCE. This plenary conference provided a good opportunity not only for an examination of the progress made so far but also to observe the climate that would be established between participating countries. We got the impression that this climate, now, is open, objective and free of ideological disputes.

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We believe that if this spirit can be maintained, INFCE can indeed achieve the main goal set by the opening conference, namely to investigate and analyse as comprehensively and carefully as possible all aspects of the peaceful use of nuclear power, so that this energy source can be made available worldwide with a minimum risk of proliferation. We shall do, what we can do, to contribute to this goal. We are glad to observe the growing understanding in INFCE that the improvement of existing technologies which are or will be commercially usable in the near future is more promising, than the consideration of completely new systems.

In addition, we observe a growing feeling, that specific

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technical amendments of isolated institutional arrangements will not solve the existing problems. It rather appears to be desirable, and also possible, to identify a package of coordinated measures which at the end of the evaluation could be submitted - with a high degree of consensus - to the Governments for their decisions. Without prejudging the further development, one might expect to find among these measures some of the following items:

- futher technical development of safeguards;
- increasing reliability of fuel supply for nuclear power stations;
- criteria for the use of highly enriched uranium in research reactors and new reactor types;

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- closer investigation of possible modifications in some current back end of the fuel cycle technologies;
- establishment of a regime for the deposit of excess plutonium as provided in the Vienna Agency's Statute and
- mechanisms for international or regional institutional cooperation.

These ideas which State Secretary Haunschild and myself have already outlined in late summer of last year have meanwhile become knows as the "bouquèt"-outcome of INFCE. Let me add a few comments to this. When we introduced this idea, we were looking for a package of coordinated measures. Many nations of the world should participate in such a demonstration programme

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of different possible technological and institional solutions which in our view should have the dimension of a large industrial scale, be including all those having the necessary know-how.

To give an example I could conceive that as the outcome of INFCE some new modes for the reprocessing technology are proposed, which on paper look quite promising with respect to non-proliferation. However, international agreements in the field of technology should not be based on paper only. Therefore, it would surely be helpful if different technologies would be tested in the different reprocessing plants existing or in planning. The coprocessing programme of your Tokaimura plants is one good illustration for such a procedure.

...

The Federal Republic of Germany is prepared to discuss in very open manner all problems which might arise during the further discussions in INFCE. We are also prepared to contribute our best efforts to help that INFCE will become a success when it will end in February of next year.

Ladies and Gentlemen, this short review was an attempt to give you an impression of the problems and perspectives of nuclear power utilisation in the Federal Republic of Germany. I hope that it has become visible how we have started to implement a comprehensive concept for the LWR fuel cycle which in our energy supply situation is regarded as necessary to meet future demand for energy under reasonable conditions.

...

If necessary, the LWR system could in future, be extended to the fuel cycle of advanced reactor systems. However, great efforts will still be required from Government and industry to achieve eventually our main objective which is to make nuclear energy a major contributor to the long-term procurement of energy and to reduce our dependence on imported oil.

Evolution of the International Nuclear Orders and the impacts on Korean Nuclear Power Program

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1. Introduction

Being a energy resource deficient country, Korea have to rely heavily on the nuclear power as a major alternative source of energy at the face of rapidly rising oil prices.

Because of the potential proliferation risks,the current generation of nuclear fuel cycle on commercial operation as well as the advanced fuel cycle under intensive developments are being reviewed in order to establish proliferation resistant fuel cycle and common ground for mutual cooperation.Evolving the new international orders for nuclear cooperations, the multinational efforts are being made through International Nuclear Fuel Cycle Evaluation, Export Guideline of London Club, and the functions of International Atomic Energy Agency. On the other hand, the unilateral efforts of the United States of America based on the Nuclear Non-Proliferation act of 1978 is being implemented through bilateral amendment of the existing agreements for cooperations.

The international discussions on proliferation concerns have been centered around the International Nuclear Fuel Cycle Evaluation, now in its final years. A principal purpose of INFCE is to identifiy and examine what "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." Along those objectives, INFCE recognized that special considerations should be given to the specific needs of and conditions in developing countries, and it is to be a technical and analytical study and not a negotiation.

The very fundations of such a cooperations should be based on the spirit of mutual trust and confidence. Without the mutual confidence, any unilateral imposition of the requirements on bilateral cooperations is doomed to failures.

In the midst of current international confusions of nuclear orders on non-proliferations and peaceful uses of atomic energy, the major issues and problems confronting Korean nuclear power program are reviewed within the context of newly imposed contraints.

2. Energy Policy

The energy policy of the Republic of Korea is directed toward:

1) A long-term assurance of energy supply, sufficient for the vital national needs,
2) maximum efforts towards self-sufficiency in energy sources,
3) the maximum conservation and optimum utilization, based on the efficient management and design of supply systems.
4) the emphasis on nuclear power as an energy source,
5) thorough study and research of feasible alternatives for both energy resources and their viable applications.

Within these contexts, the best techno-economic judgement of the Republic of Korea indicates that the nuclear power must play a dominant role, and its advantage are real and practical:

1) nuclear power provides the most secure and self-sufficient energy source,
2) nuclear power can readily accomodate whatever increase in capacity national development may require,
3) nuclear power development capitalizes effectively on the best, most reliable and most available national resource - dedicated and skillful manpower.

3. Energy Resources in Korea

Korea is the resource deficient country. It has not immediately usable oil resources and must rely on import of foreign petroleum. The current coal industry is producing at its maximum capacity and there is little coal available for power generation.

Energy resources in Korea may be represented by coal, hydro and tidal power. Economically recoverable coal reserve ranges between 500 million and one billion tons depending on the oil price. This will be depleted in the next 25 to 30 years. The potential hydro power is estimated to be 3,000MW. Current hydro power station has an aggregate capacity of 800 MW and the remaining 2,200MW may be developed in the future. As for tidal power, the potential resource is estimated to be about 4,000MW.

It is not a wise policy for any country to depend on a single source of imported energy. And naturally Korea has to develop nuclear power to diversify its energy source as well as to alleviate its balance of payment from oil importation burden.

4. Power Demand and Development Program.

Korea is a rapidly industrializing country. As a consequence we have been experiencing a remarkable power demand growth. As of January 1979, Korea has a maximum power demand of 5,200MW. With an installed generation capacity of 7,000MW it has only marginal reserve rate.

To have a feel for the growth rate during the past 15 years Table 1 gives a comparison of major parameters associated with power generation for the year 1961 and 1976.

Table 1. Growth between 1961 and 1976.

	1961	1976	Multiplied
Generation capacity(MW)	367	4,810	13.1
Hydro	143	711	4.9
Thermal	223	3,854	17.2
Internal Combustion	1	245	
Number of Plants	13	32	2.4
Hydro	7	13	1.8
Thermal	5	14	2.8
Internal Combustion	5	5	1
Peak Output (MW)	306	3,807	12.4
Average Output (MW)	202	2,632	13
T&D Loss Rate(%)	29.4	10.8	
Power Generated (1,000MWH)	1,173	23,117	19.7
Per Capity Income ($)	83	698	8.4

The average annual power demand growth over the past 15 years was 18.3 %. This figure shown in accordance with the 5-year economic development periods gives: 17.9 % for the 1st period (1962-1966), 20.6 % for the 2nd period (1967-1971) and 17.2 % for the 3rd period (1972-1976).

The composition of power demand for the recent 5 years is shown in Table 2.

Table 2. Power Demand Composition by Major Classification

	1973	1974	1975	1976	1977
Lighting	14.1	13.2	12.9	12.7	12.5
	(%)	(%)	(%)	(%)	(%)
Small Power(Below 500Kw)	23.0	21.3	20.0	19.5	19.1
Large Power(Over 500Kw)	62.4	65.1	66.7	67.4	68.1
Agricultural Power	0.5	0.4	0.4	0.4	0.3
Total (GWH)	12,367	14,048	15,970	18,363	21,220
Total (%)	100	100	100	100	100

For the 4th 5-year economic development program which will be completed in 1981, the average power demand growth rate has been projected to be 15.2 % based on the major economic indices of10.2%of GNP growth rate, 14.4 % of mining and manufacturing growth rate, For the 5th 5-year period the demand growth rate is expected to slow down and projected to be 13.4 % based on the assumptions of 10 % GNP growth rate and 12.8 % of mining and manufacturing growth rate.

Table 3 summarizes maximum power demand, total installed generation capacity and nuclear power capacity for the 4th and 5th 5-year plan.

Table 3. Power Demand Projection for 1976-1986

Year	MAX DEMAND (MW)	TOTAL INSTALLED CAPACITY (MW)	NUCLEAR CAP. (MW)	NUCLEAR FRACTION (%)
1976	3,930	5,110		
1977	4,584	6,430		
1978	5,118	6,916	595	8.6
1979	5,879	8,035	595	7.4
1980	6,773	9,436	595	6.3
1981	7,805	10,406	595	5.7
1982	8,848	11,324	595	5.3
1983	10,023	13,943	1,924	13.8
1984	11,349	16,243	2,824	17.4
1985	12,850	18,543	4,624	24.9
1986	14,547	20,936	6,424	30.7

The power development program beyond 1986 based on the computer run with WASP(Wien Automatic System Planning Package) shows that by the year 2000 the peak demand will amount to 82,000MW and optimum composition of nuclear power will be about 60 % of the total installed power generation capacity, which calls for an addition of 40 nuclear power plants between 1987 and 2000.

5. Nuclear Power Program and its Fuel Cycle

Currently four nuclear projects under construction-Ko-Ri 2, Ko-Ri 3, Ko-Ri 4 and Wolsung 1. Two projects are under bidding stage. The outline of our nuclear power project is shown in Table 4.

Table 4. Outline of the Nuclear Projects

PLANT NAME	CAPACITY	REACTOR TYPE	SCHEDULED OPERATION	CONTRACTOR	SUPPLIER/AE
KO-RI 1 NPP 1	595	PWR	June,'78	WEICO	NSSS: W T/G: GEC A/E: GAI FUEL: W
KO-RI 2 NPP 2	650	PWR	Mar.'83	WEICO	NSSS: W T/G: GEC A/E: GAI FUEL: W
WOLSUNG 1 NPP 3	678	PHWR	Apr.'83	AECL GEC HPL/CAP	NSSS:AECL T/G:HPL/CAP Switchgears GEC A/E:CANATOM Co. FUEL:AECL
KO-RI 3 NPP 5	900	PWR	'84	WEICO GEC Bechtel	NSSS:WEICO T/G :GEC A/E :Bechte
KO-RI 4 NPP 6	"	PWR	'85	"	"

Ko-Ri 1 achieved full power in June last year. As for Ko-Ri 2, both reactor and turbine building are under construction Ko-Ri 3 & 4, site preparation work was completed and excavation for both reactor building and turbine hall is due to commence in near future. Nuclear power project 7 & 8 are in its final stage of contract award. And Nuclear Power Project 9 & 10 will be open for bidding in near future.

Our first nuclear power station has been in commercial operation since last year. It enables us to reduce six million barrels per year in oil imports and at the same time considerable generating cost savings as compared with oil-fired power generation. Four other units are currently under construction.

Early last year, the Government of the Republic of Korea made a major revision of her long term plan on the nuclear power, based on a comprehensive study over the past two years using WASP program. This study shows that more than forty nuclear power stations with approximately 50,000 MWe capacity should be in operation by the year 2,000. This means that, on the average, two nuclear units of more than 1,000 MWe capacity go into operation every year until the year 2,000 .

The fuel cycle service requirement in support of nuclear power program is quite formidable. Around the year 1990, the stored spent fuels and those to be discharged every year would amount sufficient quantity to justify the need of reprocessing. According to recent OECD/IAEA Uranium Resources estimate, present reserves correspond to about 20 years of foreward requirement (i.e. until 1998). For economic, technical and political reasons, however, all of these reserves will not likely to be exploited, and additional reserves may be necessary to meet the needs. The rapidly mounting requirements for uranium suggests another challenge of improving reactor technology and fuel utilization. Clearly, thermal converters must in time be replaced by more advanced reactor systems that will conserve the uranium resources if nuclear power is to play a major role.

In our view, the most practicable advanced reactor system within the reach of current or near future reactor technology which will effectively conserve the uranium resources would be the Fast Breeder Reactor system. Eeven though, we fully share the views of U.S. that Fast Breeder Reactor fuel cycle, i.e. U-Pu cycle, and the prerequisitory thermal reactor spent fuel reprocessing have the potential risk of the proliferation, we believe such risks would be minimized to an acceptable level in due course of IAEA full scope safeguard system improvement and INFCE. Being a resource deficient country, Korea have to maximize the effort for the conservation of uranium resources lest the uranium crisis occur by the turn of this century. For these reasons, introduction of the Fast Breeder reactor may be inevitable to our nuclear power program by the mid 90's. In retrospect of these requirements, the research or follow-up of the technical assessment on fuel reprocessing and fast breeder reactor technology development should be actively promoted through bilateral or multilateral arrangements. In this respect, we would look forward to the positive cooperations within the framework of International Nuclear Order for the open and more wider nuclear energy cooperations in future.

In 1975, the fraction of electric energy needs relative to total energy requirements was 15 %. This fraction of electric energy needs has been increasing and reached 20 % in 1977.Such trend would continue also in the future.

For Korean nuclear power program, the nuclear fuel reprocessing including mixed oxide thermal recycling has the potential to reduce the national uranium needs by 20 to 25 % and enrichment service requirements by 10 to 15 % during the near term period from 1990 onward. Moreover, successful deployment of Fast Breeder economy in the sector of electric generation in mid 90's would not only contribute significantly toward the improvement of the degree of dependence on imported oil in energy supply, but decrease sharply the need to import natural uranium by the turn of century.

Therefore, the fuel reprocessing including mixed oxide thermal recycling and the fast breeder deplomyent are the imperative requirements in our nuclear power program for the energy security. For this reason, we have been actively promoting IAEA project on multinational regional fuel cycle center to assure our vital fuel cycle service. However, due to complexity of socio-political aspects involved in establishing such a center, no real progress has been made with the excellent technoeconomicaly viable concepts .

6. Issues under International Debates

To date, the IAEA full scope safeguard system has been successful in directing nuclear activities to peaceful purposes. However, the need for a more comprehensive international safeguard framework is called for because of the possible proliferation risks. In order to be acceptable universally, the evolving of such a new framework must reflect the requirements of both supplier and recipient, not just one side. In this vein, any unilateral imposition of requirements on bilateral programs might well be considered an imprudent approach, apart from the basic philosphy and framework of N.P.T.

Some of the specific features in U.S.Nuclear Non-Proliferation Act of 1978 seems to conflict with the decision-making process for sanction by the International Atomic Energy Agency and the United Nations toward the violation of N.P.T. This feature would undermine the existing IAEA safeguard system. The spirit of international cooperation and mutual trust will be maintained and reenforced in evolving new international orders.

As a party to the NPT, however,we will strictly adhere to the Treaty. We believe that a wider adherence to the Treaty and proper IAEA safeguard system will guarantee greater promise for international peace and security through mutual trust and cooperations including fuel supply and cycle service assurances and sharing peaceful nuclear reactor technology as well as information exchanges as prescribed in article IV of NPT. In the face of depleting fossil fuel resources, the nuclear power is becoming imperative and practical alternative source of energy in Korea.

We are very much concerned about present situation in which no substantial progress has been made to assure the nuclear fuel supply and fuel cycle services. To cite few examples, there has been no major breakthrough in solving socio-political problem related to establishing the Multinational Regional Fuel Cycle Center or International Fuel Bank and etc.

We have been actively participating the International Fuel Cycle Evaluation as Co-Chairman of Working Group 8. We hope that the outcome of INFCE in early 1980 would bring about the concrete prospects for proliferation resistant alternative fuel cycle and viable institutional arrangements for fuel supply assurances, by which we can be assured of the fuel cycle services in time.

Issues under international debates are taking place around INFCE . Those issues relevant to our nuclear power program are as follows:

1) Non-Proliferation assessment: possible IAEA safeguard System augmentation

2) Reprocessing and thermal recycling

3) Optimum time for fast breeder reactor introduction to the nuclear power program.

It is too early to draw any conclusion from on-going INFCE. However, it is becoming clear that the added assurance for non-proliferation is the basis for the active transfer of technology most developing countries need for their nuclear power program. For this added assurance, IAEA safeguard system must play a very fundamental role. On the other hand, the institutional arrangements such as international or regional undertakings in the fuel cycle should be carefuly reviewed to cope with the breakdown of bilateral commercial contract. For such arrangements, the incentives for participation seems to be lacking at present.

7. Possible impacts on Korean Nuclear Power Program

Unlike U.S., U.S.S.R or U.K., Korea has very little or none at present as an energy option but to rely on nuclear power. In this context, the situation is very similar to Japan. The politically influential as well as resource rich U.S. may feel that they can exert their influence on oil producers of Middle East, Mexico, China or, at worst, resort to their own resources such that the adequate energy supply can safely continue until more advanced energy system or renewable energy utilization technology becomes available in a very large scale. However, in case of Korea, the situation is very different. Her rapidly growing economy induces greater demand on energy particularly electric power eventhough scarecely having none of indeginous energy resources.

This is the very driving forces behind the exceptionally large nuclear power program compared with her size of economy. Fortunalely, being a late comer in nuclear power utilization, our nuclear industry is not so heavily committed as yet. However, in the midst of the confusions in international nuclear order, the very basic decisions for investment is now almost impossible to make for our nuclear industry as well as government policy to induce viable nuclear industry. The damage to our energy security due to undecisiveness now would not be noticed at present but show up at decade later as a many black out or excessive shortage in electric power supply, which in turn not only result to negative economic growth but force the wheel of civilization turn backward. On top of this, there would be a horrendous amount of spent fuel piled up without any assurance of immediate reprocessing and proper waste treatments. The impacts of such a grave nature due to confusion would not be felt at now but become devastating in future. Who would be blamed for such a results?

The crucial ingrediants to avoid such a mishap would be the assurances on the long term fuel cycle services through new international nuclear order or national capability. Hopefully, INFCE would be able to resolve this imperative issues in time.

Japan's Atomic Energy Development Policy
and
Nuclear Non-Proliferation

By Kinya Niizeki, Commissioner
Atomic Energy Commission

I am greatly honored to be given this opportunity to speak on "Japan's Atomic Energy Development Policy and Nuclear Non-Proliferation" at the Annual Conference of the Japan Atomic Industrial Forum.

As you know, Japan has a history of more than 20 years in the development of nuclear energy for peaceful uses.

It is already more than 15 years since the power demonstration reactor of the Japan Atomic Energy Research Institute (JAERI) succeeded in test transmission of power in 1963. The use of atomic energy in power generation in Japan expanded rapidly during these 15 years and more. Today we have 18 commercial nuclear power stations, with a combined capacity of approximately 11,500 MWe. This is about 10 % of the country's total power generation capacity. This makes Japan the world's second largest nuclear power generation country after the United States. During the rainless months of summer last year, nuclear power generation exceeded hydroelectric power generation for the first time in Japan. Thus atomic energy earned full recognition of its role and position as a highly promising source of energy alternative to oil.

Needless to say, a stable supply of energy is vital for continued economic development and further improvement of the life of the people. Japan's total energy resources, inclusive of hydroelectric power and coal, are barely enough to meet 10 % or so of her total energy requirements. Japan's dependence on imported energy resources is extremely high as compared with the United States and other industrially-advanced countries.

Japan today depends on imported crude oil for about 75 % of her total energy need. The supply of oil which is the major source of energy has become very unstable, subject as it is to developments in oil-producing countries. This became clear not only from the oil crisis of several years ago but also from the recent upheaval in Iran. It is thus imperative that Japan make efforts to secure at the earliest time alternative energy sources. In this context, atomic energy is believed to be most promising. But even in this field, Japan faces the difficulty of

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Note: This is a translation of Commissioner Niizeki's paper to be presented at the 12th Annual Conference of JAIF, March 13 – 15, 1979, Tokyo.

obtaining the raw material. With no domestic uranium resources, Japan has to depend virtually 100 % on other countries for the supply of uranium. The big question is how to secure a stable supply of uranium over the long range and how to reduce the extremely high dependence on uranium imports. This question has a direct bearing on Japan's energy security.

In order to secure stable uranium imports, it is necessary for Japan to engage directly in survey and exploration of uranium resources abroad with a view to developing them for subsequent import to Japan, in addition to arranging uranium purchases under long-term contracts and through spot transactions.

Japan has concluded a long-term contract with the U. S. Government for uranium enrichment services for power reactors with aggregate capacity of 51,000 MWe. Japan also has concluded a contract with Eurodif of France for enrichment services for power reactors with a total output of approximately 9,000 MWe. This means that Japan has already made arrangements to obtain sufficient enrichment services necessary for nuclear power generation until about 1990.

Furthermore, for her energy security, Japan plans to make efforts for domestic uranium enrichment and has decided to conduct research on and development of this technology as a national project. Japan thus hopes in the not too distant future to meet part of her requirements by producing enriched uranium with home-developed technology.

The construction of an uranium enrichment pilot plant is already under way by the Power Reactor and Nuclear Fuel Development Corporation, on the strength of experiences gained in the operation of a centrifuge step-cascade system. Part of this pilot plant is scheduled to go into operation around summer this year.

On the other hand, the uranium resources of the world are not limitless, and Japan therefore has to make effective use of uranium resources. It is thus desirable that potential energy in the spent fuel from light water reactors, which constitute the mainstay of nuclear power generation today, should be put to full use. In this regard, it is a matter of the greatest interest to Japan, which has little resources of its own, that technology is now being demonstrated to recycle plutonium and depleted uranium from the spent fuel.

In the near term, it is necessary to reduce the amount of natural uranium and enriched uranium by recyling plutonium into thermal reactors. We will, therefore, promote demonstration tests on recycling of plutonium in light water reactors while striving to develop an advanced thermal reactor (ATR) as a plutonium burner. The ATR can utilize plutonium and depleted uranium recovered from spent fuel from light water reactors. Use of the ATR can cut down the consumption of uranium and the volume of enrichment services. We will continue the operation of the prototype reactor and, at the same time, design a demonstration reactor and undertake necessary research and development.

The recycling of plutonium into the thermal reactor is a "stopgap measure" to be employed until the fast breeder reactor is developed and put to practical use. It is most important of develop as quickly as possible the fast breeder reactor which uses not only plutonium as fuel but also produces more plutonium than it burns. We have no alternative but to use the fast breeder reactor as the mainstay power reactor of the future, in order to increase nuclear power generation over a long-term. This is fundamental in Japan's nuclear power development and utilization program.

The experimental fast breeder reactor reached criticality in 1977 and tests to increase its output have been successfully conducted since then. Preparations are now being made to construct a prototype reactor for the purpose of studying the economics of this type of reactor when it is put to commercial use in the future.

Moreover, it is necessary to establish a nuclear fuel cycle parallel to the development of the fast breeder reactor. Research and development necessary for the reprocessing of spent fuel and disposal of radioactive waste are also under way.

Japan must step up her efforts toward industrial application of the technology which she has developed by her own efforts. However, in addition to difficulties created by siting of nuclear facilities and other related problems, the prevention of nuclear weapons proliferation has become a subject of great international debate in recent times. Thus, the international environment surrounding the development and use of atomic energy has become complex and delicate.

Aside from future plans, Japan at present depends totally on other countries for the entire supply of natural uranium as well as for enrichment services. Therefore, Japan cannot achieve further development and utilization of atomic energy without relying on other countries for resources and a number of other aspects. This is why Japan is greatly interested in recent international developments. U. S. President Jimmy Carter has called for expanding, and reinforcing the Nuclear Non-Proliferation Treaty system for fear of possible further spread of nuclear weapons. It is a matter of great concern to Japan which has particularly close relations with the U. S. that there are new moves to impose restrictions on the transfer of materials and technology related to atomic energy.

Ever since the enactment of the Atomic Energy Basic Law in 1956, Japan has maintained a policy to limit research, development and use of atomic energy to peaceful purposes alone. Japan signed the Nuclear Non-Proliferation Treaty because she saw that its basic concept agreed with Japan's atoms-for-peace policy. As all nations participating in this Treaty should equally enjoy the benefits from the peaceful use of atomic energy as stipulated in Article 4 of the Treaty, Japan firmly believes that energy requirements and non-proliferation needs must be made compatible with each other. In fact, Japan believes that they are compatible.

The International Nuclear Fuel Cycle Evaluation (INFCE) started in Ocober 1977 is aimed at conducting technical study and analysis of nuclear fuel cycle through international cooperation, according to the joint communique issued at its inaugural meeting. Its ultimate objective is defined as finding a way to make energy needs compatible with nuclear non-proliferation. This objective is in complete accord with Japan's thinking about atomic energy. Therefore, from the very beginning Japan has actively participated in the work of INFCE in order to contribute whatever she can to the attainment of this important objective. Japan participated in every one of the eight working groups of INFCE and is a co-chairman of the Fourth Working Group, which deals with the problem of reprocessing. All these working groups have defined the purpose and method of work as well as each country's contribution. They have already gathered basic data and have started to undertake the principal work of analysis and evaluation. At the same time, they are working on reports to be submitted to the Plenary Meeting via the Technical Coordination Committee, with the deadline set for the end of May this year. Moreover, the feasibility of establishing various institutions within the international framework is already being discussed both within and outside INFCE. Thus, the work of the INFCE has entered a crucial stage.

Now, I would like to go into some details of reprocessing and enrichment, which are currently important problems for the INFCE, in relation to Japan's atomic energy development policy. I would like to add my personal opinions.

First, let's take up reprocessing. Japan is now recognized as a nuclear-advanced country. This country is studying how she can guarantee non-proliferation of nuclear weapons while maintaining a policy to undertake reprocessing and utilization of plutonium recovered from spent fuel. Japan wishes to find, in cooperation with other nuclear-advanced nations, a truly effective way to guarantee non-proliferation of nuclear weapons.

Japan plans to construct a second reprocessing plant which will have an annual capacity several times larger than the first plant in Tokaimura constructed by the Power Reactor and Nuclear Fuel Development Corporation. Designing and construction of the second plant is expected to require at least 10 years. We wish to put it into operation by 1990 when Japan's reprocessing contracts with Britain and France expire. However, with the construction of a second reprocessing plant, Japan must consider to take a number of steps from the standpoint of nuclear non-proliferation.

The first concerns safeguards. Japan is the first country to accept international inspection by the International Atomic Energy Agency (IAEA). Ever since she has actively cooperated with the IAEA, in the field of safeguards. Japan has concluded by the deadline a new safeguards agreement subsequent to participation in the Non-Proliferation Treaty.

The future problem is how to make the safeguards in reprocessing and plutonium utilization facilities more effective. In line with the purport of the Japan-U. S. Joint Communique issued in September 1977, Japan has conducted joint research with IAEA, the U. S. and France to develop safeguards technology for the reprocessing plant by using the Tokai Reprocessing Plant. The joint research is called TASTEX (Tokai Advanced Safeguards Technology Exercise). Its results will be submitted to INFCE and they are expected to contribute to the objective of non-proliferation of nuclear weapons.

Not only safeguards but also physical protection are important, particularly in the handling of highly dangerous plutonium. From the stage of designing, therefore, adequate care must be taken at the new reprocessing plant to ensure physical protection. The storage and fabrication facilities should be co-located with the reprocessing plant.

The next problem concerns development of alternative reprocessing technology to replace the present day technology in order to prevent nuclear proliferation. In this respect, too, experiments on the co-processing method are to be made by using the Tokai Reprocessing Plant in accordance with the Japan-U. S. Joint Communique. It is also necessary to develop processing machinery and equipment suited to co-conversion, to establish the right conditions for operation and to develop the manufacturing method to produce mixed uranium-plutonium fuel. However, when we develop the new processes and new devices, we must carefully examine how much time and money will be needed, and whether or not fuel thus produced can be used effectively. A report on results of the preliminary study has already been presented to INFCE. Japan believes that she has to continue research and development in this field in view of her nuclear non-proliferation policy.

An extremely important problem related to reprocessing is plutonium management. As I mentioned earlier, Japan has a plan to use a large amount of plutonium in fast breeder reactors in the future. Moreover, she plans to recycle plutonium into thermal reactors prior to burning it in fast breeder reactors. However, the management of plutonium is, no doubt, an extremely sensitive problem. Therefore, an international system to strictly control excess plutonium, which is not to be used immediately as fuel, must be deviced. I think one way is to establish, by taking into consideration difficulties involved in the transportation of plutonium, a machinery for international management of plutonium in the same place where reprocessing facilities are located. Each time necessity arises, a certain amount of plutonium could be released from it according to specific criteria established by international agreement.

At any rate, since international management of plutonium is stipulated clearly in the Statute of IAEA, I believe that it is appropriate for IAEA to take the initiative in working out a detailed program after INFCE obtains general consensus regarding this matter.

Next is the problem of enrichment. Almost all nuclear power plants in Japan, as in many other countries, are light water reactors. It is expected that light water reactors will continue to be in the majority until around the year 2000 when fast breeder reactors are expected to come into commercial use. At present, Japan depends totally on foreign countries for her supply of low enriched uranium needed for the light water reactors. However, as I mentioned earlier, from the standpoint of stabilizing and diversifying sources of supply and of becoming independent in fuel supply, it is necessary for Japan in the future to produce domestically low enriched uranium to meet at least part of the requirements. For this purpose, Japan will continue to promote the development of technology to enrich uranium by the centrifuge method as the method best suited to her. For its development, Japan has already expended a huge amount of money and manpower over many years. By operating a pilot plant in the immediate future, Japan will perfect her own technology and put commercial plants into operation by around 1990.

Needless to say, enrichment technology, like reprocessing technology, is an extremely sensitive technology that could lead to manufacture of nuclear weapons, should there occur a crooked turn of events.

Therefore, particular care must be taken from the standpoint of preventing proliferation of nuclear weapons, and it is essential to have safeguards. Japan, therefore, is now grappling in real earnest with the development of safeguards technology applicable to the centrifuge enrichment process. It is relatively easy to have safeguards on small-scale facilities like a pilot plant. However, since safeguards on large-scale plants in practical operation have not yet been used in any country, it is necessary to develop safeguards technology applicable to large commercial plants in preparation for future need.

The centrifuge method has been adopted by URENCO, a troika consisting of Britain, the Netherlands and West Germany. A new enrichment plant currently planned by the U. S. Department of Energy will also employ the centrifuge method. It may be a good idea, therefore, that research and development efforts to improve safeguards be made jointly with these countries. As I mentioned earlier, Japan is engaged in the development of safeguards technology for reprocessing jointly with IAEA, the U. S. and France. I believe that for non-proliferation purposes it would be extremely rewarding for all countries having a common interest to conduct research on safeguards for uranium enrichment plants with IAEA participation.

At any rate, development and use of enrichment technology is a considerably difficult undertaking. It requires sophisticated industrial standards and abundant funds, as well. Moreover, it must presuppose large domestic demand. I also believe that countries which possess enrichment plants should help to guarantee a stable supply of nuclear fuel needed by countries with small-scale nuclear power generation, for example, by voluntarily offering enriched uranium to an international nuclear fuel bank, instead of supplying enriched uranium only to their own domestic markets.

At present, the positions of countries in the field of development and use of atomic energy differ greatly depending on whether a country is a nuclear-weapon country or not, whether it is a resources-supply country or a resources-consuming country, or whether it is an industrially advanced or a developing country. Therefore, the interests of countries are complex and intricate. I am sure that there is no other way to adjust the interests of countries than to establish an objective and rational standard by international consensus and to apply it in a fair manner. No country should be allowed to protect its own commercial interests or to force its domestic policy on other countries under the pretext of non-proliferation of nuclear weapons.

Director General Sigvard Eklund of IAEA, who was present at the Annual Conference of the Japan Atomic Industrial Forum last year, recently told a meeting of the U. S. Atomic Industrial Forum in effect: "Provided that atomic energy technology is for peaceful purposes, we cannot deny that there still remains a possibility of the technology being utilized for wrong purposes. I am afraid, however, that the pendulum today has swung too much in the opposite direction. Since political issues mostly give rise to fear of nuclear proliferation, settlement of political issues is the prerequisite to nuclear non-proliferation. What is basically most important in preventing proliferation of nuclear weapons is for all the countries concerned to abide by the Non-Proliferation Treaty as well as to accept safeguards in all kinds of nuclear facilities. Broad international cooperation is necessary to further reinforce and universalize the NPT." I fully agree with him.

In conclusion, energy security and nuclear non-proliferation are inseparable like the right and left wheels of a car. If their balance is lost, it will become extremely difficult to operate the car of development of nuclear energy for peaceful purposes. In this context, the current INFCE deliberations have great significance. I sincerely hope that an international consensus will be created through INFCE deliberations and that the development of atomic energy for peaceful uses will emerge from the "age of uncertainty" and take a big stride in the direction of resolving problems through international cooperation.

Thank you very much for your kind attention.

EMBARGO UNTIL
3/14 ~~a.m.~~ ~~p.m.~~ NOON

FRENCH EXPERIENCE AND PROGRAM OF REPROCESSING

by

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The initial purpose of the presentation is to give a few information and comments about the reprocessing of light water fuel at LA HAGUE plant, and also about the operation of the vitrification facility at MARCOULE, and then to introduce some outlook about COGEMA' future investment program.

The LA HAGUE facility in France was built originally to reprocess fuel from domestic gas graphite reactors. In 1969, the decision was made to add a new head-end shop to adapt the plant to reprocessing of light water irradiated fuel. This facility was completed in 1976 and started operation on May 16th 1976. The hot tests were successfully performed with 14,3 T. of fuel from the Swiss MUHLEBERG Reactor.

Since that time, a few technical modifications in the head-end, particularly in the waste transport system, have been achieved and two industrial runs with a cumulative tonnage of about 80 T. of oxide fuel have been completed in addition to the other metal fuel reprocessing program which keeps in France top priority for safety reasons.

For the near future, and within the next five years, about 1000 T. of oxide fuel are expected to be reprocessed.

As a matter of fact, the past experience in reprocessing and this flow of information coming day after day from plant operation prove very valuable for future designs. As a general outlook, we could summarize our technical comments as follows :

In future plants, the Purex will be still in use. This opinion was reinforced after reprocessing 3 tons of high burn up breeder fuel in the CEA pilot plants at MARCOULE and LA HAGUE. However, the present technology will have to be deeply modified.

Future plants will need high standard reliable technologies. More particularly great efforts have to be made on mechanical devices by extreme simplification of the mechanism and careful study of interchangeabilities and remote maintenance.

.../...

All over the process, a redundancy of the treatment lines and crossing ways from one line to another will be necessary, as well as a large buffer capacity between the different shops.

We have to keep in mind that a small technical incident could stop the plant which represents a very high financial burden due to the high investment capital cost.

After remote, the various equipments will be decontaminated and repaired in specially-equipped separated cells.

Before being transported to the interim or definitive storage, waste and residues will be continuously packed in line within the plant.

A particular attention will be granted to the ventilation concept of the cells in order to improve trapping of radioactive materials as near as possible from the emitter source.

Also, great efforts will be devoted to reduce the irradiation dose for the workers during current operations and maintenance periods.

Recycling of the radioactive waste in the plant will be developped, in order to reduce the effluent release below the present limits agreed by the relevant authorities, notwithstanding that two plants (UP2 and UP3-A) will be in full operation.

.../...

The future plants will be designed in accordance with the new safeguard concepts, such as the Pipex concept which COGEMA supports during the INFCE meetings. In this concept, the containment approach is emphasized for the safeguards improvement.

Before moving to the construction program, we have also to comment about the results of the MARCOULE vitrification demonstration plant.

In 1976, at the 9° JAIF meeting, Mr. COUTURE has already delivered a paper about vitrification. At that time, after more than 25 years devoted to R and D, the CEA has achieved enough confidence in the vitrification process to start the construction of a demonstration plant at MARCOULE, so called A.V.M., with about 100 T/Yr glass capacity.

As you know, the vitrification technology is considered as the best one because :

. it is not a coating technic, the fission products become one component of the glass,

. the product so obtained presents a number of qualities such as volume reduction, good chemical resistance, thermal stability and also a very good resistance to radiation damage.

. the composition of glass has not to be fitted very closely to those of fission products to be vitrified.

The demonstration plant started successfully operation in July 1978 and, since that time, over than 30 T. of active glass have been produced.

We started operation with cooled HLW from metal fuel but, so far, we do not foresee great difficulties to increase specific activity in order to reach the target of 1 Ton of glass for 6 Tons of LWR fuel.

The COGEMA' investment program at LA HAGUE will include a vitrification shop in each plant. This investment program is as follows :

- The present UP2 LWR fuel capacity will be increased up to 800 T/Yr in 1984-1985. New head-end and back-end shops will be constructed in addition to the existing UP2 plant. This 800 T/Yr new capacity will be completely devoted to the French domestic program.

However, the first plant built up according to the new line will be UP3-A, with the same 800 T/Yr capacity. This new plant will reprocess solely oxide fuel discharged from BWR or PWR power reactors.

The fuel will be transported from the power stations or from CHERBOURG port to LA HAGUE by road or by rail. The

.../...

total fuel storage capacity will be in the range of 4000 T. The first storage pond, so called NPH, is presently under construction and will be in operation in the beginning of 1981.

The reprocessing plant will comprise :

- a head-end treatment,
- a solvent extraction,
- a plutonium oxide conversion,
- an uranium conversion plant,
- associated waste treatment and a vitrification facility,
- interim storage facilities for plutonium oxide,
- interim storage facilities for waste.

The very important quantity of Plutonium which will transit by the plant and will be stored waiting for utilization requires to work out a new technology.

The following figure shows the general program of construction.

The included general view of the first pond storage NPH shows the first step in UP3-A construction.

It is expected that the hot tests will start at the end of 1985.

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And, as well known, this plant will reprocess about 6000 T. of foreign fuel in about 10 years, out of which more than one fourth will come from Japan.

CONCLUSION

To summarize, our opinion is that the reprocessing of LWR spent fuel has now reached an industrial level in the present UP2 plant.

The experience gained with the operation of this plant shows obviously that the large reprocessing plants, in operation by the end of the present century, will operate according to a new highly elaborated technology.

STATUS OF INTERGOVERNMENTAL COLLABORATION IN DEVELOPMENT OF THE NUCLEAR FUEL CYCLE

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INTRODUCTION

Much of the agenda for yesterday had nuclear weapons proliferation as a central theme. Tomorrow, the focus is nuclear safety and regulation. These emphases on the potential hazards of the utilization of nuclear energy are not at all uncommon today. It is countered only by the even more gloomy prospects of energy availability from traditional fossil resources. The recent developments in Iran serve as a clear warning to all who will hear, that dramatic changes in projected energy supply patterns can occur.

The principal mission of the NEA is to further the development of nuclear energy, making it a viable option for our Member governments to consider in the development of national energy plans. By exaggerating this charter slightly to include psychological factors, I would like to take as my theme for today that when seen from a somewhat broader international perspective, there are some very positive aspects to the nuclear scene today.

The major questions of a few years ago were :

1) Can nuclear power reliably be integrated into a power grid on a large scale?

2) Can the necessary industrial infrastructure, from mining and processing through construction and operation, be put in place: and

3) Can reactors be designed and built with confidence that they do not constitute an immediate threat to nearby populations?

While there are still those who from time to time will worry over feasibility and infrastructure, their numbers are rapidly dwindling and they will soon join those who still argue that the world is flat and that bumblebees cannot fly. The answers to these questions are now obviously affirmative. Previous emphases in intergovernmental collaboration were on concept development and demonstration, as illustrated by NEA's Eurochemic and Dragon projects. This phase is now largely past for most aspects of the nuclear fuel cycle. Interest in scientific and technology collaboration remains strong, and in the safety, regulatory and safeguard areas, there is still very strong interest. I will return to these questions in a moment, but let me note now that the basic questions of feasibility are resolved for all but the most extreme skeptics.

To replace the previous questions of the feasibility of nuclear energy, we now see reflected in the international arena the urgent need to close the fuel cycle and to deal with the questions inherent in that (in particular waste management and plutonium management), and a desire to deal with those questions arising from the fact that resources, technology, and industrial capabilities are not distributed according to need. There is also the question as to the extent to which this energy option should be employed relative to other alternatives, including the option of using less energy. This latter question is at a strangely low ebb today, as those who recognize the seriousness of the world's energy dilemma argue for any and all available means of meeting energy needs including conservation, while the nuclear community itself is consumed by concern over proliferation and regulation. I will pass over this most interesting question, restricting my attention to matters of feasibility of employing the nuclear option, and I will specifically omit questions related to nuclear weapons proliferation from my further remarks, in that this has already been covered by previous speakers.

I will be taking many of my illustrations from work of OECD-NEA in that I am most familiar with this. Certainly, as is widely recognized, the activities of the Commission of the European Communities (CEC) and the International Atomic Energy Agency (IAEA) are of great significance in the nuclear field. A number of other international bodies and organizations (e.g. OECD-IEA, WHO, IMCO, to name a few) also are influential in nuclear topics as part of their broader areas of interest. Another form of intergovernmental collaboration is by way of bilateral exchanges. I will not speak to this aspect, even though in some areas it is dominant.

ACTIVE FIELDS OF INTERGOVERNMENTAL COLLABORATION

a) Resources:

Assessment of uranium supply and supply/demand balance have for years been active areas of intergovernmental collaboration, including publication since 1965 by NEA and IAEA of reports on Uranium Resources, Production and Demand (Refs.1-7). More recently, this summary of resources has been supplemented by a broad survey of speculative resources (Ref.8). The International Fuel Cycle Evaluation (INFCE) is updating resource estimates again. The current estimates reflect a reserve of some 2 million tonnes of uranium, with estimated additional resources of comparable magnitude. This corresponds to something like a 20 year forward reserve. On the more speculative side, based on broad geologic considerations, each of the continents may have another few million tonnes, some of which may be discoverable and recoverable. At this time, the focus of intergovernmental collaboration is progressing from assessment of the magnitude of the global resource toward the more practical considerations of mine and mill capacity, markets, constraints (e.g. environmental and political), and economic limits on the amount of ore that can usefully be obtained from a given deposit. Questions of exploration, extraction of uranium from its ores, environmental impacts and pollutant control technology, as well as institutional and security of supply considerations are of high international interest.

One of the reasons that intergovernmental collaboration is strong here arises from the basic security of energy supply concerns of all industrialized countries today. Until such time as we return to an energy surplus situation (e.g. with a mature breeder or fusion economy), the availability of energy resources will be a matter of serious national self interest, and quantitative estimates will have substantial political as well as economic significance. Since it is less feasible to manipulate figures on an international basis, intergovernmental figures for both supply and demand may tend to have a higher degree of credibility than do private or even national figures. International collaboration is necessary here if credibility is desired. Beyond this, both nuclear resources and nuclear technology are likely to be matters of international commerce. A common understanding of the factual bases can be of substantial value in stimulating trade and the mutually beneficial utilization of resources.

b) Safety and Radiation Protection

The most active intergovernmental collaboration today is in the general area of safety and radiation protection. Here, in quite a different sense, credibility is one of the keys. In spite of the best efforts of men throughout the ages, prediction of future events is not an exact science. Both the prediction of accidents and the evaluation of the consequences of postulated future events are uncertain undertakings. It is clear that ultimately evaluations of safety and risk must rely on the judgement of reasonable men. And in areas where the real hazards of inaction and the possible risks from imprudent action are both of broad significance, the perspective potentially available from international consensus provides a strong measure of credibility.

For questions as basic as radiation protection, there is clear advantage to all in having the benefit of the widest possible discussion of the available information.

Since there is no basis for differentiation based on national boundaries, harmonized bases are clearly indicated here. All intergovernmental collaboration of which I am aware bases development of regulatory policies and practices ultimately on guidelines developed and maintained by the International Commission on Radiological Protection (ICRP), an independent international group of experts. Radiation protection programmes at the intergovernmental level, in addition to broad concern for occupational exposure throughout the nuclear fuel cycle, currently are emphasing the development and normalization of criteria, management of long lived wastes, environmental questions related to mining and milling operations, and broadly distributed gaseous effluents (^{3}H, ^{14}C, ^{85}Kr and ^{129}I).

Programs on the safety of thermal reactors are reaching a mature phase of data collection, interpretation and assimilation. As questions become more subtle, the verifications become more expensive, allowing increased scope for international co-operation. For other aspects of the fuel cycle and for advanced reactor types, broad international as well as interdisciplinary exchanges are required in the development of broadly based understandings, criteria and rational regulations. The issue of comparative risks is likely to become more significant.

In these types of areas, the incentive for intergovernmental collaboration is primarily a matter of efficiency of development. It has been estimated that OECD countries are currently spending on the order of $1000M each year in the safety area. Surely there is little benefit to duplicative development and data generation at this scale.

c) Scientific Collaboration

The sciences have traditionally been fields in which there has been strong international exchange. The scientist himself tends to seek collaboration, constrained only on sensitive or commercial information. The sciences related to nuclear power are no exception. For example, nuclear data is routinely exchanged by a network of four data centers:

NEA Data Bank, Saclay, France
U.S. Nuclear Data Center, Brookhaven
IAEA Nuclear Data Library, Vienna
USSR Nuclear Data Center, Obninsk

Nuclear design and analyses methods, as incorporated in computer codes are also often exchanged freely. Regular scientific and engineering meetings, symposia, working groups, etc., are organised by international organizations, societies, industrial and laboratory groups and others.

d) Waste Management

Having touched very lightly on the preceding topics, I would like to take a bit more time on the topic of waste management. For many people, questions on nuclear wastes and on plutonium control (proliferation) are the only questions of principle remaining regarding nuclear power for electricity generation. Of course, it is generally accepted that strong regulation is necessary to assure that appropriate safety principles are rigorously applied. As I noted, I will not speak about proliferation.

Within the OECD-NEA, over the past years, there have been extensive discussions as to the current situation with regard to waste management questions. I would like to share with you some of the conclusions that I have drawn from this exercise to date. Perhaps the most obvious conclusions are :

1. there is a great deal of misunderstanding as to the technical aspects of the problem;
2. many countries are earnestly engaged in the development of waste management policies; and
3. there is a need at the intergovernmental level to assist in formation of the bases for the national policies, in technology development, and in development of legal and institutional approaches. So far, there is little pressure for actual management of nuclear wastes at the intergovernmental level.

In order to appreciate the waste management area, it is essential to understand that there are many factors and distinctions which must be recognized. For most aspects of waste management, there are no significant outstanding technical questions as to whether one can achieve any required level of protection and assurance; the current questions are as to how much protection and assurance to buy and what is the most efficient way of accomplishing this. For example in the area of geologic disposal of high level wastes, it has been confidently stated for years that this can be accomplished without significant risk to man or the environment. This contention is not seriously challenged but as I will discuss in a moment, massive development and data programs will be involved in the responsible implementation of this process.

For the reasonably short term, there are technically adequate means for safe storage of all waste types for many decades ahead and these are demonstrably sound. These measures allow ample time for the specific developments required for final disposal.

The disposal of low level, short lived materials need not present any serious technical difficulty. While there have been examples in which less than desirable conditions have been present, there is no evidence that even these operations have caused significant damage. Under proper and carefully controlled conditions, shallow land burial is a safe and generally inexpensive option for disposal of solid wastes of this type. These conditions (see, for example, those listed in paragraph 120 of Ref. 9) are based on the short duration of the hazard and on the fact that these materials are or can readily be treated to limit their dispersion in the air or by ground water. Natural or man-made containment is normally reinforced by surveillance for the relatively short period before the wastes become harmless and the land can again be made available for unrestricted use.

In some instances, there is still work to do to properly codify the appropriate procedures and conditions, and careful regulation is appropriate.

Some countries which have difficulty in providing suitable sites for shallow land burial have elected to dispose of some low level materials by the alternative of dumping in the deep ocean. For some years, OECD-NEA actually sponsored such operations. The London Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matters adopted in 1972 provides a regulatory framework for this type of disposal, which is now carried out solely on the authority and responsibility of particular countries. NEA services a Multilateral Consultation and Surveillance Mechanism, which provides a framework for review by interested countries of procedures, criteria and container specifications, site safety assessments, and information on the actual conduct of each operation. While there is evidence that the containers specified for these operations will retain these wastes until the radioactivity has decayed to insignificance, no formal reliance is placed on the long term integrity of the containment beyond that required for the waste to reach the ocean floor. Protection for man and the environment is assured by the very great dilution potential of the ocean should radioactivity leak from the containers.

Most if the discussion of nuclear wastes centers around those wastes which remain hazardous for long periods to time; for practical purposes, these wastes may be considered as persistent hazards. This applies to spent fuel itself if it is not to be reprocessed, to wastes from reprocessing of nuclear fuels, and to some other wastes. The high-level (spent fuel or reprocessing) wastes include well over 99% of the radioactive wastes produced by the nuclear industry, and amount to a few cubic metres annually for each full-scale nuclear power plant. The long lived component in this waste consists for practical purposes, only of radiation of low concentration and very low penetrating power, which would nevertheless constitute a low level hazard if taken up internally by ingestion or inhalation. Many fission products are characterised by more penetrating radiation, which can cause harm to individuals either by internal or by external exposure, but these are not significant after certain time periods. In addition, high level wastes generate heat, which is a key factor relative to their management.

For many decades, it is necessary to provide physical shielding (e.g. a few metres of earth) to protect people from external exposure to the associated penetrating radiation. For several centuries, it must be ensured that the contained caesium and strontium are not released e.g. by way of the contamination of local water supplies, to the human food chain. Over much longer time periods, the effects of release to the human environment of the few long-lived products should be kept to a small fraction of those from natural background radiation.

A management strategy for these materials can be based on the following sequence :

- storage of spent fuel for cooling;
- preparation of spent fuel for final disposal;

or

- reprocessing;
- transient storage in liquid form of wastes;
- solidification of liquid wastes;
- storage of the solidified wastes for cooling, as required;

then

- disposal into suitable geological formations.

Alternative strategies are also possible (Ref.9). Each stage in the scheme summarised above represents a progressive improvement in the degree of isolation provided for the waste and a decrease in the reliance placed on human control.

For any part of the radioactive wastes emplaced in a deep geological disposal site to reach the food chain or the atmosphere would require a massive geological disruption or leaching of the waste material by ground water. Leaching can be minimized by putting the waste in a chemically stable form in relation to the geochemical environment; and the possiblity of transport by ground water can be greatly reduced by proper choice of the geological site, notably in relation to its stability or freedom from major geologic disruption. Several deep geological formations have been studied for the disposal of long-lived wastes. Most attention has been directed to disposal into salt, but recently clays, shales and hard rock formations have also been considered. It appears that in selected instances any of these media would be suitable.

During the emplacement phase in deep geological formations, and perhaps for some time afterwards, monitoring and administrative control of disposal sites will be desirable to prevent intrusion as a result of human activities. Registration of emplacement sites and related records will also minimise the possibility of accidental penetration by man. Restriction on surface land use should not normally be necessary beyond that required during emplacement operations.

The specific priorities of current research and development relating to deep geological disposal are:

a) studies and practical geologic experiments including work utilizing actual waste forms;

b) more elaborate analyses at specific and illustrative sites of the natural barriers providing the main long term containment and, in case of their failure, of the pathways radioactivity may follow from geologic repositories back to the biosphere;

c) investigation of alternative disposal possibilities, including in sub-oceanic geological formations.

Significant conditioning and storage programmes and intensive R and D work on disposal of long-lived waste, as well as the development of regulatory criteria for the longer term aspects, are enjoying increasing priority in a number of countries. Never before in history has man sought to put something back into the earth, and to know with good confidence what would happen to this material over long periods of time. The rapidly increasing R and D on waste management as well as substantially increased production-type efforts, will yield vast quantities of new data on waste form, on containment, on treatment technology and on geology. Very active and at times excited technical interchanges can be expected.

Other materials which present a low level persistent risk include materials which, though substantially contaminated by actinides, do not generate significant heat. They are therefore easier to handle. The large volume of these wastes and their low level of contamination, however, may preclude the effective use of some of the treatment and disposal techniques which can be used for high level wastes. The tailings from uranium mining and milling similarly present a long-term low-level hazard due to their content in natural radium and the products resulting from its decay. The dominant risk to man presented by these materials depends on the means employed for their disposal. In some circumstances these materials may present a risk of inhalation; in others, it is important to avoid leakage and transport of actinides (e.g. through ground water) into the human food chain. The technology for treatment of long lived waste materials is well advanced.

International collaboration in the waste management area increases as the national programs grow. In addition to efforts to correlate basic understandings and approaches, active programs are being put in place to develop consensus positions on the appropriate criteria, based on ICRP guidelines, for waste management and regulation. For several years the CEC has had a very strong program on waste management R and D. NEA is also preparing several collaborative R and D projects in this area based on national experimental undertakings. Preliminary steps have been taken to create an international bank of data relative to modelling of nuclide migration through geological media. An intergovernmental study of the legal and institutional implications of the long term aspects of radioactive waste management has been initiated. Thus, the entire spectrum of policy approaches, technology and legal and administrative aspects are active topics of intergovernmental collaboration. There is every reason to actively pursue these questions on an open international basis, including credibility, efficiency of resources, time and manpower; also, since any low level residual risk from long lived wastes placed in deep geology would be highly dispersed, there is the aspect of mutual self interest.

e) Other

While I will not take the time to elaborate on other topics; I would be remiss not to mention several other very active examples of intergovernmental collaboration. The safeguards area of IAEA is perhaps the most obvious. The IAEA standards area is also of major interest. NEA and IAEA both have active programs in the obviously international area of nuclear third party liability. Regulation of international transportation of materials is clearly of intergovernmental concern.

CONCLUSIONS

In this forum, which properly gives considerable attention to problem areas, I have tried to provide a broad overview of ways in which intergovernmental collaboration is being used to address problem areas in the nuclear fuel cycle. If we are not careful in our attention to problem areas we can overlook the facts that :

> The basic questions of the feasibility of the use of nuclear energy as a major segment of an electricity network have not only been solved, but substantial areas, and several nations already have utility systems which would collapse without the existing nuclear component. This has been accomplished without serious damage to man or his environment.
>
> The remaining questions which some consider to be matters of principle (waste management and pu management) are not questions as to whether there are solutions, but questions as to which solution is best, and what degree of confidence in this solution is required.
>
> There are very large tasks ahead, such as in generating adequate geologic data for deep disposal of radioactive wastes, very careful management will be necessary to ensure that necessary questions are addressed without burdening nuclear energy with the job of totally understanding subsurface geology. But the technical outcome is clear. All types of wastes can be safely disposed of into geologic media with insignificant risk to man or the environment.

The need is clear, and nuclear power can make a major contribution to world energy supply. Intergovernmental collaboration is a reasonable tool, and in some instances a most effective and efficient tool for developing the data and credibility necessary to permit the confident exploitation of this option.

REFERENCES

1. Uranium Resources, Production and Demand: OECD-NEA/IAEA, Paris 1977.

2. Uranium Resources, Production and Demand; OECD-NEA/IAEA, Paris 1975.

3. Uranium Resources, Production and Demand: OECD-NEA/IAEA, Paris 1973.

4. Uranium Resources, Production and Demand; OECD-NEA/IAEA, Paris 1970.

5. Uranium Production and Short Term Demands: OECD-NEA/IAEA Paris 1969.

6. Uranium Resources, Revised Estimates; OECD-ENEA/IAEA, Paris 1967.

7. World Uranium & Thorium Resources: OECD-NEA Report, Paris 1965.

8. World Uranium Potential; OECD-NEA/IAEA, Paris, Dec. 1978.

9. Objectives, Concepts and Strategies for the Management of Radioactive Waste arising from Nuclear Power Programmes (The "Polvani Report"); OECD-NEA, Paris, Sept. 1977.