第9回原産年次大会 英語論文

1976年3月

社団法人 日本原子力産業会議

第9回　原産年次大会プログラム

と　　き　　昭和51年3月10日(水)　11日(木)　12日(金)

ところ　　イイノ　ホール〔内幸町・飯野ビル　7階〕　東京都千代田区内幸町2－1－1

基　　調　　「原子力発電開発総合システムの確立をめざして」

第1日　3月10日(水)

開会セッション(9:30～12:00)

	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	伏見康治　氏	(日本学術会議　副会長 日本原子力産業会議　常任理事)
	原産会長所信表明	有澤廣巳　氏	(日本原子力産業会議　会長)
	原子力委員長所感	佐々木義武　氏	(国務大臣　原子力委員長)

〔特別講演〕

	議　　長	松根宗一　氏	(経済団体連合会エネルギー対策委員会委員長 日本原子力産業会議政策会議委員)
10:30	代替エネルギーの選択		
①		U.ランツケ　氏	(国際エネルギー機関　事務局長)
11:15	原子力エネルギーへの挑戦　－1976年－		
②		R.フライ　氏	(米国エネルギー研究開発庁　副長官)

午餐会(12:20～14:10)　ホテルオークラ　<別館地下2階・曙の間>

挨　　拶　　河本敏夫　氏　(通商産業大臣)

〔特別講演〕　科学と技術

田中美知太郎　氏　(京都大学　名誉教授
日本文化会議　理事長)

原子力関係映画上映　(12:40～14:10)　<ホール>

自　由　参　加

セッション1『エネルギー開発と原子力発電』(14:30～17:30)

〔講　演〕

	議　　長	石原周夫　氏	(前　日本開発銀行　総裁)
14:30	エネルギー戦略と原子力発電		
③		W.ヘーフェレ　氏	(国際応用システム分析研究所副所長)
15:15	原子力発電計画とその課題		
		伊藤俊夫　氏	(関西電力㈱　副社長 原産原子力発電開発規模検討委員会副委員長)
	議　　長	守屋学治　氏	(三菱重工業㈱　社長)
16:00	フランスにおける原子力発電計画		
④		A.デジュー　氏	(フランス電力庁　副総裁)
16:45	米国における原子力開発:産業界と政府の役割		
⑤		E.ウイギン　氏	(米国原子力産業会議　副理事長)

第２日　３月１１日　（木）

セッション２　『原子力産業－２０年の歩みと将来展望』　（9：30～12：00）

〔講　演〕

議　長　玉置敬三氏　（東京芝浦電気㈱　社長）

9：30　原子力産業の発展と展望

田島敏弘氏　（㈱日本興業銀行　常務取締役）

10：00　軽水炉の定着化と課題

吉岡俊男氏　（日本原子力発電㈱　常務取締役）

＜休　憩　（１０分）＞

議　長　永倉三郎氏　（九州電力㈱　社長）

10：50　動力炉開発政策のすすめ方

武井満男氏　（日本エネルギー経済研究所　研究理事）

11：30　原子力機器産業の課題

吉山博吉氏　（日本電機工業会　会長　㈱日立製作所　社長）

セッション３　『原子力行政の新しい展開のために』　（13：30～17：00）

議　長　茅　誠司氏　（日本原子力産業会議　副会長　元東京大学学長）

〔講　演〕　（13：30～14：50）

13：30　新しいエネルギー行政における原子力規制の１年

E．メイソン氏　（米国原子力規制委員会　委員）

14：00　西独の原子力行政

W．－J．シュミットキュスター氏　（西独研究技術省　エネルギー研究担当次官補）

14：30　原子力行政懇談会の中間答申と今後の課題

生田豊朗氏　（科学技術庁　参与）

＜休　憩　（１０分）＞

15：00　〔パネル討論〕　（15：00～17：00）

議　長　岸田純之助氏　（朝日新聞社　論説委員）

パネリスト

青木賢一氏　（全国電力労働組合連合会　事務局長）

内田秀雄氏　（東京大学　教授）

正親見一氏　（電気事業連合会　副会長）

川崎義彦氏　（茨城県東海村長）

生田豊朗氏　（科学技術庁　参与）

E．ウイギン氏　（米国原子力産業会議　副理事長）

原産創立２０周年記念レセプション　（17：30～19：00）
日本工業クラブ　＜3階　大食堂＞

第３日　３月１２日（金）

セッション４『核燃料サイクルの確立をめざして』（９：００～１２：００）

議長　山口恒則氏（四国電力㈱　社長）

〔講演〕（９：００～１０：００）

９：００　ＣＡＮＤＵの燃料サイクル　ー　現状と将来

Ｊ．Ａ．モレィディアン　氏　（カナダ原子力公社　副総裁）

９：２０　フランスにおける高レベル廃棄物管理の現状と政策

Ｊ．クチュール　氏　（フランス原子力庁　核燃料部長）

９：４０　米国の核燃料サイクル助成策

Ｆ．バラノウスキー氏　（米国エネルギー研究開発庁　核燃料サイクル・生産部長）

＜休憩（１０分）＞

１０：１０　〔パネル討論〕（１０：１０～１２：００）

議長　田中直治郎　氏　（東京電力㈱　副社長）

議長イントロダクション

パネリスト

瀬川正男　氏　（動力炉・核燃料開発事業団　副理事長）
田宮茂文　氏　（濃縮・再処理準備会　顧問）
高島洋一　氏　（東京工業大学　教授）
森島国男　氏　（日本核燃料開発㈱　社長）
井上力　氏　（通産省資源エネルギー庁　長官官房審議官）

セッション５「国際パネルー原子力開発における国際共通課題の解決」

（１３：００～１６：５０）

議長　一本松珠璣　氏　（日本原子力発電㈱　会長　日本原子力産業会議　副会長）

〔講演〕（１３：００～１３：３０）

１３：００　地域核燃料サイクルセンターと原子力安全基準のための国際協力

Ｉ．ジェルーデフ　氏　（国際原子力機関　事務局次長）

＜休憩（１０分）＞

１３：４０　〔パネル討論〕（１３：４０～１６：５０）

議長　向坊隆　氏　（東京大学　教授）

議長イントロダクション

パネリスト

Ｉ．ジェルーデフ　氏　（国際原子力機関　事務局次長）
Ｕ．ランツケ　氏　（国際エネルギー機関　事務局長）
Ｗ－Ｊ.シュミットキュスター　氏　（西独研究技術省エネルギー研究担当次官補）
Ｊ．クチュール　氏　（フランス原子力庁　核燃料部長）
Ｆ．バラノウスキー　氏　（米国エネルギー研究開発庁　核燃料サイクル・生産部長）
Ｗ．マーシャル　氏　（英国原子力公社　副総裁）
村田浩　氏　（日本原子力研究所　副理事長）

Dr. ULF LANTZKE
EXECUTIVE DIRECTOR OF THE
INTERNATIONAL ENERGY AGENCY OF THE
OECD

3/10 (水) 10:30 ~
開会 Session

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未公表に付
取扱に注意

Paris, March, 1976

"CHOICE OF ALTERNATIVE ENERGY"

Speech by
Dr. Ulf LANTZKE

to

the Japan Atomic Industrial Forum Inc.,

Tokyo
10th-12th March, 1976

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CHOICE OF ALTERNATIVE ENERGY

It is a pleasure for me to participate in this year's Conference of the Japan Atomic Industrial Forum. I look forward to hearing your views about the prospects for achieving the nuclear power programmes which are being implemented in a number of countries, the problems associated with completing those plans on schedule, the policies that might help further their realisation, and particularly your ideas concerning the role that international co-operation can play. For my part, I would like to convey to you some of the impressions we have gained at the International Energy Agency concerning the outlook for developing alternatives to imported oil.

First I would like to identify some of the important trends in consumption of different forms of energy by the industrialised countries prior to 1973, and show how the pattern might have evolved to 1985 in the absence of fundamental changes in international energy markets. Next I shall indicate some of the possibilities for altering this pattern, giving special emphasis to the sorts of uncertainty and problems involved. This will lead to a discussion of some of the policies required, and of the contribution which these policies could make towards reducing import dependence. Finally, I would like to point out the importance of international co-operation among consuming countries and the role of the IEA.

Trends in Energy Consumption in the OECD

From 1960 to 1972, energy consumption grew at an average rate of 5 per cent per year, and forecasts made before October 1973 indicated that growth would continue at nearly that rate until 1985. Five per cent growth rate means a doubling of energy requirements every 14 years. If this trend had continued a very large effort would have been needed to make available the energy needed to supply those requirements. I am not one of those who believes that the energy resources in general will become exhausted in the foreseeable future. We know that the world possesses very large reserves of coal which can eventually be made into gas or liquids once low cost supplies of oil and gas are depleted, and there is a high probability of exploiting solar energy and of developing breeder reactors and other new forms of technology which can expand usable energy almost indefinitely. Nevertheless rapid growth in demand would almost certainly have led to rapidly escalating costs of energy, though not necessarily as quickly as we have experienced during the past two years. In addition if OPEC intervention had not occured there eventually would have been problems related to the uneven geographical distribution of energy resources throughout the world. These problems can be illustrated by looking at the pattern of energy consumption as it has evolved over time.

In 1960, 35 per cent of OECD energy consumption consisted of coal, 40 per cent consisted of oil, while the remainder was accounted for by gas and hydro electricity, with the contribution of nuclear power being negligible. By 1972, oil's share had risen to 54 per cent but coal's share had fallen precipitously to 22 per cent. Nuclear's share was still insignificant. Projections made in 1972-73 indicated that by 1985, oil consumption would reach 56 per cent and coal consumption only 15 per cent, but nuclear power would account for 10 per cent.

The most significant change, however, is for the share of oil imports in total consumption, which rose from 18 per cent in 1960, to 34 per cent in 1972 and was projected to reach 45 per cent by 1985.

When we move from the aggregate picture for the total OECD, and look at the situations of individual Member countries, we find even greater imbalances. In 1972, 18 of the 24 OECD countries each produced less than 8 per cent of their own domestic oil requirements. Only one country, Canada, was a net exporter, and even it depended on imports to supply nearly half of its domestic oil consumption. Indeed most countries supplied under 25 per cent of their total energy requirements from their own resources. Only in a few countries did primary energy production account for 50 per cent or more of requirements. These countries include:

Canada, Australia, United States, Norway, the Netherlands, the United Kingdom and West Germany. Soon West Germany will no longer be in the group. This situation differs markedly from the past when coal was dominant and most OECD countries met their coal requirements largely from their own resources.

Before 1973, it was realised that the increasing dependence on oil imports from a relatively small number of nations involved some risks, and some countries did place restrictions on oil imports, while others took measures to limit the decline of their coal industries. These measures were adopted for other reasons as well as the risk of import dependence; nevertheless they probably resulted in the advance of oil occurring more slowly than in their absence. For the most part, however, it was evidently believed that the benefits of low cost oil exceeded the costs associated with the risks of import dependence.

The New Energy Situation

Since the end of 1973, the energy situation has, of course, been changed radically, and governments have begun to introduce measures to limit the growth of energy consumption and to diversify sources of supply.

Even without government encouragement the OPEC price increases would have led and are in fact leading to some alterations in the pattern of energy supply and demand predicted prior to 1974. And indeed some studies made soon after the largest of those increases predicted very large changes. Now, after two years' time to reflect more carefully, we believe these studies to have been too optimistic.

One change that is still expected to be large is a reduction in estimates of economic growth over the next 10 years. This change is only partly related to the increase in international oil prices, but in any event it is expected to contribute to substantially less growth in energy consumption than was previously anticipated, although there may be some offsetting effect due to increased energy requirements resulting from the adoption of certain forms of environmental controls. Any reduction in oil import dependence achieved by this route, however, is a somewhat mixed blessing.

Another consequence of OPEC's actions is the realisation of significant economies in the use of energy. In 1974, OECD energy consumption fell 2 per cent below the 1973 level despite a drop in GDP of only 0.4 per cent. While a portion of this fall is attributable to the temporary disruption in oil imports during the first part of 1974, and to psychological reactions which may have diminished since then, another part is undoubtedly due to the price increases. And the price induced effect is expected to become larger over time as consumers gradually undertake the investments needed to reduce their consumption on a longer term basis.

I stress the reduction in the growth of energy consumption, although my main topic is "choice of alternative energy", because it now appears that its contribution towards reducing dependence on oil imports will be greater than the contribution made by increasing energy production in the industrialised countries. In addition, energy savings have some important advantages when compared with increased energy production. They help to conserve the world's energy resources; they have beneficial environmental effects, and they may be realised more quickly than production increases.

Energy Supply

Over the very long term there is a large potential for increasing energy supplies in the industrialised countries, but, not surprisingly, these increases cannot be realised overnight. Lead times are long, and for each form of energy there are certain obstacles to overcome. These considerations can be illustrated by looking at the various energy sources individually, starting first with oil and natural gas.

Oil and Natural Gas

For the past seven years, oil and gas production in the traditional producing areas of the United States and Canada has exceeded new discoveries, and the pressure decline which occurs as existing reserves become depleted has resulted in diminishing production. Large discoveries have been made in frontier areas such as Alaska and the Canadian Arctic, but very large and costly transportation investments are needed to bring the products to market, and it takes a long time to build the necessary facilities. Not only is the construction phase time consuming, it is also necessary to undergo a prolonged period prior to getting approval to begin construction, during which time it has to be shown that the environmental effects are tolerable, that adequate compensation is paid to native groups affected by the projects, that the projects will not have intolerably adverse macro economic effects, and that in general the benefits to the affected societies exceed the costs. Furthermore, because the transportation costs are very large, the oil or gas reserves needed to justify building the projects must be correspondingly large. Because of these considerations, the natural gas discovered in the Canadian Arctic Islands at the start of the 1970's is not expected to reach markets until the mid to late 1980's.

Further reserves are expected to be found in onshore and offshore areas of North America closer to markets, but until they are found we do not know how much is there. Projections of production for even as short a period as the next 10 years include supplies from reserves which have not yet been proved up. Naturally, there is considerable uncertainty surrounding these.

The large amounts of oil and gas found in the North Sea will help a great deal towards reducing European oil imports, and to keeping them from exceeding current levels for 10 years or more. From this year on production increases from the North Sea will more than offset decreases which will continue to occur in the United States until Alaskan oil reaches market. However, production expansion for oil has fallen behind schedule due to understandable difficulties of trying to construct facilities in the North Sea.

Government policies towards oil and gas have evolved rapidly in the past two years making it difficult to sort out all their consequences. Tax systems have been modified in order to bring about an appropriate distribution of the windfall profits on production in OECD countries resulting from the general increase in oil prices. While these changes were under way investors were left uncertain as to profitability from future production but this uncertainty is lessening now.

There are controls on prices for oil and gas in some countries, adopted for anti-inflationary and other reasons. Some of these have existed for a long time, but others were introduced after 1973. The rate at which and the extent to which they are removed will have effects on production.

In some cases, rights to explore in certain regions have been granted more slowly than hoped, partly for environmental reasons, partly out of concern for economic and social dislocation which could accompany rapid development.

Governments which export oil or gas are subject to pressures with respect to the extent to which exports should be allowed. There are concerns that unrestricted exports would lead to later difficulties in covering future domestic requirements.

Costs of production from Canadian tar sands have escalated more rapidly than general inflation in the past year, thereby diminishing prospects for rapid development. In early 1975 it was necessary for the Canadian government, together with two provincial governments, to provide financial support for the second tar sands plant in order to ensure that its construction continues on schedule. Tar sands production is expected to be about 15 million tons annually by 1985.

Taking account of these various considerations, but not assuming significant new policy departures, it is estimated that the increase in OECD oil production between 1974 and 1985 could be about 220 million tons compared with total additional energy requirements of 1830 million tons oil equivalent. Additional gas production could be about 50 Mtoe, with increases in European, Canadian and Australian gas production being partly offset by decreases in the United States.

An important means of diversifying sources of supply is to increase imports of natural gas. The increase in gas imports to 1985 could be about 150 Mtoe, part coming from the USSR, and part from OPEC countries. An unresolved question concerns the extent to which imports of gas from OPEC countries are a more reliable source of supply than oil. Gas, however, has an advantage over oil in that it causes less pollution, an advantage which is appreciated in this country.

Coal

OECD coal production could increase by 280 Mtoe between 1974 and 1985, with nearly all of the expansion likely to take place in the United States, Canada and Australia. Prior to 1974 European coal production was expected to decline because of high costs. It is now anticipated that it will maintain present levels or increase a little. Costs outside of Europe are lower than oil prices in terms of equivalent energy content, but there are other obstacles to a greater expansion. Among these is limited demand. Since there is no longer much demand for coal in the residential, commercial and transportation sectors, nor for steam coal in industry, the available coal will be consumed mainly for electric generation and for coking purposes in the steel industry. Slower economic growth in the future, however, could reduce the growth of steel and electricity outputs and thereby limit demands for coal. To some extent coal can be used in electric generation to displace oil and perhaps also as a substitute for new nuclear plants but difficulties of controlling pollution from coal burning plants limit this possibility in some regions, and in most areas coal produced electricity is more costly than nuclear.

One way to get around the demand constraint associated with coal is to transform it into liquid or gaseous form but at present the costs of doing so are still too high to lead to expectations of any substantial progress in this direction occurring before 1985.

Environmental difficulties relating to the production of coal may also impose some constraint. Furthermore there are uncertainties arising out of possible construction delays and transportation bottlenecks.

Hydro and Geothermal

Hydro and geothermal energy could contribute an additional 80 Mtoe to OECD production by 1985. Further increases in hydro power are limited by lack of available sites while lead times needed to increase geothermal production are long because there are still some technical and environmental problems to be solved.

Nuclear Power

I turn now to the much-publicised option of nuclear power, in which the JAIF has a particular interest. One of the most important reasons for the widespread interest in nuclear power is that it is almost the only promising means which many of the relatively energy poor countries have for diversifying their energy supplies. The lack of a domestic market large enough to justify a nuclear plant may preclude the use of this option by some countries but even Luxembourg is planning to build a nuclear power station.

By 1980 the OECD could have 180 gigawatts of nuclear capacity, and by 1985, 400 gigawatts, and nuclear's contribution to the increase in OECD energy production between 1974 and 1985 could be 444 Mtoe, which is substantially greater than the contribution of any other single form of energy. Given the technical complexity and the very large capital investments associated with nuclear power, increases of these magnitudes would constitute a major accomplishment. Nevertheless these estimates are considerably less than the targets adopted by governments after the OPEC oil price increase; indeed they are lower than projections made before 1974. Furthermore, in order to achieve the 1985 targets the current lead times of 10 years imply that it will be necessary to establish the necessary sites by the end of 1976, and it is not certain that this can be done.

One of the most important reasons for reduced nuclear forecasts has nothing to do with difficulties of building nuclear plants. It is that the need for nuclear power will be less because of the expectation that the industrialised countries will reduce the growth in their energy consumption, and therefore also the growth in their electricity consumption.

Other factors include financing difficulties, and licensing and construction and commissioning problems. For example, the accumulation of the larger volume of capital required for financing new nuclear power growth - estimated already a year ago to be over $250 billion for the OECD area, poses problems at a time when ambitious investment policies in the energy sector are being hampered by Government restrictions on aggregate demand to control inflation and redress balances of payments. In addition, costs of nuclear power stations are more sensitive to inflation and interest rates than the less capital intensive fossil fuel burning plants. Although the earlier bottlenecks which were experienced in some countries on the licensing, the construction and the commissioning of nuclear installations have now largely disappeared due to more streamlined regulatory procedures within national administrations and improved engineering experience, a new form of regulatory obstacle is rapidly becoming consolidated in the shape of public opposition to the widespread growth of civilian nuclear installations on the grounds of health and safety. You in Japan are already well familiar with this phenomenon, so I hardly need dwell further upon it.

So far I have not mentioned nuclear fuel, since until now there have been plentiful supplies of it at low cost. However, there may soon be problems. As a result of the tripling of the price of natural uranium over the last three years, and the prospect of steep rises in the cost of enrichment facilities, which have hitherto been subsidised by national governments, nuclear fuel costs may not in future be a negligible component of cost as they have been in the past. Furthermore, present resources of low cost uranium correspond to only about 13 years of forward requirements, and there are not yet enough enrichment facilities under contract to provide adequate full supplies over the lifetimes of nuclear plants now being planned.

While these problems are serious and will require close attention, we are confident that nuclear power will make a major contribution towards increasing energy supplies in the next ten years, and that by the end of that period it will represent a significant proportion of total energy production in the industrialised countries.

Other sources of Energy

Other sources of energy, such as solar, wind power, wave power, biomass conversion, methanol and thermonuclear fusion have promising prospects and much research is being carried out to overcome technological problems. However, with the possible exception of solar energy, they will not make a significant contribution over the next decade.

Government Policies

Putting together the various projections which I have given you, but mindful of the uncertainty surrounding them, we find that, by 1985, OECD's oil import dependence could be reduced from the ratio of 45 per cent expected prior to 1974 to a level of well below the present ratio of 36 ~~35~~ per cent. This is a significant improvement but it nevertheless entails a large absolute increase in oil imports above 1974 levels ~~(a change of 11 million barrels per day)~~, and hence could promote a pronounced sellers' market. Furthermore, since most of the production increases are expected to occur in a few, relatively energy rich, countries, the majority of the industrialised countries will continue to be dependent on imports for all, or nearly all, of their oil requirements.

A key assumption underlying these projections is that government policies will continue. There are now some indications that the application of new, more vigorous, policies could have large beneficial consequences, and I therefore wish to discuss some of the policy approaches which could be taken. The policies may be divided into two categories. The first includes measures to reduce import dependence by means of increasing indigenous supplies of energy, and reducing growth in consumption of energy. In the second category are policies related to the consideration that the availability of energy is not evenly distributed among consuming countries.

I have already mentioned a number of policies which are affecting the consumption and production of energy in the industrialised countries, particularly in the discussion of oil and gas.

One of the most important options, perhaps the most important, is to allow domestic energy prices to rise to international levels. This will allow market forces to have a fuller role, and will serve to encourage energy savings and increases in energy production, both of which lead to less dependence on a limited number of outside sources of energy supply.

Higher prices alone are not sufficient to achieve the desired amounts of energy savings. Other measures to encourage conservation include minimum requirements for insulation in residential and commercial buildings, taxes and other measures to discourage the use of large or powerful automobiles which consume large amounts of gasoline, lower speed limits on highways, rationalisation of airplane flight schedules, encouragement of public transportation relative to automobiles, laws requiring appliance sellers to indicate to potential buyers the amounts of energy required to operate their products, publicity campaigns, special economy efforts within government organisations, and so on.

I indicated earlier some of the environmental and social reasons why some governments have been reluctant to permit full scale exploration in certain oil and gas bearing areas. If these problems could be resolved in such a way as to permit more rapid granting of rights to explore, it is believed that a great deal more production could be achieved.

Since a slowdown in the rate of growth of electricity consumption is expected to act as a constraint on the production of both coal and nuclear power, it is useful to investigate whether ways can be found to increase electricity's share in total energy consumption. This option needs to be appraised very carefully, because some seemingly promising uses for electricity result in excessively large wastage of potential useful energy. One possibility, however, may be to increase the use of electricity in the transportation sector, for example in railways and urban travel, particularly in North America, where electricity is not generally used for these functions.

Efforts should be made to ensure that projects are not delayed because of financial difficulties. In the case of nuclear projects, this may involve ensuring that increases in electricity tariffs do not lag behind cost increases, as they may do in periods of inflation.

Studies should be made to anticipate bottlenecks arising out of shortages of construction and other materials and measures taken to alleviate difficulties.

All possible steps should be taken to resolve the environmental difficulties surrounding new energy projects. One helpful approach is to carry out careful studies of possible environmental consequences in order to establish as accurately as possible the extent of conceivable damages. Success along these lines could alleviate inhibitions which arise for the very reason that the consequences are not well understood.

It is important that the environmental effects of the production and use of an individual form of energy not be considered in isolation, for restrictions placed on one form of energy will necessitate making more use of other forms, thereby intensifying the environmental difficulties associated with those. Indeed, environmental policies in general need to be carefully co-ordinated with overall energy policies.

Regarding nuclear power in particular, in addition to measures I have already mentioned, special attention needs to be directed towards solving certain key technical problems, for example those relating to radioactive waste disposal and commercial fastbreeders.

These are only a few of the approaches which governments might adopt to reduce their energy import dependence. If, however, measures along these lines are vigorously pursued, it is possible that oil imports by the industrialised countries could be reduced by as much as 5 to 8 million barrels a day below levels projected on the assumption that present policies continue, and overall oil import dependence could be reduced to 26 per cent.

Co-operation among consuming countries can help achieve these gains. In addition it is necessary, in order to carry out actions coming under the second category of policies which I identified earlier. I now turn to discuss the role of international co-operation.

<u>International Co-operation</u>

To achieve the results I have mentioned it will be necessary to have close international co-operation of the type that Governments can accomplish through the International Energy Agency, and I now would like to describe this concept to you in some detail because the situation in itself is a new one.

You will remember that before the energy crisis of 1973-74, co-operation among consumers was largely limited to a general exchange of information. Today, I am happy to report, we have 18 industrialised countries working closely together in the International Energy Agency which, as you know, was conceived at the Energy Conference in Washington in February, 1974.

The novelty of this organisation is not only the fact that nearly all important consumer countries of the Western world (North America, Western Europe and Japan) agreed to join the Agency but that they also agreed to the majority principle for decisions on implementation.

Much has been accomplished by the IEA considering the short time elapsed since the Conference in Washington. This is especially noteworthy if we remember that we are dealing with a completely new form of international co-operation in a very complex and difficult field, which is continuously subject to structural shifts and changes.

What is this new concept all about? First, it is designed to avoid or at least minimise short-term risks in energy supply and therefore the agreement itself contains provisions for an emergency system. If there is another crisis of supply this system will have created a buffer, consisting of stocks, and available supplies will be shared by Member countries. This will ensure that the burden of a reduction in consumption will be equally borne. While the sharing system does not lead to an increased availability of crude oil quantities, it will prevent a situation in which, in an emergency, the world economic system would be severely strained by the fact that one side of the world must suffer enormous restrictions in consumption while the other side is fully supplied. I am happy to say that the IEA's emergency system is ready for use and therefore an important weakness has been corrected.

Second, a very important political aspect of the Program is the need for a greater transparency of activities in the world energy market, with special emphasis on the mineral oil market. On the one hand there clearly is a political need to clarify causes and effects on the world's energy market. On the other hand it is also clearly in the interest of governments not to jeopardise the principle of competition by allowing too much transparency. A balance must be found, therefore, which will put at the disposal of governments of industrialised countries all important data so as to avoid a possible missuse of special market conditions while at the same time maintaining the principle of free competition between the various oil companies. The description of these problems makes them sound simple. The solution, however, is immensely difficult because the degree of importance each government attaches to the principle of free competition on the one hand and to the transparency of the market on the other, varies considerably. In countries in which a major portion of the energy market is already regulated, the importance of the principle of free trade is obviously less than in countries where the principle of free trade still dominates the energy market, thereby making them more sensitive to the dangers of too great a transparency.

Despite these difficulties we have today an information system on crude oil prices, production costs and finished product costs, and we have been assured by governments that their data flow is better today than before the International Energy Agency was created.

Let me conclude my remarks on international co-operation with the most important item: the Long Term Energy Programme of the Agency which will contribute to the conservation of energy, to the development of new traditional energy sources, and to the intensification of research for new energy.

After lengthy negotiations, the 18 member countries of the Agency agreed to such a programme on January 29th and 30th, 1976. While the programme does not, of course, solve all problems, it is a positive starting point for a co-operation in the energy field.

Here are the main points of the Long Term Programme:

- First: Member countries will co-operate to achieve a higher energy production in their own area. (Incidently, they thereby support the position of OPEC countries, which have always pointed out that depletable energy such as oil must be used sparingly, with less flexible energy forms being used to cover the basic requirements.) Member countries have agreed to co-operate on projects, i.e. establishing new energy reserves, like the Canadian tar-sands or American oil-shale. Procedures have already been established which regulate the general basis for co-operation in this direction.

The Agency's Member countries have also agreed that investments in energy within their own areas must benefit from a minimum protection. This can be achieved by not selling crude oil below the basic price of $7.00/bbl (the present market price of crude is around $11.51). This point was discussed with particular intensity because it implies a divergency from the free market competition principle. I see it, however, as an insurance against a repetition of a situation, within free market competition, which would contain the potential for a serious world-wide economy crisis - a danger with which the world just cannot live. And I must stress that it will be very dangerous for the industrialised countries themselves to create another situation in which prices would be unstable and drop, just to enjoy a short-term price advantage.

The second main element of the Long Term Programme is intensified development of energy research. Although immediate results cannot be expected, it is important that we begin to develop new technologies today, so that they may be marketable by the end of this century. Both OPEC and the Club of Rome have issued serious warnings on the possible depletion of the world's raw materials, and particularly of energy reserves. A joint effort is necessary to avoid this danger. The research programme, developed by the Agency, is therefore more oriented towards new technologies than it is towards nuclear energy on which research had mainly concentrated until now.

A third point is the conservation of energy which leads us to the need to give thought to our energy consumption habits, not purely in terms of short-term savings but primarily in relation to a much more rational structure of long-term consumption than we have at the moment. The programme, therefore, has so far given priority to concrete conservation targets for 1975, '76 and '77. For the future the task will be to go into much more detail and to offer practical technical suggestions to all industrial, transportation and household users which will ensure more economy in consumption in terms of the national economy.

Last but not least is a particularly important point in the Programme - the so-called question of access. Agency Member countries are required to develop a system in which the freedom of energy trade can be better guaranteed than it is now. For what is the use of all the positive elements in the Programme if the countries of the Agency that have plenty of energy - in particular Canada, the United States, Great Britain and Norway - close their frontiers in a critical situation and only allow energy exports in such quantity as suits their unrestricted freedom to determine their own policy? Countries with meagre energy resources - in particular Japan but also most European countries - obviously could not accept such a development, for they would be contributing to the burdens of the Programme without receiving anything in return in a really difficult situation. Of course, this subject impinges on the very thorny area of national sovereignty. In considering the subject, it is of course not possible to alter the realities of this world from one day to the next, but what has been achieved is that all the Agency countries -

excluding Canada, for very specific reasons - have committed themselves to a policy which will lead to a step-by-step opening up of the markets and to the removal of obstacles to trade.

From what I have just told you, I think it is fair to say that international co-operation through the International Energy Agency is off to a good start.

Conclusion

In conclusion, let me say a few words about the economists' theory of exhaustible resources, according to which the optimal solution to the problem of choice of alternative energy is to use the lowest cost resources first, then the next lowest cost forms, and so on, with the highest cost sources being left until last. If costly resources are resorted to before the cheap supplies are used up, society must direct into energy production resources which could be invested elsewhere sooner than otherwise would be the case, thereby sacrificing the real returns that could be achieved in the interim. To ensure that consumers actually use resources in the appropriate sequence the theory requires that prices correspond to real costs of production. It also requires that there be free trade in energy to permit all nations to have access to the lowest cost energy before having to shift to more costly sources.

Unfortunately, the real world is not like this. Prices have been set above costs. Nations place restrictions on energy exports and imports, thereby forcing the resort to higher cost energy sooner than otherwise and requiring diversion of productive resources from elsewhere. Furthermore, the danger that trade interference can be used for political purposes obliges countries to limit their dependence on imports.

And so we must try to do the best we can within the existing situation, taking account of all the constraints. The approach which I have emphasised so far is to search for ways of protecting ourselves from dangers relating to potential interference with trade, for example, to economise on the use of energy, to increase indigenous supplies and to emphasise trade with countries that give the greatest assurance of a continuing flow of supplies.

However, since I have already given enough emphasis to this approach I wish to conclude by suggesting that it is equally important to continue, and indeed to increase, efforts taken at the same time along a different route, namely of trying to find ways to achieve a better relationship between prices and costs, and ways to bring about greater trust between trading partners, thereby encouraging freer and more secure international movements in energy. Participating countries within the IEA are trying to move in this direction with respect to energy in the IEA area. I hope it will be possible to make progress along these lines with other countries as well.

Thank you for inviting me here today and I hope that my remarks have been helpful in clarifying a highly complex subject.

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3/10 11:15〜

Speech Prepared for Delivery by
Robert W. Fri, Deputy Administrator
Energy Research and Development Administration
to the
Japan Atomic Industrial Forum
March 10, 1976

THE NUCLEAR CHALLENGE 1976

I am deeply honored by this invitation from our long-time friends and historic partners in the development of the peaceful uses of atomic energy. This mutual quest of ours represents the most benevolent instincts of mankind in that it seeks to channel the vast power of an energy source which nature has given us--the atom--to serve the interests of all the peoples of the world. And it also challenges us to reap its benefits without being injured by its potential dangers, to taste its sweet inner fruit, if you will, without being stung by the barbs that surround it. It is well established in the world that the Japanese people have brought to the very highest level of excellence the subtle art of living in harmony with nature. Thus we in the United States look to you, our long-time friends and partners to help us to learn how we all may better live in harmony with this gift of nature--the awesome power of the atom.

Our partnership in this venture is indeed historic and of long standing. In 1955, now more than 20 years ago, our nations signed our first agreement of cooperation in atomic energy, the first of many agreements which were to follow. In the ensuing 20 years, there has been much exchange of information, of effort, of materials...and of people in pursuit of this quest. My organization, the U.S. Energy Research and Development Administration, and its predecessor, the U.S. Atomic Energy Commission, have received more than 3,500 official visitors from Japan in those 20 years, and we also had more than 800 Japanese assignees actually working in our facilities during the same period. Truly, the roots of our friendship and partnership grow very deep.

Like you, we see an urgent need to proceed with the development of this gift of nature. Indeed, we regard it as a matter of national survival. When the Congress of the United States created ERDA over a year ago, it directed us to develop a plan, or strategy of research and development that would hopefully relieve our dangerous dependence on unreliable sources of imported petroleum and assure our Nation of a plentiful supply of energy for our future generations.

We delivered such a plan to Congress last June 30th after giving much thought and analysis to our present situation and to the various options we saw open to us.

In the plan, we arrived at a number of key conclusions: First, it was clear that we as a Nation are overly dependent on petroleum and natural gas, a rapidly declining energy resource, and that we must shift as expeditiously as possible to alternate, more plentiful fuels--in our case, mainly coal and uranium, both of which we have in plentiful supply. It was clear to us also that we have to begin working now to develop the longer term energy technologies--fusion, the breeder and solar-electric--if we are to have them available a generation hence when we think we will need them.

Perhaps our most important conclusion, however, was the realization that no single energy technology, no single fuel resource, could meet our long-term requirements. We cannot satisfy our energy needs with just coal or just nuclear or just conservation or just solar or even a combination of just a few of them. We have computer simulations to prove that.

Thus, we must pursue all the technologies, for only a combination of all has a chance of satisfying our energy requirements. It is this theme that lies at the very heart of our plan.

The obvious derivative of this theme with regard to nuclear power is that we must move ahead aggressively with its development. As a matter of fact, we welcome such a conclusion because we regard nuclear as one of the most attractive and promising sources of energy. It is, after all, environmentally clean, economical, already in an advanced stage of development and plentiful--particularly with the prospect of the breeder coming along later. And it meshes beautifully with the rest of our energy plan. Let me explain:

In the United States, some 40 percent of our energy consumption goes to the industrial sector, whose primary energy requirement is "process heat"--heat used to melt, soften, cook or cure materials to be fabricated. We believe that at least for many years to come, we can best meet this process heat requirement through the direct combustion of coal, particularly through fluidized bed combustion. We also need our coal resources to supply our proposed synthetic fuel industry which we hope will be able to provide us with liquid and gaseous substitutes for petroleum and natural gas.

These two applications--process heat and synthetic fuel--together can consume several times the current capacity of our coal industry. And it is to these applications that we think our coal ought to go. Thus we are left with the need for another major energy source to supply increments in our electrical capacity, which we know we will need. Nuclear power is, of course, ideally suited to fill that need.

It therefore makes sense for us to make a firm commitment, as a matter of national policy, to the accelerated development of our nuclear power capability. We have done that, as only a cursory glance at our nuclear related budget clearly indicates. Let me quote a few figures:

In the Fiscal Year 1977 budget we just proposed to Congress, we have requested \$304.5 million for fusion power research and development, up from \$223.8 million a year ago. For fission power reactor development, we have asked for \$684.3 million, up more than \$160 million from \$521.7 million a year ago. Our nuclear fuel cycle funds request nearly tripled to \$147.1 million from \$59.1 million a year ago. The nuclear materials security and safeguards request nearly doubled to \$27.3 million from \$14.7 million a year ago, and our waste management request jumped 400 percent to \$62.8 million from just \$12.2 million a year earlier.

Overall, our proposed budget for nuclear development in the coming year is approximately $1.295 billion, up 42.4 percent from a year earlier. And it also represents 53.6 percent of our total proposed budget for direct energy research, development and demonstrations. I think those figures offer dramatic testimony to our commitment to the furtherance of nuclear power in the United States.

Our commitment, however, extends beyond our shores. We are equally committed to international cooperation in atomic energy, and to shouldering our responsibilities in providing necessary materials and assistance to our friends. Just about one month ago, U.S. Secretary of State Henry Kissinger testified before a committee of the Congress about our international intentions:

"Our policy of sharing the peaceful benefits of nuclear energy with others," he said, "has been the key factor in the development of an unprecedented network of international agreements, arrangements and institutions which have, to an encouraging degree, enabled us to avoid the unrestrained proliferation of nuclear weapons...

"In foreign policy terms, however, the benefits of U.S. nuclear cooperation, in which our enrichment supply capability has been a key ingredient, go beyond even the crucial issue of advancing our non-proliferation objectives... Out of the energy crisis has emerged an enhanced understanding of the benefits--in fact, the absolute necessity--of interdependence if we are to avoid the stultifying effects of dictated prices and insecurity of energy supplies on our economic health and our political well-being...Thus the United States is serving its own interests by creating a framework which will enable it to return to the international enrichment services market, offering such services abroad under comparable terms and conditions to those available to domestic customers." (Unquote)

I should add by way of explanation that this testimony was in connection with a legislative proposal to the Congress by President Ford to assure the United States' capability of supplying not only all of our domestic enrichment needs but also those of our customers abroad. We are confident that the Congress will respond favorably to this clear and urgent need.

At the same time, we recognize that many other equally urgent matters also call for our attention as well as the attention of other nuclear nations. There are those "barbs" or problems I mentioned earlier. In the United States, for example, we still--even after some 30 years of operation of an ultra-safe nuclear power industry--have a continuing problem of public acceptance of nuclear power. In a number of our states right now, notably California, small but vocal groups are agitating for moratoriums on the construction of nuclear plants or, in other cases, are simply expressing grave concerns about the safety of nuclear power or its effects on the environment.

This public concern is a problem, and we must deal with it. Since in many cases, the sources of concern are based on emotional fears or uninformed assertions, our initial response is simply the dissemination of the facts about nuclear power. This alone can clear up much of the misunderstanding. But our basic strategy is founded on a much more potent and inarguable stance--a steady and growing record of responsible action and performance.

Our performance can speak louder than even the strongest words of advocacy or protest. It will overwhelm even the loudest din.

Interestingly, in this regard, we have some critics from within our own nuclear industry who say that we in government have not responded adequately to nuclear critics, that we have not taken a sufficiently strong position of advocacy, that the split of the old AEC into our two organizations has eliminated a focal point for nuclear advocacy within the Federal government. We believe, on the other hand, that we have a far better approach than merely a verbal advocacy, convincing only to our friends. If the objective of advocacy is to influence, then our policy of quiet advocacy through responsible performance will surely win the day.

What do I mean by performance? It is the sum of many actions spanning the entire spectrum of nuclear activity. It consists in part of the past record of our commercial nuclear power industry--not a single fatality associated with the operation of a commercial nuclear power reactor in the entire 30 year history of the industry.

This is unprecedented in the history of American industry, or perhaps any industry in the world.

Performance also includes our equally unsullied record in the area of nuclear material safeguards and security. While the doomsayers warn darkly of thefts of nuclear materials by terrorists, criminals or other malevolent beings, the record shows that it has never happened in the history of the industry--not so much as an ounce.

The creation by Congress of ERDA and our sister organization, the Nuclear Regulatory Commission, also contributes to that sum of responsible performance. By separating the regulatory and developmental responsibilitie of our old Atomic Energy Commission, we said to our public, in effect, that now there is no conflict of interest, that each agency is now free to act responsibly in its separate assigned mission. At least with regard to such past potential conflict, we are now like Caesar's wife, above suspicion. That too is responsible performance.

Our responsible performance, however, does not consist merely of past deeds. In fact, we believe that the past, as always, is prologue.

The responsible future course, as we see it, is not to issue blanket denials of the critics' charges, but to address their concerns head-on and deal with them. We can, and should, demonstrate our capacity to solve what problems exist.

We know, for example, that people are worried about the disposal of high-level radioactive waste. But this is not an insurmountable problem. We have technology at hand--a number of different technological approaches in fact--which can adequately deal with this problem. In the very near future, ERDA expects to present to the Congress a firm program for the disposal of radioactive wastes. We will be demonstrating our capability for responsible action. And that will be only the start. In our proposed budget I mentioned earlier, we have requested $62.8 million for continued work on waste management, up 400 percent from the $12.2 expenditure of a year earlier. That too is responsible action.

We know that despite our perfect record in the area of nuclear materials safeguards and security, people still are worried about the threat of terrorists and others. We can build on that record too. Today---right now--we are constantly revising and upgrading our safeguard and security techniques and equipment. I believe that I can say with confidence that our current system employs the very latest security technology and that we will continue to introduce new technological advancements just as soon as they become available. I mentioned earlier that our expenditure in this area has virtually doubled in our new budget. This too is responsible action.

In mentioning these expenditures, however, I would not wish to imply that these monies represent the entire effort to address these problems. In the last 20 years or so,nuclear technology has become diffused among many nations of the world. And these nations are no longer neophytes in its applications and subtleties. Their technological capabilities have matured so that they,too,are now able to make significant contributions at the very forefront of nuclear technology.

The problems associated with nuclear technology, the barbs surrounding the fruit, are common to all nuclear nations. Thus we have a commonality of purpose which supersedes even competitive considerations. We all can benefit from finding the solutions to these problems, and we all have the capability and expertise to contribute to the solutions. In the United States, we are committed to the pursuit of this quest, to the solution of its associated problems, and to a policy of full cooperation with our nuclear partners around the world in finding those solutions. We believe that in working harmoniously with our partners, we may together achieve that much desired goal of harmony with nature.

Thank you.

3/10 14:30~
Session 1

未公表に付
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(3)

ENERGY STRATEGIES AND THE CASE OF NUCLEAR POWER*

by

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INTRODUCTION

In the second half of the sixties electricity generation by nuclear power stations became competitive with conventional power stations. An order boom followed. In Japan, the U.S., the F.R.G. and other countries this led to a commercially significant production of nuclear electricity. This commercial competitiveness was much in line with a more general wish to strive for technological innovation.

Yet the necessity to provide an energy production capability in view of the limited and vulnerable supply of cheap oil and gas was not necessarily the same thing. While this need was recognizable as an ever increasing problem already in the early sixties it became fully apparent to a wider public only in 1973. Today it is clearly this adequate supply of energy which establishes the scope for energy strategies. For the consideration of energy strategies it is fundamental to identify their time horizon; here it must be observed that there appear to be three time phases of the energy problem (Figure 1).

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*Invited paper, Ninth Annual Conference of the Japan Atomic Industrial Forum, Tokyo, March 10-12, 1976.

TIME PERIOD	CHARACTERISTICS	OPTIONS
1960 – 1973 (YESTERDAY)	– CHEAP OIL, GAS – LOW CAPITAL COSTS – WIDE TRANSPORTATION OF OIL	– OIL, GAS – (OLD) COAL
1973 – 1990? (TODAY)	– EXPENSIVE FUEL – ENERGY CONSERVATION	– OIL, GAS – NUCLEAR ELECTRICITY – ENHANCED (OLD) COAL
1990 – ? (TOMORROW)	– CHEAP FUEL – SIGNIFICANT CAPITAL COSTS – TRANSPORTATION AND STORAGE OF SECONDARY ENERGY	– NUCLEAR – (NEW) COAL – (SOLAR?)

Figure 1. Three Time Phases for Energy

Since the early sixties we have been in the phase of cheap and at the same time versatile fossil fuels. Remarkably enough, these cheap fossil fuels also allowed for low capital costs. Advancements in tanker ship technology as well as the installation of oil pipelines made world wide transportation of cheap oil possible without adding significantly to the fuel costs. In the industrialized countries this led to cheap energy and in turn to an energy intensive economic infrastructure that freed capital and labor for additional and expensive purposes: we all experienced high economic growth rates, the most striking example being Japan.

Now fossil fuels have become expensive, one reason being the physical limitation of a miracle of nature: the oil sources of the Middle East. The other reason is the worldwide political confrontation of the developing countries with the industrialized world. Any technological strategy to meet these challenges takes time, however. The second phase of the energy problem is therefore characterized by expensive fuel and the necessity of energy conservation. Traditional coal production will be enhanced and nuclear electricity will be given the largest possible share as these technologies are available today. If the industrialized nations are encouraged enough to prepare and launch long range technological programs this will have to be done in the second phase.

In the medium and long range future there are several options for a practically unlimited supply of energy: the fast breeder, solar power, coal within certain limits, possibly fusion and also geothermal energy. They all are capital intensive. One of these options, or more probably a combination thereof, will characterize the third time phase. In view of the then fundamentally and radically different natures of primary and secondary energy energy storage will become an integral part of modern energy systems, probably in line with the related energy transportation. The fundamental constraint for related energy strategies will probably be the availability of capital.

GROWTH OF NUCLEAR POWER

Latest figures for electricity generating costs are given in Table 1. Referring to the F.R.G. in January 1976, they are typical of the beginning of the second phase of the energy

Table 1. Electricity Production, Cost Components in U.S.mills*/ kWh for New Plants (Load Factor 7000 h/a)

	LIGNITE	HARDCOAL	OIL/GAS	NUCLEAR (LWR)
FUEL INCLUDING FUEL CYCLE	6.8	23.2	19.2	7.2
OPERATION AND MAINTENANCE	2	2.8	1.2	2.4
CAPITAL COST	9.6	6.4	6.4	14.4
TOTAL	18.4	32.4	26.8	24.0

SOURCE: DATA PUBLISHED BY GERMAN UTILITY (RWE) JANUARY 1976

* 1$ ∧ 2.5DM

problem. Electricity from lignite is unbeatable but nuclear electricity is close. The capital cost component is shown to be high and the fuel costs are low inspite of the fuel cycle services that have lately become so expensive. At the same time one may note the high fuel costs of coal as well as its capital costs which reflect environmental abatement measures.

Table 2 shows figures of a recent OECD nuclear power growth estimate [1]. Accordingly, in the early nineties Japan can expect roughly 100GW(e) of nuclear power and the U.S. 500GW(e), while a low OECD total would be at 1TW(e). For comparison one should remember that the world total of electric power today is only at roughly 2TW(e). This, therefore, indeed reflects a worldwide expected technological development.

Table 2. OECD Nuclear Power Growth Estimate [GW(e)]

	1976	1980	1990	2000
JAPAN	9	17	84	157
F.R.G.	7	19	77	134
U.S.	48	82	385	1000
OECD (HIGH)	87	183	889	2089
OECD (LOW)	86	171	773	1685
WORLD (HIGH)	88	192	1003	2489
WORLD (LOW)	87	179	874	2005

SOURCE: R.E. CRAWFORD, W. HÄUSSERMANN
OECD/NEA, NOVEMBER 1975.

Table 3. OECD Nuclear Fuel Cycle Estimates
(Low Estimate, without Pu Recycling)

	1976	1980	1990	2000
POWER CAPACITY [GWe]	86	171	773	1685
ORE REQUIREMENT ANNUAL	19	45	124	202
[10^3 t U] CUMULATIVE	36	171	1023	2748
SEPARATIVE WORK ANNUAL [10^6 S.W.U]	12	27	85	148
LWR FUEL FABRICATION [10^3t H.M.] ANNUAL	2.6	5.9	20	35
LWR FUEL REPROCESSING [10^3t H.M.] ANNUAL	1.2	3.3	14	31
CUMULATIVE	2.1	10.7	102.3	377.3
FISSILE PU AVAILABILITY [t Pu] ANNUAL	8	18	84	190
CUMULATIVE	14	79	614	2374

SOURCE: R.E. CRAWFORD, W.HÄUSSERMANN
OECD/NEA, NOVEMBER 1975

The nuclear community is only gradually learning to envisage not only the nuclear power stations but also the related fuel cycle and in particular its hot tail end. Table 3 gives data from OECD nuclear fuel cycle estimates that are consistent with the low OECD estimate of Table 2 and with the case of no Pu recycle. Cumulated LWR fuel reprocessing requirements build up from about 2 000t in 1976 to about 300 000t in the late nineties. A comparison with the figures for fresh uranium demand indicates a time delay of about 15 years, the time to build a nuclear power station, to burn up the first core and to wait for reprocessing. This time delay to some extent explains why the nuclear community only now comes to fully envisage the problems of the hot tail of the fuel cycle. What the nuclear community has to envisage too is the fact that it is these amounts of irradiated fuel which frighten a scientific and more general public. Such concerns are further highlighted by the amounts of plutonium so available. Table 2 indicates an OECD cumulative total of 1 000t of fissile plutonium to be available in the mid-nineties. Fears are so extreme that reasonable people maintain that plutonium makes the difference between good and evil.

TIGHTNESS OF A LARGE COMMERCIAL FUEL CYCLE

The most pressing problems of the hot end of the fuel cycle are with the reprocessing facilities. Here we leave aside the chemical engineering problems of radiation damages to the TBP leading to DBP and MBP as well as similar problems. Significant as they are, they can be solved if chemical engineering tests and related developments are pursued at a large enough scale. It should be realized that this requires adequate amounts of highly irradiated LWR fuel elements and that these have been available only since recently. What is necessary is to have and operate a few prototype facilities to develop and test dissolving and processing engineering schemes that deal with technologically significant amounts of highly irradiated LWR fuel elements, perhaps above 30 000 MWd/t. One should recall that there were--and still are--several such facilities that tested the dissolution and processing of fuel elements with low and medium burnups of up to 12 000 MWd/t (e.g. Hanford, NFS, Winfrith, La Hague, Mol). The above quoted chemical engineering problems turned up unexpectedly when burnups higher than 12 000 MWd/t and up to 35 000 MWd/t had to be reprocessed. Such a few reprocessing facilities for the development and testing of modern chemical engineering schemes would assume a function that relates to Dresden, Yankee and Indianpoint in the development of LWR's in the U.S., and Gundremmingen and Obrigheim in the LWR development in the F.R.G. To some extent the WAK facility of Karlsruhe fulfills this function in the F.R.G. and the PNC* fuel reprocessing plant in Tokai Mura is expected to play that role in Japan.

As mentioned above, the line of reasoning of this paper assumes that this problem can be taken care of. But there are still others. On the technological side there are problems of tightness: What retention factors have to be installed under normal operating conditions? What is the required tightness in design basis accidents for such forthcoming reprocessing facilities?

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*Power Reactor and Nuclear Fuel Developing Corporation

Let us look at a few figures. The ~~enrichment~~ reprocessing plant of Mol (Belgium) was permitted to release $4 \cdot 10^{-8}$ Ci/sec of Pu or 1.2 Ci/year [2]. The fuel throughput was at 100 t/year. In case of the WAK of Karlsruhe only a few mCi/year were released but the throughput was smaller than that of Mol by at least one order of magnitude. At Hanford (U.K.) a total of 5.3mCi of α-emitters were released in 1972 together with the effluents of the "200 areas" where the reprocessing and waste treatment facilities were located [3].

The important point here is the fact that such releases are streams of α-emitters per time. If the streams become limited by regulation one has to anticipate a possibly small but steady buildup of α-emitters in the environment. In view of their very long half life this can, in principle, become a significant buildup. This raises two questions:

a) What are the pathways for the various isotopes in a given environment and are there accumulating mechanisms?

b) What are the reference time periods for the continuous buildup of radioisotopes in the environment when regulations for the facility effluents of α-emitters are conceived?

The first question is of a strictly technological nature. Much work needs to be done in this area. But it can be done; cumbersome as it might be, it is an ultimately straightforward task. This is not so with the second question. Is a time period of fifty years sufficient or will only a hundred years do? What happens after such a reference time period if nuclear power then is still a necessity? Needless to say that this question not only refers to α-emitters. A perhaps even more striking case is that of I^{129} having a half life of 17 million years. Iodine does enter the biosphere. Estimates show that within a 10km radius around a 1500t/year reprocessing plant a relative I^{129} buildup of $1.6 \cdot 10^{-4}$ per year takes place [4], assuming a retention factor of 10^3 which is consistent with today's technology. König believes that not more than a fraction of $1.6 \cdot 10^{-3}$ of I^{129} should be in the thyroid [5]. Arithmetically this would lead to a permissible time period of only 10 years, assuming, however, that a given individual lives in the neighborhood of the reprocessing plant throughout that period.

It is hard to give a conclusive and straightforward answer to such questions. Let us therefore put the question of permissible effluents of α-emitters differently: What retention factors are technologically feasible? To this end it is important to reflect on the transuranium activitiy of spent LWR fuel one to three years after shutdown. Table 4 gives values for such activities per 10^3t of spent LWR fuel. Practical experience at Oak Ridge [6] has shown that air waste streams contain about 10mg of aerosols per m^3 of air. Such aerosols also come from chemical dissolution processes of the spent fuel. Assuming air ventilations of 10^3 m^3 per 10t of dissolving fuel one gets an inherent, anyway existing, retention factor of 10^{-5} to 10^{-6} for the actinides involved. It is then possible to apply absolute filters or combinations thereof. Additional retention factors of 10^4 to 10^5 are then technologically feasible. To maintain such filter factors for all conditions of the day by day operation of a reprocessing facility requires not

Table 4. Transuranium Activity of 10^3t of Spent LWR Fuel* (H.M.) (1-3 Years after Shutdown, in Curies).

Pu238	$8.2 \cdot 10^6$
239	$3.3 \cdot 10^5$
240	$3.3 \cdot 10^5$
241	$1 \cdot 10^8$
Am241	$5 \cdot 10^5$
243	$2 \cdot 10^4$
Cm242	$2 \div 30 \cdot 10^5$
244	$3 \cdot 10^5$
αACTIVITIES t 1/2 > 1a	$1.3 \cdot 10^7$

*WITHOUT Pu RECYCLING
SOURCE: SYSTEC, DÜSSELDORF, 1975

only absolute filters as such but also a mode of operation where all other maintenance and repair steps are consistent with the high filter factors. This might be more cumbersome than expensive; yet it can be done. We therefore arrive at overall retention factors in the order of 10^{-10} which today must be considered as technologically feasible. What does such a retention factor imply? As shown above, something like 300 000t of spent LWR fuel is expected to have passed reprocessing in the late nineties. Per 10^3t of such fuel we get about $3.3 \cdot 10^5$ Curies of Pu^{239} according to Table 4. The total is therefore 10^8 Curie. Applying a retention factor of 10^{-10} we get 10^{-2} Curie of Pu^{239} or the equivalent of a fraction of one gram. This is obviously acceptable in view of the fact that it represents the OECD total. For comparison one should recall that all the weapon tests of the fifties and sixties released a total of 5 to 10t of Pu to the global atmosphere. This result requires an interpretation:

a) We are dealing with orders of magnitude considerations and not with exact figures.

b) Not only Pu^{239} and reprocessing facilities must be taken into account. All fuel cycle facilities must be considered.

c) By the year 2015 or so the total of reprocessed LWR fuel is expected to be higher by a factor of 10 or so. Accordingly, a fraction of 10g of Pu would be released.

d) We have studied the technological feasibility of retention factors of 10^{-10}. To be consistent with such a high retention factor under all practical operating conditions requires indeed a very high degree of meticulousness.

Let us come back to the consideration of the reference time periods. The above given orders of magnitude clearly show that we are on the safe side if retention factors of 10^{-10} are installed. In this case one buys time, learning can take place, experience can accumulate. Let us now consider the fuel cycle as a whole. At the International Institute for Applied Systems Analysis R.Avenhaus, W.Häfele and P.McGrath considered the large scale deployment of a nuclear fuel cycle for 3600GW(th) [4]. The scenario considered fast breeders and high temperature reactors only. If we are interested in order of magnitude considerations only this is equally significant for 3600GW(th) of LWR. One may relate this to 1TW(e) of LWR capacity, which fits nicely with the OECD LWR estimates for the mid-nineties as mentioned. The intent of the IIASA study was a broader one. We wanted to understand:

a) the order of magnitude of the total impact of deploying such a fuel cycle;

b) the priorities in which attention must be given to the various parts of the fuel cycle;

c) the kinds of regulatory decisions involved.

Basically we considered expectation values for dose rates. By expectation values we imply their mathematical meaning: Linear average of high and low values and over time. Figure 2 explains the procedure. Two types of dose rates were considered: the dose rate for an individual in $\left[\frac{\text{mrem}}{\text{year}}\right]$ and the dose rate for a

NORMAL OPERATIONAL LOSSES

DOSE RATES=(EMISSION)·(METEOROLOGY/POPULATION)·BIOLOGY

$$\underset{\left[\frac{\text{mrem}}{\text{year}}\right]}{B} = \underset{\left[\frac{\text{Ci}}{\text{sec}}\right]}{Q} \cdot \underset{\left[\frac{\text{sec}}{\text{m}^3}\right]}{s} \cdot \underset{\left[\frac{\text{mrem/year}}{\text{Ci/m}^3}\right]}{g}$$

$$\underset{\left[\frac{\text{manrem}}{\text{year}}\right]}{BM} = \underset{\left[\frac{\text{Ci}}{\text{sec}}\right]}{Q} \cdot \int dF \cdot s(r) \cdot f(r) \cdot g \cdot 10^{-3}$$

$$\left[\text{km}^2\right] \cdot \left[\frac{\text{sec}}{\text{m}^3}\right] \left[\frac{\text{man}}{\text{km}^2}\right] \qquad \left[\frac{\text{rem/year}}{\text{Ci/m}^3}\right]$$

ACCIDENTAL LOSSES, SUBSTITUTION

$$Q \longrightarrow \underset{\left[\frac{1}{\text{sec}}\right]}{P} \cdot \frac{d}{3.15 \cdot 10^7} \cdot \underset{[\text{Ci}]}{C}$$

C: CURIES RELEASED AT ONCE

d: EXPOSURE TIME (sec)

Figure 2. Dose Rates.

population in $\left[\frac{\text{manrem}}{\text{year}}\right]$. Such dose rates are obtained by multiplying the emission in question by a typical meteorology factor and ICRP values for the biological/health impact. In view of the broad purposes of the study we kept a high level of aggregation or simplification; the idea was to get an overview. Table 5 then gives results for typical normal operating losses for 3600GW(th). Consistently with the above observations on the rigorous meaning of expectation values we evaluated the ratios of these dose rates to the anyway existing natural radiation dose rates. Only values larger than 10^{-3} are shown in Table 5. The results indicate that Kr85 releases from reprocessing facilities are not acceptable. Retention factors of 10^{3} or so must be enforced. All other relative dose rates are very small. This very reassuring observation, however, rests on the choice of the other retention factors indicated in the Table. For Pu we had assumed 10^{8} in the study. As we have seen values of 10^{10} can be considered feasible. The relative burdens then go down to values of 10^{-4} and less; and this illustrates--not in terms of reference time periods but in terms of relative dose rates--the degree of precaution such a choice of retention factors does imply. It translates into reference time periods accordingly.

The IIASA study also considers accidental situations. Thus we substituted the emissions of the normal operating case by the product of a probability per second and the anticipated release of radioactivity. But here a normative approach was chosen. We fixed the dose rates and in a backward fashion calculated the so implied accident probabilities. These probabilities

Table 5. Typical Normal Operating Losses for 3600GW(th) (Larger than 10^{-3} only).

	REACTOR			REPROCESSING AND INTERMEDIATE WASTE STORAGE				FABRICATION PLANT	WASTE SOLIDIFICATION
	KR85 AIR	XE135 AIR	H3 WATER	KR85 AIR	H3 WATER	Pu WATER	ACTINIDES AIR	Pu AIR	Cs137 AIR
$\frac{B}{B_o}$ 1)	$5.3\cdot10^{-3}$	$2.9\cdot10^{-3}$	$1.4\cdot10^{-3}$	0.31	$2.5\cdot10^{-3}$	$2.1\cdot10^{-3}$	$1.5\cdot10^{-3}$	10^{-2}	$2.4\cdot10^{-2}$
$\frac{BM}{BM_o}$ 2)	$5.3\cdot10^{-3}$ a)			0.24 b)					
RF RETENTION FACTOR	3)	3)	3)	1	10^2	10^7	10^8	10^8	10^5

1) $B_o = 110 \frac{mrem}{year}$,

2) $BM_o = 4\cdot10^7 \frac{manrem}{year}$, POPULATION/METEOROLOGY FACTOR $= \begin{cases} (a) & 2.7\cdot10^{-3} \\ (b) & 2.8\cdot10^{-4} \end{cases} \left[\frac{mansec}{m^3}\right]$

3) CONSISTENT WITH TODAY'S TECHNOLOGY

then serve as target values for reliabilities, i.e. we have a normative approach. The actual design basis accident probabilities of a given facility must then be smaller than this target. Reliability control studies like those by Rasmussen and his team for the LWR case must sufficiently assure that this is so. Our IIASA study considers not only accidents of facilities but also the case of physical protection and the adverse spreading of plutonium. Table 6 shows some of the results of that study. It must be realized that small values of normative accident probabilities reflect a precarious situation, while large values indicate an inherent permissiveness of the technological situation in question. It is surprising to learn from Table 6 that reprocessing, plutonium contamination and the explosion of a crude device whose plutonium was obtained by inadequate physical protection, are of less concern than intermediate waste storage, the case of a Pu fuel fabrication plant and the case of final waste disposal. It is obviously unavoidable to make certain assumptions in all these rather straightforward calculations.

A special case is final waste disposal, where the underlying assumptions influence heavily the resulting ordering of concerns. Figure 3 illustrates the scenario we had assumed: Waste is stored in glass cylinders of 20cm diameter where a break-in of groundwater occurs because of unforeseen geological events. Fraction F_1 of the total glass cylinder surfaces is exposed to the water. We further assumed ad hoc that the groundwater circulates in a closed loop. The soil filters the water, resulting in a filter factor F_2. We further assumed that people

Table 6. Normative Accidental Losses for 3600GW(th)

$$\left(\text{FOR} \quad \frac{B}{B_o} = \frac{25}{8}\right) \quad 1)$$

	REPRO-CESSING	INTERMEDIATE WASTE STORAGE	FABRICATION PLANT	FINAL WASTE STORAGE	CONTAMINA-TION	CRUDE EXPLOSIVE DEVICE
$\frac{BM}{BM_o}$ 2)	$7.2 \cdot 10^{-5}$	$3 \cdot 10^{-3}$	$2.5 \cdot 10^{-5}$	0.15	$3.2 \cdot 10^{-4}$	0.02
$P_D^o \left[\frac{1}{yr}\right]$	0.4	$5 \cdot 10^{-3}$	$P_D^o \cdot X = 1.4 \cdot 10^{-3}$ 3)	$P_D^o \cdot F_1 \cdot F_2 = 4.2 \cdot 10^{-6}$ 4)	$P_D^o X = 14$ 3)	0.05

1) $B_o = 110 \left[\frac{mrem}{year}\right]$

2) $BM_o = 4 \cdot 10^7 \left[\frac{manrem}{year}\right]$ POPULATION/METEOROLOGY FACTOR: $2.8 \cdot 10^{-4} \left[\frac{mansec}{m^3}\right]$

3) AMOUNT OF X [g] Pu RELEASED

4) F_1 : PERCENTAGE OF WASTE CYLINDERS EXPOSED TO WATER
F_2 : SOIL FILTRATION FACTOR

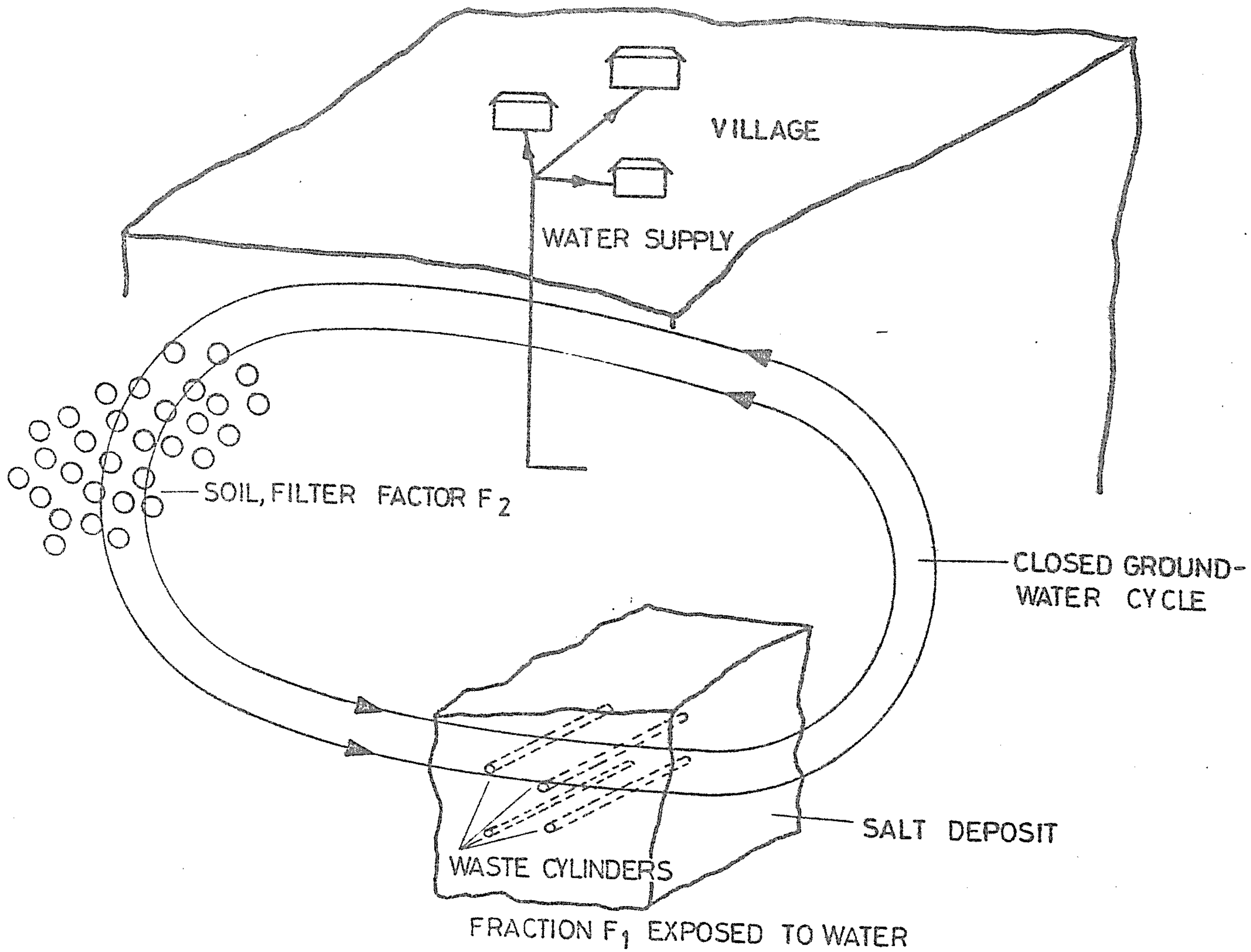


Figure 3. A Waste Disposal Accident Scenario

would have to use the groundwater for drinking for ten years, the period needed for appropriate measures to stop the ground water circulation. Given this scenario the resulting normative accident probability follows in Table 6. This normative accident probability means that the site of final waste disposal be selected in such a way as to have geological probability for the water break-in that is smaller than the normative accident probability. For each considered final waste disposal site the accident scenario will probably be different and has to be properly assessed. More generally, the resulting normative accident probabilities should not be smaller than approximately 10^{-4} per year. Smaller values would be required if the waste inventory together with leach rates and other technical parameters would be so high that they in turn imply these low accident probabilities. Instead, waste inventory and technical parameters should be such that the resulting normative accident probability is one in 10 000 years or so: in this case geologists can probably make assessments; 10 000 years are a short time period in geological terms. This reasoning is not meant to lead to this or that geological assumption or this or that choice of an accident scenario. Experts will do this job. The point is rather to show that a design basis accident scenario must be anticipated and that resulting normative accident probabilities must be derived from permissible dose rates. Thereby upper bounds for required reliabilities are introduced and one cuts the otherwise prevailing openendedness of debates on final waste disposal problems. In other words: Once the specifications are given engineers can do their job of designing and constructing final waste disposal facilities. The problem is not engineering, it is rather to identify such specifications. And this in turn is a soft problem of regulations.

A SET OF REGULATORY DECISIONS

Regulatory decisions for a rational deployment of large scale nuclear power can be logically organized and Figure 4 shows the structure reflecting the organization.

A first decision is whether one wants to establish limits or cost benefit ratios. The famous $5\frac{\text{mrem}}{\text{year}}$ for LWR are an example for a predetermined limit and in each particular case the actual dose rate must be below that limit. The alternative is a cost benefit ratio. Recently the U.S.Environmental Protection Agency established such a ratio by stating that for each GW(e) year a release of 0.5m Ci of Pu^{239} should be tolerated. One GW(e) year relates to roughly 200kg of Pu and thereby $\approx 10^4$ Curie of Pu^{239}. 0.5m Ci/GW(e) therefore implies a retention factor of 10^8. If accounting for other α-activities one becomes consistent with the retention factor 10^{10} that was elaborated earlier in this paper. Another cost benefit ratio is the value of e.g. 1000$/ manrem. It implicitly relates to a value of life. If 1000 rem are considered a lethal dose the value of a life is rated to be at 1 million $. J.Linnerooth of IIASA recently made a survey of mathematical techniques in conjunction with such assessments of the value of a human life [7].

If one opts for limits the next decision to be made is whether one wants to control effluents or ambient dose rates.

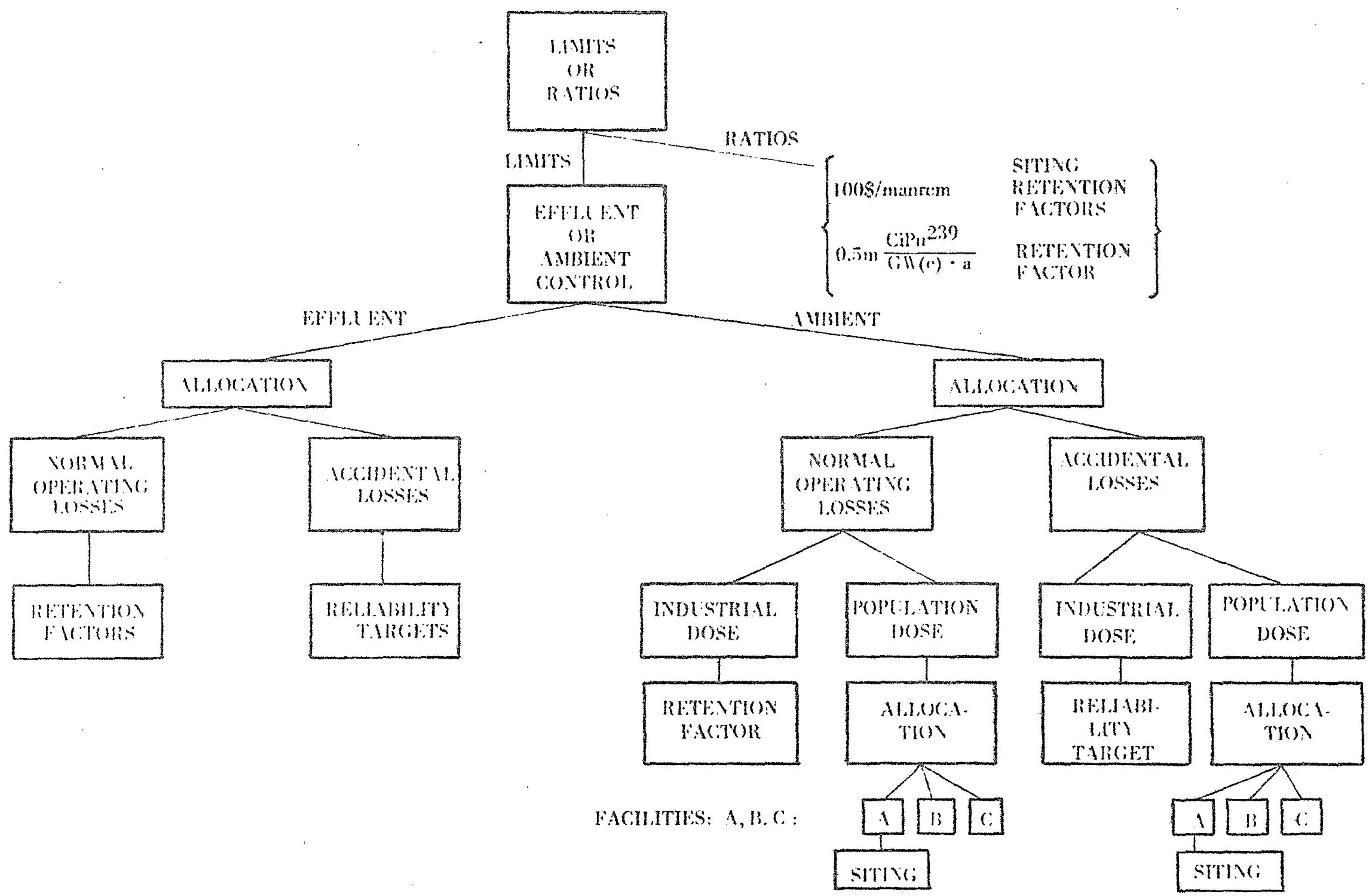


Figure 4: Sequence of Decisions for Large Scale Nuclear Power

The difference is in pathways and meteorology. Ambient dose rates account for this while a control of effluents is easier to assess on the one hand. On the other hand it implies that effluents should be limited even if ambient dose rates permitted possibly higher values because diffusion and accumulation mechanisms are not fully known or because any release into the environment is considered detrimental.

In both branches allocations must be made between normal operating dose rates and dose rates due to accidents. If there is an upper limit one must reflect on a certain reserve for accidental situations and not all of the allowance can be used up for the normal operating conditions. This too must be viewed as a normative decision.

In case one has opted for effluent control one can straightforwardly calculate the required retention factors and the normative accident probabilities which in turn then establish a target for plant reliability.

In case of ambient dose rate control one has to identify a dose rate for the individual and a dose rate for the population, as explained earlier. It might be considered to be of relevance whether a dose rate, permitted for an individual, is applied to a major share of a population or not. For instance, genetic considerations could induce this. The individual dose rate would again lead to retention factors and reliability targets. Population dose rates would require an allocation to the various facilities of the fuel cycle and criteria for siting these facilities could be derived. One should realize that only regulations on population dose rates would lead to such siting criteria while individual dose rates would not.

Today only individual dose rate limits for the case of the normal nuclear reactor operation are fully established. What is particularly needed is the establishment of dose rate limits for accidental situations. The political and psychological difficulties for doing so are more than obvious. But the observation shall be made here that it is this lack of regulatory decisions which, in my judgement, is the greatest obstacle to mastering the problems of a large scale deployment of nuclear power. It is the software that is missing. The hardware, that is engineering, is not the problem. If the software of establishing the regulations is not done the situation of nuclear power is openended and this very openendedness endangers the deployment of nuclear power.

This situation is summarized in Figure 5. One may call this scheme: How to deal with the unknown? Traditionally engineers

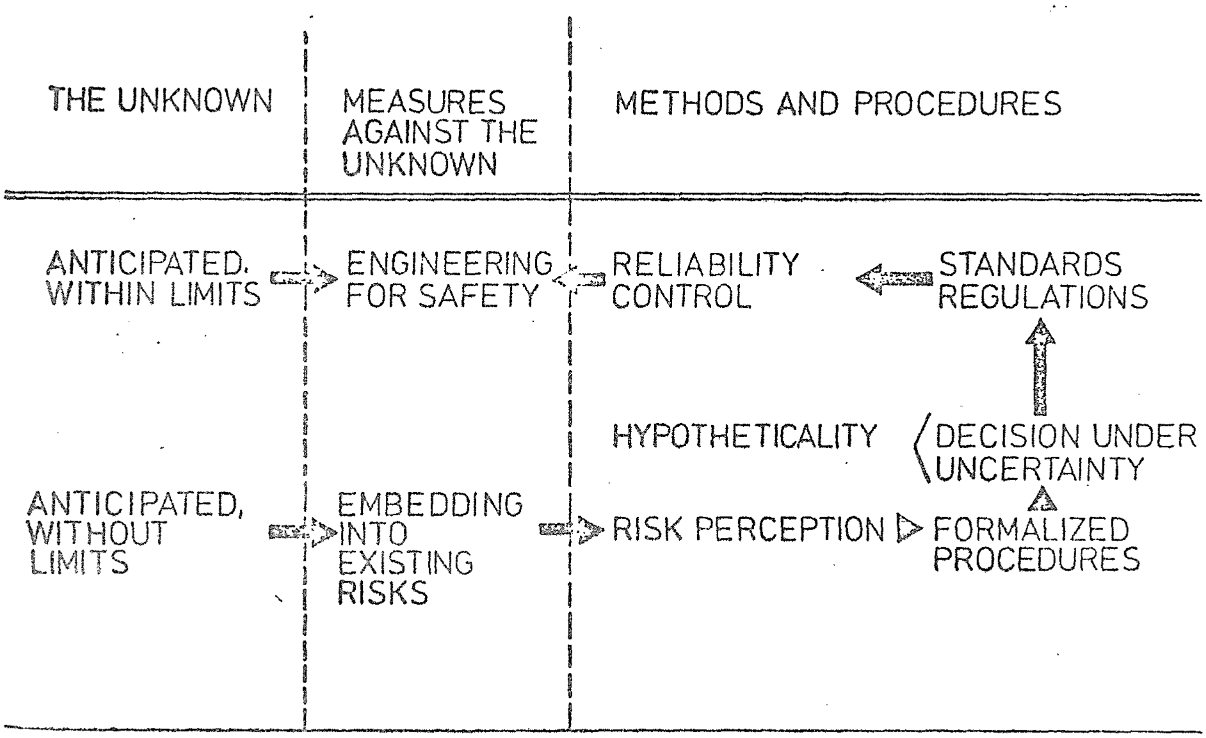


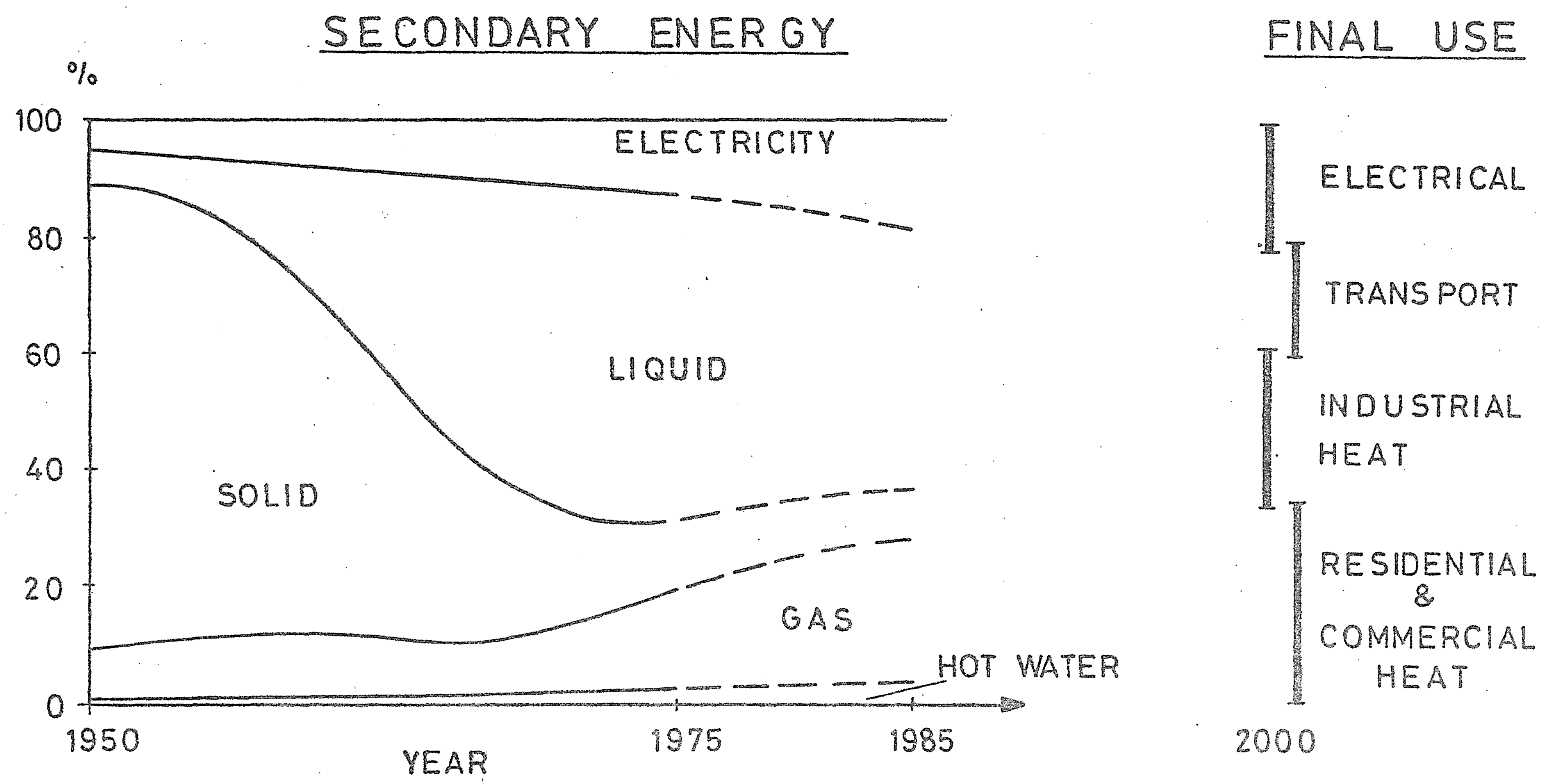
Figure 5. How to Deal with the Unknown?

anticipated certain accidental events. By necessity such anticipation had to be done within limits as it is then possible to take engineering measures against the so anticipated unknown. In view of the large scale consequences typical of many of the new technologies it is now felt that the whole spectrum of accidental situations must be anticipated, which means anticipation of the unknown without limits and this leads to the question of C.Starr: "How safe is safe enough?". By necessity residual risks occur as any engineering measure is limited by its very nature while the anticipation of the unknown is without limits. Such residual risks must then be embedded into the natural and manmade anyway existing risks. This requires an understanding of these risks as well as the understanding of the perception of these risks by individuals and society. The joint IAEA/IIASA group is trying to do this [8]. Against that background it is then necessary to establish regulations and standards providing targets for reliability control that proves that a given design meets these targets. The LWR Rasmussen study is the most prominent example of that part of the chain of reasoning. Again one arrives at engineering measures for safety. But they must now be seen in conjunction with the embedding of residual risks.

NUCLEAR POWER BEYOND ELECTRICITY GENERATION

Up to now nuclear power has almost exclusively been concentrating on the generation of electricity. It is a well known fact that only about 25% of the primary energy demand are for such electrical purposes. In terms of demand for secondary energy it is only 10%. Figure 6 shows expected trends for forms

Figure 6: Partitioning and Final Use of Secondary Energy (FRG)



of secondary energy. The share for electricity will rise up to 20% or so but not much beyond. There is also a trend for gaseous secondary energy carriers to increase their share while the shares for solids in particular and for liquids to some extent will decline. One must realize, therefore, that large scale nuclear power should generate not only electricity but also a gaseous secondary energy carrier. The most prominent candidate is hydrogen. To a lesser extent also ammonia may be considered. Gasification of coal also has to be envisaged. It is not the point of this paper to elaborate on this in greater detail. Instead, reference is made to an earlier paper of the author [9] and more so to the work of C. Marchetti [10]. The foreseeable future of nuclear energy will be characterized by the LWR; yet one should realize that there are natural ways of combining a near term LWR generation with fast breeders and high temperature reactors to allow for the production of electricity and a gaseous secondary energy carrier. Figure 7 explains this reactor combination. The Pu production of LWR is used for first core inventories of fast breeders. The breeding gain of such breeders could be in terms of U233 for instance by providing a radial blanket of thorium elements. The U233 produced would then be used to comply with the net requirements of a THTR. In this scheme LWR and breeders are expected to generate electricity, while the THTR is expected to generate the gaseous secondary energy carrier. One should realize that for an energy demand that only evolves slowly the FBR/THTR combination can operate independently once the first core inventories are provided for. This combination would operate on the breeding principle, thereby essentially de-

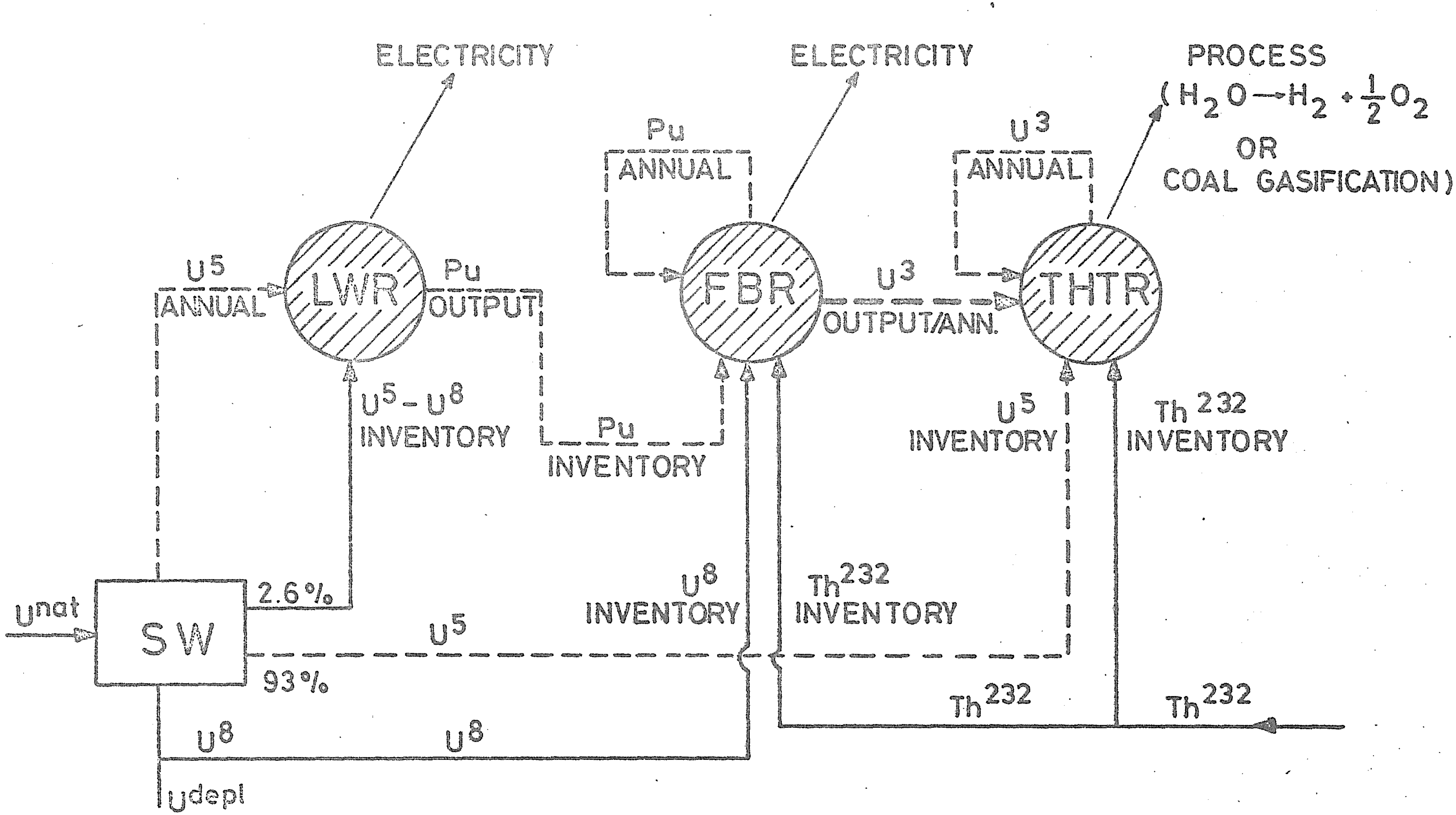


Figure 7. Transient Reactor System

coupling this power generation system from the problem of resources. At IIASA the transition into an all nuclear energy supply scenario was studied by W. Häfele and A.S.Manne [11]. A. Suzuki extended these studies considerably and enriched their results by disaggregating energy demand and by also considering solar power and coal power [12].

THE CASE OF PLUTONIUM AND ENERGY PARKS

It is not only the problem of radiation dose rates that matters. Earlier in this paper we elaborated on such considerations in greater detail. It is therefore important to extend the scope of considerations of the deployment of large scale nuclear power and to envisage the problem of physical protection. One has to realize that there are four classes of required physical protection as outlined in Figure 8. The least problematic class is that of irradiated fuel elements. They are essentially selfdefending by their own strong radiation. Besides, they are heavy equipment and not easy to divert. The timing of their appearance can be seen in Table 3 (LWR reprocessing). As explained earlier there is a time lag of about 15 years if compared with the appearance of fresh nuclear material. Such fresh material forms the second class of required physical protection if its enrichment is less than for instance 5%. Such material is not selfdefending, it is already in use in significant quantities but would require further enrichment for explosive purposes. A third class consists of Pu and U233. It appears after reprocessing, is not really selfdefending and requires no additional enrichment for explosive

CLASSES	CHARACTERISTICS	TIMING	REQUIRED PROTECTION
IRRADIATED MATERIAL	SELF DEFENDING	TO COME	VERY SMALL
MATERIAL ENRICH. < 5%	NOT SELF DEFENDING ENRICH.REQUIRED	IN USE	SMALL
Pu, U^{233}	NOT SELF DEFENDING NO ENRICH.REQUIRED	TO COME AFTER REPRO-CESSING	SIGNIFICANT
MATERIAL ENRICH. > 20%	READY MATERIAL	NO LARGE AMOUNTS SO FAR HTGR ?	HIGH

Figure 8. Four Classes of Required Physical Protection.

purposes. Clearly enough, a fourth class is made up by highly enriched uranium. Besides chemical conversion it is readily usable for explosive purposes. Such classification is helpful in conceiving a decision tree for the deployment of a large nuclear fuel cycle. This decision tree is given in Figure 9.

Obviously the first decision is whether to use nuclear power or not. If not, it is necessary to identify alternatives thereby trying to understand the implications of such a decision. If yes, the next decision is whether to go into chemical reprocessing or not. If not, strategies for intermediate waste storage and appropriate final waste disposal have to be identified. One should realize that this implies some kind of chemical processing anyway. If yes, the next decision is whether to go into plutonium utilization or not. If not, plutonium storage is required. If yes, the next decision is whether to avoid transport of open plutonium or not. If not, one fully faces the problems of physical protection for class three as well as related environmental concerns. If yes, one is led to the scheme of collocating the fuel cycle facilities for reprocessing, scrap recovery and plutonium fuel fabrication. The AGNES facilities in South Carolina follow that scheme, the same is intended for the F.R.G. The next decision is whether also to eliminate the transport of freshly fabricated plutonium bearing full elements. If not, physical protection problems of class three in the milder form for strongly encapsuled plutonium have to be faced. If yes, one is led into the scheme of having both the fuel cycle facilities and the reactors that use fresh plutonium bearing fuel elements

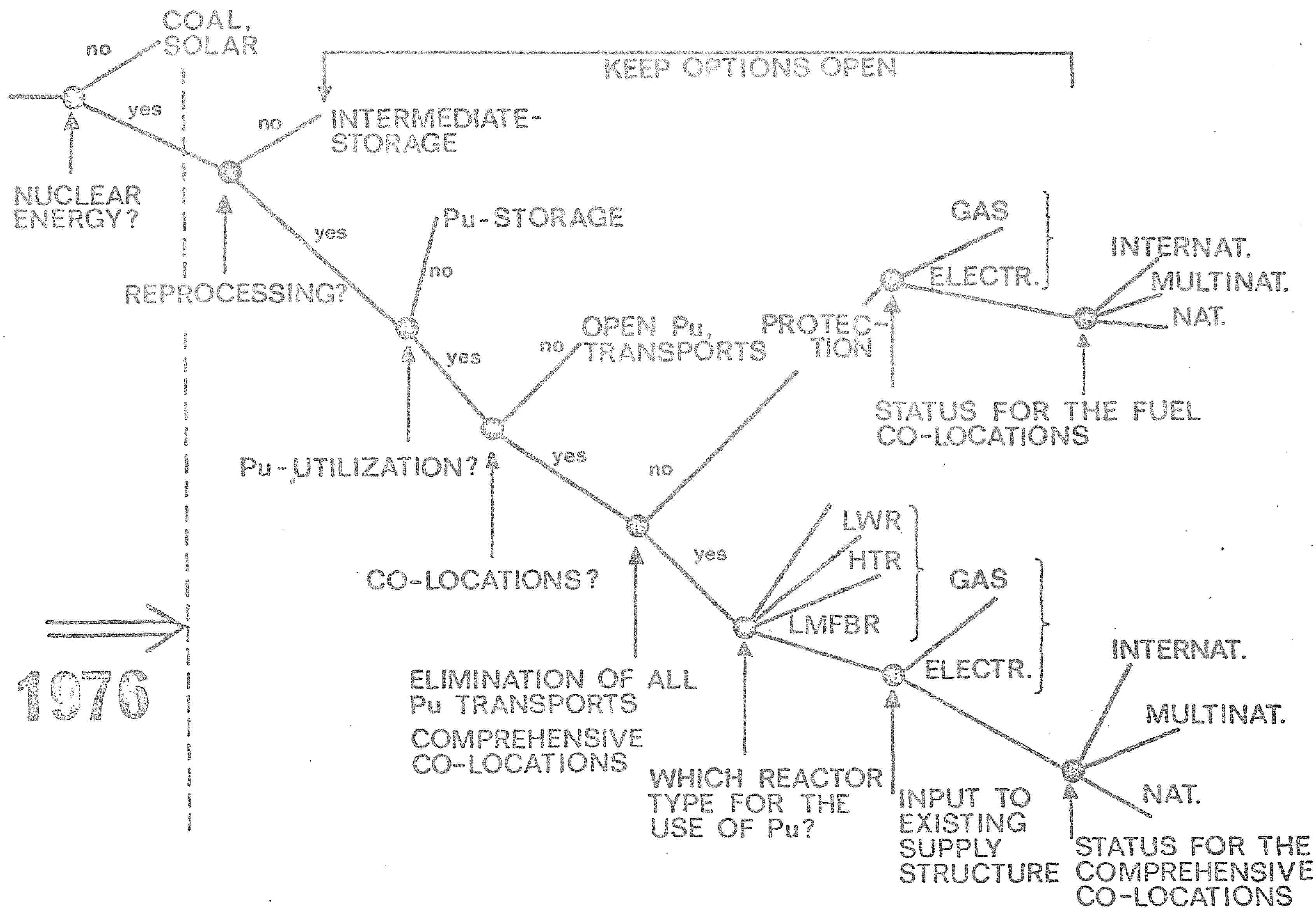


Figure 9. Decision Tree for the Deployment of Peaceful Nuclear Energy

on the same site.One must obviously decide on the appropriate reactor type. In view of the reasoning of the last chapter one may decide to have these collocated reactors produce a gaseous secondary energy carrier. The incentive for doing so is the easiness of long distance energy transportation in the GW domain. Comprehensive collocations really mean a strong centralization. As indicated in Table 3 about 2 300t of fissile plutonium isotopes are available by the year 2000 and within the OECD. For quick orientation let us assume that these plutonium amounts would be used as first core inventories in fast breeders much along the lines of Figure 7. One can expect a rating of roughly 1MW(th)/kg of fissile Pu; therefore 2 300t of fissile plutonium would correspond to roughly 700GW(e) of Pu fueled reactors (if allowance were made for an out-of-pile inventory). This is roughly 40% of the expected overall OECD capacity of the year 2000. If distributed over five comprehensive collocations, i.e. energy centers, it would mean 140GW(e) for each of them. Long distance transportation of such electric power quantities may be beyond available technology, while transportation as a gaseous secondary energy carrier is clearly within existing technology. If we now recall the anyway ecxisting necessity for large scale nuclear power to produce besides electricity a gaseous secondary energy carrier one is led to a natural division of tasks: Normal nuclear power stations, based on U235 fueling and along the lines of the now available technical experience, would continue to function as electric power stations on a decentralized basis. The irradiated fuel elements would be transported within class one of required physical protection (very little protection required) to the collocations and the Pu would never leave these energy centers again. Instead, it would fuel reactors that would probably produce mainly the process heat for synthesizing a gaseous secondary energy carrier with subsequent easy transportation in an (already existing?) pipeline system. Of course, we do not want to exclude electricity generation in such energy centers, when appropriate.

One arrives therefore at a sequence of modes for the geographical deployment of nuclear energy as shown in Figure 10. As time and with it the capacity of a modern energy system evolves, we started with a transition from coal to oil and we are now beginning to see the transition to local nuclear plants on the basis of U235 fuel. The nuclear community now faces the problem of appropriate uses of large plutonium amounts. We here suggest as a further transition to use this plutonium in comprehensive collocations, i.e. in large centralized energy centers, possibly offshore. It is encouraging to know that Japanese scientists like H.Murata of JAERI at Tokai Mura pursue such a concept steadily and consciously.

It should also be noted that the provision of a gaseous secondary carrier allows for the easy integration of other primary energy sources to come such as solar power. Solar power by inherent necessity requires large scale energy storage and this can be done naturally on the basis of such a gaseous secondary energy carrier which would, in fact, then significantly increase the versatility and resilience of a modern energy system [9].

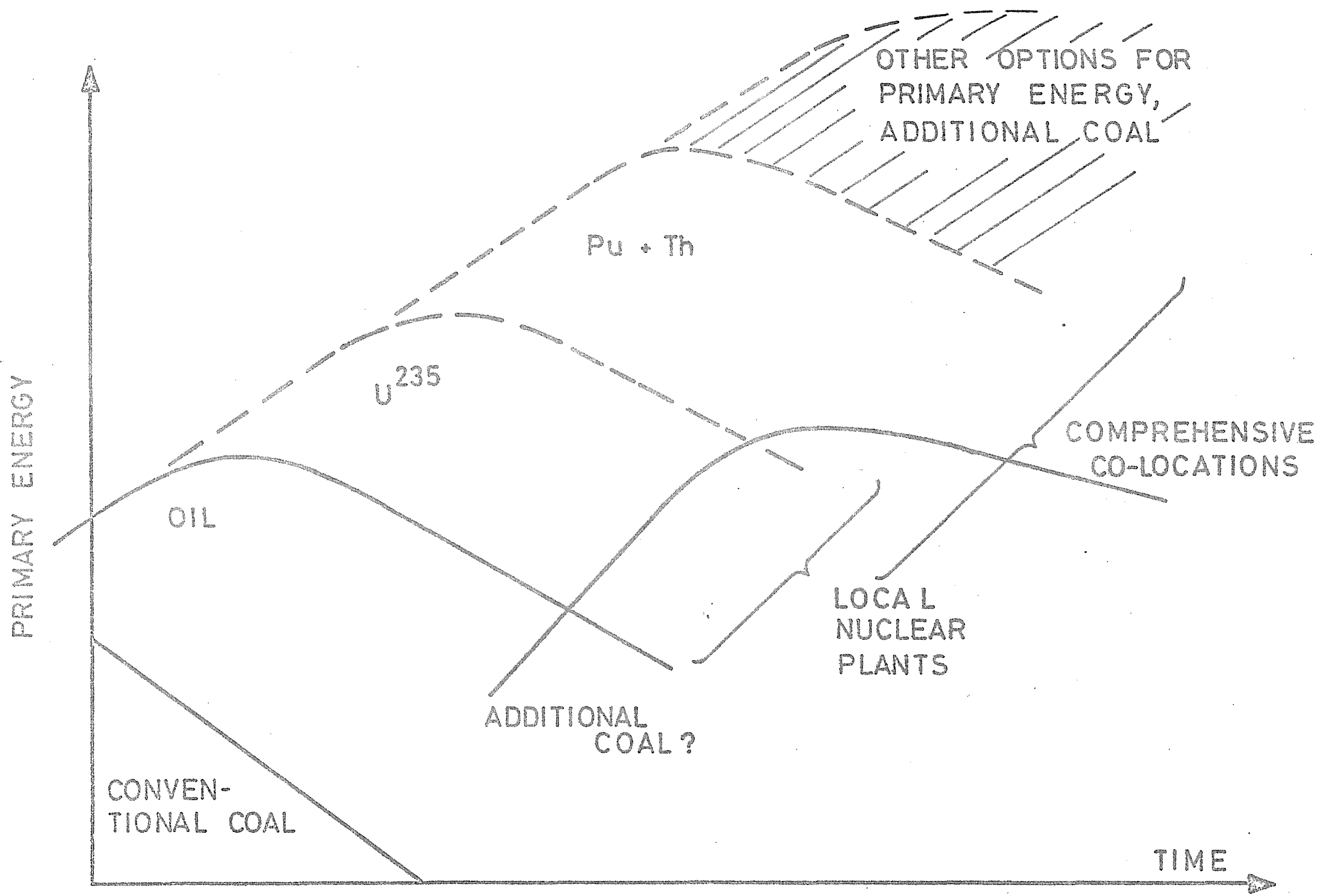


Figure 10. Modes for the Geographical Deployment of Nuclear Energy.

A REMARK ON MULTINATIONAL ENERGY CENTERS

It was mentioned in the beginning of this paper that present oil supply bridges global distances. Transportation in large tankers facilitates the shipment of about 25 million barrels per day which is the equivalent of 1.7TW(th). We also saw that the problems of installing large scale nuclear power are the problems of going into the TW domain. The scale of nuclear power expected for the OECD until the year 2000 demonstrates this but also, more inherently, the amount of Pu to be expected. We saw that by the year 2000 the equivalent of 700GW(e) would be based on plutonium. In this context one must recall that 1g plutonium is the equivalent of 1t of coal power year. One must understand that this is not only a physical equivalent; it also relates the effort and attention that goes along with 1t of coal per year to those required for the adequate handling of 1g plutonium. In this perspective it is then not surprising to visualize a concept of energy parks. Energy parks mean the transition of nuclear power from the GW to the TW domain. We connected the nuclear energy parks concept to the production of a gaseous secondary energy carrier. A gaseous secondary carrier can be liquified. In case of ammonia this is conventional technology; it can be done for hydrogen, too. Energy centers in the TW domain could therefore serve as an artificial substitute for natural oil fields. Contrary to natural oil fields such artificial oil fields would be inexhaustible.

By such a reasoning we are led to possibly conceive such energy centers on a multinational basis. This would also smoothly eliminate the concern about non-proliferation of nuclear weapons and adequate physical protection. It is obvious that the problems for implementing such a scheme are not of a technological nature. Engineeringwise it can be done. The problems are soft ones: Who is responsible for the operation of such centers, who is liable, who gives the commercial guarantees for timely delivery and who guarantees the security? In the reasoning of this paper it is not surprising that it is the soft aspects which make up the problem, not the hard technology.

LEVELS OF ABSTRACTION/UTILITY

To complete a total system of nuclear power has led us into considerations in the TW domain. It may be helpful to realize the more subtle implications of such a step as explained in Figure 11. Until a hundred years ago mankind was operating with horses and other animals as far as energy systems were concerned. This was the kW domain. A distinct evolutionary step was taken when physicists realized the more abstract and thus more general meaning of the term energy. It led them beyond mechanics into thermodynamics. and electrodynamics Maxwell's name may stand for that. On the utility side James Watt and Werner von Siemens may characterize the amplification of technological possibilities that went along with it. The change from the kW to the MW domain was opened. Physicists went on by conceiving quantum mechanics, realizing the more abstract and thus more general meaning of the term information. It is broader and more powerful than energy. The name of Heisenberg may symbolize this level of abstraction.

LEVELS OF ABSTRACTION / UTILITY

ELEMENTARY PARTICLES ?	1963	GELL–MANN (QUARKS) ?	PATTERN	?	TW	INSTITUTIONS, ? 'GESTALT'
QUANTUM THEORY	1930	HEISENBERG	INFORMATION	V. NEUMANN, FERMI	GW	COMPUTER, CONTROLS, SECOND INDUSTRIAL REVOLUTION
ELECTRO / THERMODYNAMICS	1870	MAXWELL	ENERGY	WATT, SIEMENS	MW	POWER, FIRST INDUSTRIAL REVOLUTION
MECHANICS	1690	NEWTON	MATTER	LEONARDO DA VINCI	kW	BUILDINGS, AGRICULTURE

Figure 11. Levels of Abstraction/Utility.

On the utility side it led to the technology of information processing and to nuclear energy technology. The names of John v. Neumann and Fermi may be represetative. It meant a change from the MW to the GW domain.

We should not be very surprised nowadays that it means again a new and qualitative step if we want to enter the TW domain. One may conjecture that it relates to a step physicists may have taken recently. The theory of elementary particles is more a problem of patterns than of information. The Quark concept of Gell-Mann points into that direction.

On the utility side one must now also anticipate a new element. This paper has stressed the observation that the problems of bringing nuclear power into the TW domain are soft in nature. They all point to management and institutional problems. Mere information is not doing the job any more. We need more than information, something that may be addressed as "Gestalt" or a body of institutional capabilities.

Therefore it is time to realize that a distinct cultural step is needed to enter the TW domain. It is much to be compared with the evolutionary step the old civilizations in the large valleys managed to take when they tamed rivers like the Euphrates Tigris or the Nile. The problems were neither to build a dam here and there nor to install sluices, water the land and develop new agricultural methods.

The basis for supporting peoples was only formed when a "gestaltete Technik" on a (at that time) worldwide scale was combined with a new idea of managing benefits and risks on that scale: the advent of the idea of a state. New technology and a new social structure formed a symbiosis.

Upon reflection our present difficulties to prepare for that appear to be in line with the process of natural evolution.

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FRENCH NUCLEAR ENERGY PROJECTS

[INT]RODUCTION

Before the oil crisis which followed the Yom Kippur War, and the economic problems experienced by all the industrialized countries of the free wold, Futurology claimed to have almost reached the level of pure science. "Think Tanks" predicted the future with the utmost precision, and with a confidence that was more than reassuring for those who had to make decisions - decisions which only the future would be able to evaluate.

Only a very brief period of time has been necessary to remind us that events do not always follow the course we expect them to take, and that one has to be extremely prudent in formulating our forecasts.Nonetheless, it is unavoidable, for those who have to decide on the major investments which require the creation of a whole sector of industry, to define the assumptions of their decisions.

In the case of the development of nuclear energy for producing electricity, decisions are based, first,on the estimated evolution of the consumption of electrical energy - which itself depends on economic growth and the rate at which electrical energy is substituted for other forms of energy by the consumer - and, second, on the proportion of nuclear-generated electricity which is reckoned desirable in the future.

On the strictly economic side, this proportion obviously depends on the costs of investment, and the cost of fuel in power-stations using fossil fuels, as compared with nuclear power stations. These costs differ in structure, and are equivalent only for a certain load factor. But in addition to the economic aspect, lies the desire to lessen national dependence on outside sources of energy, and to economize on foreign currency. These considerations have encouraged us to go ahead, and it is in this frame of mind that the French plan for nuclear installations was drawn up. To start,it consisted of a range of pressurised water reactors (PWR) only, with on increasing share of fast breeder reactors.

LIGHT WATER REACTOR DEVELOPMENT IN FRANCE

1 - France started its nuclear programme with reactors of the natural uranium - gaz-graphite type. This was the only type France could develop quickly, and independently since we had no plants for separating isotopes or producing heavy water. This independence

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of course, was strictly necessary as soon as the decision had been made to develop atomic weapons. The 8 reactors of this type in operation now are working very satisfactorily, with a high level of availability.

At the same time, however, as we were carrying on with our natural uranium - gaz-graphite programme, we were also studying a heavy water - gaz type reactor. Our Brennilis reactor - after a few initial snags - is working well, and with the new prices for fossil fuel it is now economically viable. There is also the pressurised water reactor at the Chooz nuclear power station, which was put in service in 1967 and built by French and Belgian constructors under licence from Westinghouse, for a company which is owned fifty-fifty by Electricité de France and the associated Belgian producers. Here again, after a few major difficulties at the beginning, the power station is giving entire satisfaction.

A second installation of the same type (PWR), but with greater capacity - 900 MWe - has been built in Belgium by the same constructors for the same Belgian and French producers. This is the Tihange nuclear power station. It was put into operation last year, and, since then, has had a very good level of availability.

A few years ago we decided not to proceed with natural uranium - gaz-graphite reactors for economical reasons, and also to give us access to a market bigger than just the French market. Therefore we have naturally chosen to concentrate on the light water reactor range, which will be, by far, the most commonly used throughout the world. In the light of our experience with Chooz and Tihange - the latter was being built at the time - we commissioned the first light water power stations entirely owned by Electricité de France - Fessenheim and Bugey - with pressurised water reactors carried out in France by the Société Framatome under licence from Westinghouse.

We then studied the possibility of diversifying by commissioning a certain number of boiling water reactors. But after lengthy analysis and considerable discussion, we had to give up this idea, because of the major cost involved - the sort of cost invevitably linked to launching a new technique, and which would have led to the fragmentation of a market which, on the national level at least, was too small.

Our decision to concentrate all our orders for nuclear installations on the PWR range does not imply - and I must emphasize this point - any judgement between these two different techniques, but is simply due to circumstances which do not allow us to split the national market in France among two different constructors.

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1.2 - To concentrate all our orders for nuclear power stations within the framework of one technique, coupled with the size of the French nuclear programme, has enabled us to carry out an ordering policy : the orders are grouped in long-term contracts spread over a number of years, to be carried out in successive stages. Thus, the 900 MW stage planned at present will comprise 32 units. 6 of these had already been ordered for Fessenheim and Bugey ; a first long-term contract was then put in hand, for 16 others, to become operational over the following three years - 1979, 1980, and 1981. The last ten 900 MW units form part of a second contract, where the last two are optional.

While these last 900 MW size units are being built, the 1300 MW type will be progressively introduced from 1982 on. This is directly derived from the 900 MW type by adding an additional "loop" in the primary circuit.

All the light water reactor installations put in service after 1985 will be of this 1300 MW type. We have however decided to develop simultaneously - and I shall deal with this later on - a range of Liquid Metal Fast Breeder Reactors (LMFBR).

The change-over from the 900 MW to the 1300 MW stage is obviously due to economic reasons, since the increase in size will give us a 10 % percent profit on our investments, and we shall gain 7 % percent on the cost per kilowatt hour.

It would of course be ideal if all sections ordered for one particular stage were strictly identical. - But it is obviously impossible to reach this ideal. Local conditions vary from one power station to another, and even conditions of cooling - as we shall see later - vary considerably. This, however, is a question of adapting to the site. It affects the total cost of the installation, but does not impinge on the actuel construction of the nuclear steam system, nor on the market for this part of the plant.

The same cannot be said for the progressive - and no doubt sometimes over-zealous - tightening of safety regulations. This fact has led us in the middle of the 900 MW stage, to make a certain number of technical modifications between the first an second of our long-term contracts for nuclear plant.

Here it is perhaps worth noting that Electricité de France usually acts as the prime architect for its power stations, and does not go in for a policy of turnkey-contract. Separate orders are given to different constructors for the main components, defined in such a way that individual responsibility may be clearly pin-pointed in the event of any incident. The most important orders cover : the nuclear steam system, the turbines and generators, and the civil engineering work.

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Experience has shown - as may easily be guessed - that this policy of orderin groups of major components in sizeable series to be supplied over a number of years enables the constructor to amortize his research, and rationalize both his supplies and the work in his workshops, thus leading to a clear reduction in the cost price. Thus it will enable French industry to be an important and efficient one on the world market of nuclear reactors. It must be added that the French "Commissariat à l'Energie Atomique" holds now 30% of the Framatome shares and that an agreement organizing the cooperation for development has been concluded between "Electricité de France", French "Commissariat à l'Energie Atomique", Framatome and Westinghouse.

1.3 - The nuclear power station programme has been planned on the basis of an estimated consumption of 385 thousand million kWh of electricity in 1985 (1) as compared with 181 thousand million in 1975. The equivalence between the cost per kWh produced by fossil fuel power stations, and the cost per kWh by nuclear power stations is obtained for 4000 hours operating time. An additional hypothesis deals with the probable availability of the various units planned, varying from 40 % or 50 % for the first winter, to 85 %, which will only be attained by the 5 th or 6th winter for the first 4 units of a stage, and by the 3rd winter for following units.

Taken overall, this programme gives the following development of electricity production in France between 1975 and 1985.

In 1975, the breakdown of power generation was as follows :

- hydroelectric : 18200 MW
- thermal (fossil fuel) : 26000 MW
- nuclear : 3300 MW

with a respective production of 60, 101, and 17.5 thousand million kWh. The remaining 2.5 thousand million kWh was imported.

In 1985, power generation is estimated as follows :

- hydroelectric : 22100 MW
- thermal (fossil fuel) : 26500 MW
- nuclear : 46800 MW

with a respective production (given average hydroelectric conditions) of 61, 54, and 270 thousand million kWh.

Thus, between 1975 and 1985, additional hydroelectric power stations (in the form of pumping stations for the most part) with a capacity of 3200 MW will become operational. In 1976 and 1977, 4 units with 700 MW capacity using fossil fuel will come into operation - these are the last power stations of this type which were planned. The reason for the very small variation in traditional thermal power between 1975 and 1985 is due to the decommissioning of old units whose working life has ended compensates the effect of the last units which become operational. In actual fact, the number of traditional thermal power stations will be at its maximum in 1977/78

5 thousand million kWh included, to be used for isotope separation by gas diffusion.

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As regards nuclear energy, decommissioning will only affect a small amount of power before 1985. The differences in power generation thus roughly correspond to the new installations which have become operational, i.e. 32 units section 900 MW, 10 units 1300 MW, and 3000 MW in fast breeder reactors, as will be seen later. The production of electrical energy by nuclear means will at this date be more than 80 % of total thermal production, and 70 % of total electricity production.

Presently, we are authorised by the French Governement to order nuclear power stations until 1977, i.e. for those which will be put into operation up till 1983. Following its first decision to attain 13000 MW during the two years 1974 - 1975, the Planning Council has fixed the capacity to be attained during 1976 - 1977 at 12000 MW. A complementary decision should shortly be taken including the years 1978 and 1979. It would appear reasonable to maintain a rate of 6000 MW per year for this period.

It may be noted that this level of commitment - if it is maintained - should bring about a progressive reduction in the number of PWR units to be installed each year, due, on the one hand, to the increase in unit power, and on the other to the progressively increasing importance of fast breeder reactors. It is thus desirable that in addition to the national market, a sufficiently large export market be available to the French nuclear industry.

SITING POLICY

2.1 - First of all, we must consider an important fact as regards developments in electricity production : the increase in unit power approximately follow the increase in requirements. Thus, the number of units operating is more or less constant, and the number of power stations in service (forty), will vary very little during the next years so long as the present solution with 4 units for each site is maintained.

However, along with the development in unit power, the evolution of certain limitations make it impossible to use land where thermal power stations have fallen into disuse - these sites are usually small, near towns, and situated on rivers with insufficient flow at low water mark. New sites must therefore be opened up.

If during the next few years we aim at an average rate of 6 units per year, we shall have to open up three sites every two years on average.

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Siting a nuclear power station requires : considerable space (150 - 200 hectares) with a large quantity of water available ; very good quality rocky subsoil, situated, if possible as it is in France, in a zone free from serious seismic shocks ; easy access ; proximity to transmission lines and consumer centres.

In addition, this land should be of no agricultural value, offer no attractions to tourists, and have no industrial, aesthetic or historic value. The site for a nuclear power station should cause no inconvenience to anyone, and should not be subject to outside risks such as explosions, fire, plane crashes, flooding, etc... Finally, it should be possible to construct and operate a nuclear power station on this site under good working conditions without prohibitive cost.

Needless to say, the perfect site does not exist, and the choice of each site brings its own specific problems which always entail a search for a compromise between opposite interests. A comparison must then be made between the various potential sites.

One of the key criteria in this analysis is the cooling : - where large quantities of water are available, the power station may be cooled by open circuit. Such is the case for seaside sites. Areas with strong currents are preferable, coupled with sufficient depth and open frontage to the sea so that the heated water from the power station may be rapidly assimilated by the enormous mass of seawater. Thus, at a distance of 2 or 3 kilometres from the power station the temperature of the water is raised by less than 1°C, which is equivalent to natural temperature variations for short periods, for example during daytime.
- where the amount of water available is less than the equivalent of 50 cu.metres per second flow, per 1300 MW unit, the power station must then be cooled by closed circuit. Together with their huge size, atmospheric cooling-towers have the disadvantage of evaporating water (0.6 to 0.7 cu.metres per second, for a 1300 MW unit) and require purging to avoid deposits of salts and organic matter on the evaporation surfaces. In view of these problems it would in practice be difficult to install 4 x 1300 MW beside a river with less than 10 cu.metres per second flow at low water mark.

Quite apart from the technical problems (which can be quantified), there are a whole series of other difficulties such as the environment, and possible harmful effects which concern the installation of a power station on such a site - evaluation of these becomes extremely subjective, and impact the political as much as the technical field.

Due to present-day technology sites should essentially be selected in view of their water resources, with respect to the cooling capacities of this water.

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France benefits from three sea fronts, and from numerous rivers, but unfortunately of low through put slow-flowing.

As regards the seaboards, the zone heated by 1°C extends for 5 to 15 km^2 for a 5000 MW unit, depending on weather conditions. On the ecological side, apart from an attraction or repulsion for certain species in the areas mentioned above, the only effect which merits serious study is the passage of water through the condensers. Potential changes in plancton must be verified and specified so that there is no risk for the environment receiving the outflow. The constant renewal of the mass of seawater is a guarantee against any danger of localized pollution or any type of accumulation. This implies a choice of sites with excellent "ventilation" as regards sea conditions.

As regards her rivers, France has 450 km. where the flow at low water-mark exceeds 200 cu.metres per second, 100 km with a flow varying between 100 and 200 cu.m/sec., 850 km with a flow varying between 50 and 100 cu.m/sec., and 2100 km with a flow varying between 15 and 50 cu.m/sec.

It is clear therefore that sites with 4 units can easily be installed with closed circuits in most cases.

To sum up, the nuclear power stations which will be operational in 1985 - whether they are now in service, in construction, or only planned - will be spread over 19 sites which, very probably, will comprise 5 on the seaside and 14 on rivers, the majority equipped with wet atmospheric towers.

4.2. - Choosing a site consists of a series of fairly distinct phases :

First of all, preliminary studies are carried out with discretion, since it is pointless to rouse public opinion about sites which are only being considered amongst others, and where the probability of actually installing a power station is minimal. These studies are examined together with the Central Administration and, at the end of this first phase, it is decided that a certai n number of sites may be actively considered.

The second phase then starts, with pilot-studies and discussions. The pilot-studies aim either to confirm or reject the preliminary studies, and in particular to show the feasibility of the power station. At the same time, numerous contacts are made with the general public concerned, and local representatives.

The aim of these various contacts is to inform the public and its representatives, and to gather information on the opinion of local groups and elected bodies about the project and its key features.

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Informing the public can take various forms : "official" meetings : meetings of regional assemblies, municipal councils ; meetings, often contradictory, for the purposes of information organized at the request of local groups or municipalities ; the regional press.

The regional or prefectoral body (in charge of the area) safeguards the objectivity and free discussion facilities within these various meetings.

The finalizing of pilot-studies regarding the feasibility of a nuclear power station is the job of both the technicians and the Administration. Even if the power station is technically feasible, it must also be acceptable for the local groups concerned. This means that the Administration must examine the various ways the power station will affect the environment where it is installed, whether they be physical, ecological, socio-economic, or political. At the end of this second phase, the Central Administration gives its advice. This is not yet an official go-ahead for the project, but simply an opinion authorising, if favourable, the start-up of studies of the project, and procedures for subsequent authorisation. However, should this opinion be favourable, land will be reserved in urban planning schemes for future possible installation of a nuclear power station.

Finally, in a third phase, project studies are launched and comittments taken regarding the requirements in equipments, followed by the official authorisation procedures for constructing the power station.

These complex procedures take about two years. As the construction, tests and bringing on power of one unit section take five years, it is desirable for project studies to be started eight to ten years before putting into operation the first unit of the site in question.

.3 - Research is going on at the present time on "dry" cooling systems, which do not use water by evaporation, but transfer heat to the atmosphere by conduction and convection. If such a system isacheived - so long as it is accompanied by the total suppression of liquid effluents - it would clearly widen the possibilities in the choice of site and unit power. But for the moment, these cooling systems are extremely costly both in investment and operating costs. It is certainly necessary in order to make this process viable, to modify the thermodynamic cycle and most probably to go over to a two-fluid cycle. There is still a long period of research and development ahead.

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3. FAST BREEDER REACTORS

My friend Georges VENDRYES, Director at the French "Commissariat à l'Energie Atomique", in charge of the industrial applications of nuclear energy, gave an address in this very place a year ago, during the meeting of the Japan Atomic Industrial Forum, on "Early operating experience with the Phenix 250 MWe demonstration plant". He dealt with the development of this range up to the following stage, called Super-Phenix.

However this is such an important question in our nuclear energy development projects, that I feel I must briefly come back to it again.

3.1 - First of all, as you heard last year, both Rapsodie and Phenix are working in an extremely satisfactory way. Phenix, for example, reached 84 % availability during its first industrial operating year (July 74 to July 75). At the present time, there have been no ruptures for the 20.000 fuel pins fed into the core, some of which reached a burn-up of 63.000 MWd/te (Megawatt days per tonne), and 3500 of which reached or exceeded a rate of 50.000 MWd/te.

Deficiency was recently discovered in the water circuits near their entry into the steam generators : this incident does not affect either the nuclear parts nor the sodium circuits. Repair work has already begun, and will take four months during which Phenix will be kept working at two-thirds power.

3.2 - As was also mentioned last year, an international Company, the NERSA, has been jointly founded by the French E.D.F. (51 %), the Italian ENEL (33 %) and the West German RWE (16 %), with the aim of constructing a power station whose power will be of the level of light water reactor power stations, and will be representative of the fast breeder reactor stations which will follow.

This prototype power station, Super Phenix, will give an output of 1200 MWe and be built along the Rhône, upstream from the town of Lyon, on the "Creys-Malville" site. The techncial dossier is complete, safety procedures are being terminated, the preliminary work on the site has been done, the factory and engineering teams of workers are ready, and the decision to start the actual construction should be taken in the very near future. This power station is planned for operation in 1982.

3.3 - But we are already convinced that so long as Phenix continues to give complete satisfaction, and the start of building work on Super Phenix does not throw up any hitherto unforeseen problems, we will launch a programme of fast breeder reactors after Super Phenix, starting with an order for a first pair of

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units in 1979 - 1980, followed by a second pair to be ordered before 1985. The delay of 3 to 4 years between Super Phenix and the power station which follows will enable us to profit to the maximum from our experience in building Super-Phenix, as regards actual costs and delivery-dates, organiszation of the building site, and all problems concerning the main components which, three years after the site has been opened, will be in process of installation.

The features of this first stage will result from studies which have just been begun by EDF, the CEA and French industry. Power will certainly be more than Super Phenix's capacity, but not exceeding 1800 MWe.

Our building programme for fast breeders is taking shape with the use, as and when it becomes available,of the plutonium produced in thermal reactor stations (natural uranium/gaz-graphite type, and light water type). Two pairs of units planned for 1979 to 1985 should supply (together with Phenix and Super Phenix) some 8000 MWe in service in 1991. From 1985, the yearly commitments could reach 2000 MWe which implies that the range of fast breeder reactors would, in the year 2000, be one quarter of the power installed, and one third of the energy produced by nuclear power stations, since the very low proportional costs of energy produced by this type of reactors would tend to keep them at the base of the load diagram.

If, in accordance with certain present forecasts, the rate of increase in the demand for electricity began to fall off towards the end of the century, we could meet our requirements with fast breeder reactors only, which would be a final step as regards our independence in energy.

USION

French nuclear energy projects are straightforward : commitments for operational power stations are clear up to 1982/1983, they are fairly well defined till 1985, and they are obviously vaguer for the years that follow since our day and age does not lend itself kindly to exact forecasts about long-term developments in energy consumption.

Our projects are, in their first phase, essentially concentrated on big pluriannual contracts for pressurised water reactor-type power stations, and their second phase sees the progressive introduction of a range of liquid metal fast breeder reactors.

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Should present assumptions on change of energy consumption prove valid, and if these programmes are respected, the following results should be obtained :

- from 1985, electricity production should be dependent on only 10 % imports.
- at the end of the century, there should be a marked reduction in this dependence for the whole sector concerned with energy.

In view of their reasonable operating costs, and the economies that can be made in foreign currency transactions, Nuclear Power Stations are the only means - as far as man can see -, for countries with no natural resources in energy, to resolve their energy problems without becoming totally dependent on supplies from abroad.

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3/10 16:45~

Atomic Energy Development in the U.S.
The Industry-Government Interface

by

Edwin A. Wiggin
Executive Vice President
U.S. Atomic Industrial Forum

I am deeply honored to have this opportunity to address this Annual Conference of the Japan Atomic Industrial Forum. I had the honor of participating in a conference here in 1957, jointly sponsored by our two organizations. It is a pleasure to be back in Japan and I extend to you greetings and best wishes on behalf of Forum Chairman John W. Simpson, Forum President Carl Walske and the other officers and directors of the U.S. Forum.

The registration for the 1957 conference included 1,000 Japanese, 89 Americans, and 48 representatives of 13 other Asian countries, bringing the total to more than 1,100. In addition to the turnout for the technical conference, 1,200 persons attended an evening series of lectures open to the general public; 7,500 students attended a three-day series of lectures for young people; and more than 120,000 persons visited a 10-day atomic energy exhibit held in conjunction with the meeting. It was a most impressive convocation.

Within a week after that conference ended, the Japanese Federation of Electric Power Companies announced that the nine utilities which made up the Federation planned by the end of the year to form a new joint-stock company "to import power reactors of practical use, conduct experimentation and research, and to wholesale the generated electricity."

Continuing my recollections for a moment, let's move ahead three years. The year is 1960 -- just 15 years ago. Shippingport was into its third year of operations and Dresden I and Yankee Rowe had come on line. The Japan Atomic Power Co. had just signed a contract with the British General Electric Co., Ltd. for the construction of a 150 Mwe reactor of the Calder Hall type and before the year was ended, General Electric Japan would sign a contract with Japan Atomic Energy Research Institute to build a 12.5 Mwe demonstration nuclear power plant at Tokaimura.

Back in the U.S., uranium was selling to the AEC at $8 per pound, although the Japan Atomic Fuel Corporation was able to buy 13 tons that year for an average price of $4.63 per pound. "Reactor safety" and "public acceptance" didn't get enough press attention that year to make the subject index of the Forum Memo and the terms "environmental impact statement", "low as practicable", and "low as reasonably achieveable" hadn't even been invented.

This doesn't mean that those of us on the Forum staff at that time didn't have our problems. One of our biggest concerns was that things were going so well that we could see the day ahead when all the problems would be solved and we would literally have worked ourselves out of a job.

This look backwards prompts me to remark: "Oh, for the good old days." Although this is a phrase generally reserved for parents in reminiscing to their children, I can think of nothing more appropriate to describe my own feelings of frustration when I consider the potentials and accomplishments of the nuclear industry in the context of its problems.

Advancing our calendar to the year 1976, let's take a look at today's problems in the context of the nuclear industry's experience over the last couple of years. What perspective does this give us in assessing the seriousness of today's problems and the likelihood of their early resolution?

Last year was not a good year for the U.S. nuclear industry. Words like "dislocation", "confrontation", escalation" and "frustration" describe it pretty well.

During the year, only 5 new nuclear power plants with an aggregate output of 6,400 Mwe were ordered against the highwater mark of 1973, when firm orders were placed for 38 units with a combined megawattage of 42,000 Mwe and nine additional letters of intent were signed, bringing the grand total to over 52,000 Mwe.

During 1975, the deferrals continued. To the approximately 120,000 Mwe deferred in 1974, another 20,000 Mwe was added in 1975.

The industry could take little comfort in the caveat that outright cancellations during the past two years have accounted for only about 6% of total nuclear commitments. Nor could the industry find much solace in the fact that stretch-outs during the past two years have also hit approximately 80,000 Mwe of fossil-fired generation. There is simply no way of comparing the five new orders in 1975, against an average of 28 new orders per year over the previous five years without concluding that 1975 was a rotten business year.

Nor does it appear that 1976 is going to be much better than 1975. Conversations with the NSSS vendors suggest that we can expect to see no more than a dozen, and some believe not more than a half-dozen, new orders placed this year. On the other hand, 1977 could see a turn around and a resumption in the ordering of nuclear plants.

Also, the situation, I submit, is not as bleak as the above statistics might at first suggest. For instance, the 1975 record also shows that at the end of the year, 58 domestic power reactors were licensed to operate, 69 units were under construction and 101 more were in various stages of the pre-construction licensing process.

The Federal Power Commission has reported that nuclear power produced more than 121 billion net kwh of electricity in the first nine months of 1975. This was 8.5% of all the electric power generated in the U.S. during those nine months and more than all nuclear power plants generated during the previous twelve months. If the same 121 billion kwh had been produced in fossil-fired plants, it would have required 7.5 billion gallons of oil or 40 million tons of coal. On a weighted average basis, the nuclear power at a cost of 12.5 mills per kwh was 63% less expensive than it would have been had the electric power been produced with oil and 27% less expensive than if it has been produced with coal. Further, the cost savings attributable to nuclear would have been even greater had the 76.6% availability factor of the base-loaded nuclear plants been able to match the 81.4% availability factor of the base-loaded coal-fired plants or the 85.8% availability factor of the base-loaded oil-fired plants. There is no doubt in my mind that as further experience is gained, nuclear power plant availability factors will go up. And so will the comparative cost savings. Admittedly, nuclear power costs are also on the rise, but so are the other means of generating electric power and for the same reason -- inflation.

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In the time available, I would like to discuss five of the most serious problems currently confronting the nuclear industry, review what steps are being taken to resolve them, and finally, consider what additional measures might be taken to make the full potential of the nuclear option available to help meet the electric power requirements of our nation between now and the turn of the century. I will, of course, be talking about the U.S. nuclear program and the respective roles of industry and government in the states, but I suspect that neither the problems nor the involvement of government and industry in your country are markedly different.

If one were to look for a single root cause of many of today's problems, one might simply note that the atom has gone public and as a result it has been emotionalized and politicized. This, of course, is too simplistic an answer and it also implies that there is something wrong with emotion and politics, which is not necessarily the case. Nor is there anything wrong with the atom's going public; indeed, it must if atomic energy is to become a major factor in the future economic welfare of the U.S. or for that matter, most other nations.

The problem is that atomic energy has gone public before its time. What I mean is that we have attempted to involve the public in the decision-making process in an area where it has little knowledge of the underlying technology and little understanding of the implications of its decisions on the further development of that technology or on its potential contributions in terms of cost/benefit relationships.

Neither our institutions, nor our policies, nor procedures, nor people in government or industry are geared to deal with the problem effectively. For example, I know of no more than a half dozen people in the nuclear community who have been able to cope effectively with the histrionics of Ralph Nader in a public debate. And there are probably less than two dozen members of the Congress, comprised of 435 representatives and 100 senators, who have ever seen a nuclear power plant or could tell you how one works.

Although this may suggest, and correctly so, that I consider the winning of public understanding and confidence in atomic energy to be the industry's most serious problem, let me go back to my identification of the other four problems to which I referred earlier.

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The problems I have in mind are: (1) raising the capital funds necessary to build nuclear plants; (2) assuring an adequate future supply of uranium; (3) expanding in a timely fashion uranium enrichment capacity; (4) closing the back-end of the fuel cycle, including resolution of the question of whether mixed oxides should be used as light water reactor fuel and defining and implementing a waste management program; and (5) the problem to which I have already referred, winning public confidence in a vigorous pursuit of the nuclear option. Let's take them up in the order listed.

Raising Capital Funds

The problem the utilities have had during the past couple of years in raising capital investment monies for nuclear power plants appears to have abated somewhat in recent months. The reason for this, in part, is because an increasing number of the state commissions that regulate the rates utilities may charge their customers have come to recognize that utilities must recover the operating expenses attributable to higher fuel and labor costs. Utility cash flow must be sufficient not only to meet operating and maintenance costs, but also to permit the utility to compete in the money market for debt capital. Rate relief by state commissions has traditionally lagged the money needs of the utilities and this will probably continue to be the case, but the situation today seems somewhat better than it did a year ago.

It is not yet clear how the utilities' improved financial situation will influence the likelihood of their opting for nuclear power. Such a decision, of course, depends on many factors. When and how much new generating capacity will be needed on a particular utility system? Following an average nation-wide historical electric power growth rate in the U.S. of 7% per year for 20 years, the recession year of 1974 produced no growth. And, notwithstanding the projections of some utility economists that 1975 would produce a growth rate of approximately 5%, it turned out to be less than 2%. The net result is that some utility systems now have capacity margins as high as 30-40%. With this kind of margin, new capacity commitments and accompanying capital investment commitments are being deferred. Does this mean, then, that the financial status of the utilities simply appears better because they aren't spending capital monies?

But, if future electric power requirements are to assume an annual growth rate of 4-6% instead of the earlier 7% or a doubling every 15 years instead of every 10 years, this isn't a very long time in terms of the 9-10 years lead time now required to bring a nuclear power plant on line. When one adds to these imponderables the unknowns of future cost escalation and inflation, it helps explain why projecting the extent of nuclear power additions and their capital requirements tends at the moment to be more of an art than a science.

And, of course, another factor that will be taken into consideration by the utilities in deciding whether to opt for nuclear power will be the comparative costs of nuclear power vs. the cost of power from alternative generating systems. The capital costs of a nuclear power plant, for example, continue to run higher than those of a fossil-fired plant, although with limestone scrubbers on a coal-fired plant, the difference is minimal. The lead time for constructing and bringing into operation a nuclear plant continues to be longer than for a fossil-fired plant because of protracted licensing requirements, thereby increasing the potential impact of cost escalation and inflation. But nuclear fuel costs continue to run significantly less than fossil fuel costs as, for example, was indicated recently in calculations made by the Commonwealth Edison Co. These calculations showed nuclear fuel on a present replacement cost basis to have a 66% advantage over high-sulfur coal, a 166% advantage over low-sulfur coal, and a 383% advantage over oil.

Commonwealth also found for their system in the Chicago area that nuclear has an advantage in terms of bus-bar costs of electric power. The calculations were based on constant dollars, figured on a replacement cost basis, using 1974 construction cost levels but reflecting the latest NRC licensing requirements for nuclear plants and probable EPA requirements for scrubbers on all high-sulfur coal stations, and using 1975 market prices for replacement fuel. Under these assumptions, they found that nuclear generated electric power would cost 24 mills per kwh, coal-fired electric power would cost 29 mills per kwh and oil-fired electric power would cost 35 mills per kwh.

Returning to the problem of raising capital, the future needs of the utilities will be tremendous. Over the last decade, they totaled approximately $100 billion in the U.S.; over the next decade they are projected at $325 billion. Most utility executives feel that they will have to decrease their dependence on outside financing. As one utility treasurer put it: "This means improving internal cash generation, which basically means that more money must come from the customer sooner."

Many utility common stocks, even after the recent recovery in the stock market, are still selling at prices below their book balue. Capital monies of both the equity and debt type will only be assured if utility stocks can offer a sufficient rate of return to attract investors and this will happen in the opinion of most utility executives only with realistic increases in electric power rates. This opinion was reflected in the industry's reserved reaction to the measures provided in the Administration's utility financing legislation proposed early last year and to the Energy Independence Act proposed last October.

Although there was general acceptance within the utility and nuclear industries of the thrust and objectives of the latter bill, Forum Chairman John Simpson summed up the reaction of many in the industry when he said: "Ordinarily, one would expect any industry to be able to hack it in the private sector without direct government assistance."

Uranium Supply

One of the allegations sometimes voiced by the nuclear critics is that the nuclear industry is going to run out of uranium and for this reason, among others, we should not be building nuclear power plants. And from time to time, this same matter is raised within the nuclear industry, not as an allegation, but rather as a concern. In both cases, the question posed is whether we will have enough uranium to fuel each of the reactors for 40 years that will be put into operation between now and the turn of the century.

Both the allegation and the concern are prompted by a number of factors, among them: (1) we do not now have in place a sufficient number of mines or mills to supply the quantities of uranium that will be needed in the future; (2) some utilities have experienced difficulties in purchasing uranium under long term contracts; (3) quantitative information on uranium reserves is often couched in terminology that is difficult to understand and for this reason raises doubts as to its validity; (4) the government has adopted a policy of permitting the gradual import of uranium, starting in 1977, thereby suggesting to some that the government believes domestic supplies will run short; (5) the government is no longer purchasing uranium and appears to have pretty well worked off its stockpile via its mixed tails approach to selling enrichment services; and (6) uranium prices have about tripled during the last two or three years.

Although time will not permit me to address each of these factors individually, there is, I believe, a logical answer or explanation for each which in the aggregate convinces me that sufficient supplies of uranium will be available when needed and at prices that will not preclude the economic attractiveness of nuclear power.

Last year, exploration drilling in the U.S. totaled 26 million feet which represented an increase of 20% over the 21.6 million feet drilled in 1974. As Nuclear Industry's correspondent in Colorado explained the increased activity in the uranium industry last fall: "Anyone flying over the Uravan Mineral Belt on the Colorado Plateau these days would think the clock had been turned back two decades. Trucks and jeeps are again rumbling over almost forgotten haulage roads and scurrying hither and yon among the dry basins, twisted canyons and flat mesas. The ubiquitous drill rigs dot the sagebrush-covered terrain, poking puny derricks against the blue sky."

ERDA's National Uranium Resource Evaluation (NURE) program, initiated by ERDA's predecessor, AEC, in 1973, to map the entire U.S. for uranium deposits, including formations that have never been investigated as possible sources of uranium, was funded at $2,327,000 in FY 1975. For FY 1976, this funding will go up to $11,385,000. Although the first comprehensive NURE report is not due until early 1980, its contract studies are targeted at many areas other than the sedimentary sandstones where most present domestic production activities are centered. For example, one NURE contract investigation is surveying granitic and dolomitic rocks in Vermont, New Hampshire, Massachusetts, and New York, while another is surveying Triassic Basins in the Appalachians, primarily in Virginia and the Carolinas, and still another is looking into the feasibility of aerial radiometric and magnetic surveying of the entire state of Alaska. The comprehensiveness of the NURE program reaffirms the basic fact that uranium is known to exist in all types of geologic formations, in contrast to fossil fuel deposits whose origins require the former existence of vegetation. It seems reasonable to assume that under circumstances of pending shortages, uranium would undoubtedly be recovered from deposits that today could not be considered economically viable.

ERDA's most recent estimates show "reasonably assured reserves" of 600,000 short tons of U_3O_8 yellowcake and "estimated additional resources" of 2,900,000 short tons of U_3O_8 yellowcake, bringing total resources to 3,500,000 short tons. These resources, ERDA estimates, are recoverable at forward costs of $30/lb. of U_3O_8 or less. ERDA puts the cumulative demand for yellowcake during the 1975-2000 period at 1,660,000 short tons which indicates a comfortable margin of supply over demand.

For those who question whether there will be enough uranium to fuel the reactors on line in the year 2000 for their anticipated productive lifetimes of 40 years, we would point out that if the combination of reasonably assured reserves and estimated additional resources become available as needed and if we assume that 5,000 tons of yellowcake are required to fuel a 1,000 Mwe reactor over a lifetime of 40 years, the indicated total of 3,500,000 short tons of yellowcake will accommodate 700,000 Mwe of nuclear power. Against the 226,000 Mwe of nuclear power capacity now operating, under construction and on order, such supplies would, of course, be more than adequate. Even against the 800,000 Mwe of nuclear power capacity which ERDA projects will be in place by the year 2000, there would appear to be ample ground for confidence in knowing that presently indicated supplies of uranium would accommodate more than 85% of the projected requirements.

Perhaps of more importance in the short term is the fact that there is considerable activity under way in the development of new mines and in the building of new mills. On the basis of reported plans, some 6,300 short tons of U_3O_8 production capability, including expansion of existing mills, new mills, in-situ leaching and phosphate recovery operations, will be coming on stream over the next few years. Construction of additional capacity is known to be under consideration but has not yet been announced. Even so, still more capacity will have to come on stream by the early 1980's.

Although anti-trust considerations restrict what can be said about prices, particularly future prices, they do not restrict me from noting what is already on the record. Part of that record is that the price buyers in the U.S. last year were willing to pay for spot deliveries was $35 per pound of U_3O_8. This compares to a $15 spot delivery price in 1974. As to the impact of future price increases or decreases, a change of $10 per pound in what a utility has to pay for yellowcake has recently been calculated to equate to a change of 0.96 mills per kwh in the cost of nuclear generated electricity at the bus bar. The other observation that might be made about prices is that as further exploration proves out additional reserves, as the uranium producers become willing again to enter into long-term supply contracts, and as restrictions are removed on the import of uranium, the U.S. buyer should be able to anticipate greater stability in uranium pricing than has been the case during the past couple of years.

Enrichment Capacity

I suspect the members of the JAIF have followed recent events on the U.S. uranium enrichment scene as closely, if not more closely, than have the members of the U.S. Forum. Hence, there may be little I can add to your assessment of the problem or to your best guess as to when and how it will be resolved. I say "guess" because at this stage, there is still ample room for speculation as to what is going to happen and in what time frame.

In capsule form, the problem shapes up as follows. ERDA's three existing gaseous diffusion facilities at Oak Ridge, Tennessee, Paducah, Kentucky, and Portsmouth, Ohio will have a combined capacity to support the enrichment needs of 290,000 Mwe of nuclear power plant capacity without plutonium recycle and 350,000 Mwe of capacity with plutonium recycle. These numbers assume installation of a cascade involvement program (CIP) and a cascade upgrading program (CUP), both of which I understand are proceeding on schedule, that will bring the combined annual capacity of the three plants up from 17.2 to 27.7 million separative work units (SWU.) It also assumes that the 1,300 Mwe of additional input power required to achieve the 10.5 million SWU CIP/CUP addition will be available as needed. I'm not sure that we have yet been told that all of this additional 1,300 Mwe is under contract. The capacity numbers also assume an equilibrium operating tails assay of 0.3% U-235. ERDA calculates that by raising the tails assay to 0.36% U-235, it could increase the output capacity by about 10%, that is, up to where it could support 320,000 Mwe of nuclear power plant capacity without plutonium recycle.

Against this capability, ERDA now has contract commitments to supply separative work for 329,000 Mwe of nuclear power capacity. This number includes 208,000 Mwe of U.S. nuclear power plants and 121,000 Mwe of overseas plants. Although these numbers indicate a deficit in enrichment capacity equivalent to about 9,000 Mwe of nuclear power plant capacity, ERDA points out that its contracts to supply enrichment services for 14,000 Mwe of overseas capacity are contingent on those plants being able to recycle plutonium. Even so, ERDA tends to look upon its contract commitments to supply enrichment services for 329,000 Mwe of nuclear power plant capacity as an "over-commitment" of sorts since it is not sure that the utilities will be able to acquire sufficient quantities of uranium to make up the extra feed to operate the plants at 0.36% U-235 tails.

In any event, ERDA is accepting no more purchase orders for separative work. It expects such additional requests to start coming in about 1984-85.

As to how additional requirements for separative work will be met, the Administration hopes that the Nuclear Fuel Assurance Act, now pending before the Congress, will be enacted, thereby permitting private companies to get into the enrichment business and serve the needs of all new orders for separative work. ERDA has already accepted as a basis for further negotiation, proposals from Uranium Enrichment Associates to build a 9 million SWU gaseous diffusion plant and from three other organizations to build smaller centrifuge enrichment plants, all on a modular basis. Centaur Associates, Exxon Nuclear and Garrett Corp. each hope to have their first modules in operation in 1981. Centaur's first module will have an output of 300,000 SWU's, Garrett's will be 350,000 SWU's, and Exxon's will be 1 million SWU's. Each of the three plants will be expandable to 3 million SWU's capacity.

The Administration is giving very strong support to passage of the legislation. Perhaps the most recent evidence of this to come to public attention is that last month it withdrew a request for design money in the FY 1976 budget for an add-on at the Portsmouth plant. Most, although not all, of the companies that comprise the U.S. nuclear industry support the bill and both the Forum and the Edison Electric Institute have indicated their strong endorsement to the Joint Committee on Atomic Energy.

As this paper was being completed, it was being rumored about Washington that the bill's chances of passage during the present session of Congress were reasonably good although there seemed to be little chance of action on any other nuclear-related legislation during this election year. If the bill is passed, I would expect to see an effort made to speed up the negotiations between the industry sponsors of the four proposed private facilities and ERDA in order to complete them in time to bring them before the Congress before it adjourns. If the bill isn't passed, it is difficult to speculate on what sequence of steps will next be taken by either government or the industry. In any event, the Forum's international conference on uranium enrichment, to be held in New York next June 6-9, should prove to be a most interesting and informative meeting.

Closing the Fuel Cycle

When one speaks of closing the nuclear fuel cycle, he is usually referring to the so-called back-end of the cycle, that is, resolving the problems that attend the reprocessing of irradiated fuel, recovering the unspent uranium and bred plutonium values, recycling the recovered uranium and plutonium as mixed oxide fuel, and disposing of the other product of reprocessing, namely the fission wastes. These problems are so interrelated that all of them must be solved in the same time frame to realize the economic benefits of reprocessing.

I might insert here the observation that notwithstanding occasional references to the contrary, the so-called "throw-away" fuel concept is not a viable option today in the U.S. There is simply no regulatory criteria or justification for such a concept. Hence, reprocessing is a "must" according to our current ground rules. The interim storage of irradiated fuel prior to reprocessing is, of course, possible and it is an option that nuclear utilities must use pending the availability of commercial reprocessing services. It is also an option that utilities may favor until the issue of plutonium recycle has been resolved and/or the price of uranium economically justifies reprocessing.

To complicate further the closing of the fuel cycle, we must concurrently solve the problem of transporting irradiated fuel and high level wastes and the problem of safeguarding plutonium against illicit diversion.

A cursory assessment might lead one to conclude that each of these problems should be resolvable by a straightforward and sound engineering approach. Indeed, the record would appear to support such a conclusion. For example, we have been successfully reprocessing reactor fuel at government installations at Hanford, Idaho Falls and Savannah River for years and we successfully reprocessed commercial reactor fuel at West Valley for more than five years. A prerequisite to these operations was the successful transport of irradiated fuel, albeit not in the same quantities nor throughout the same geographic domains as would be involved in large-scale commercial operations. We have successfully stored high level radioactive wastes, albeit not without occasional unnecessary tank leakage that led to some bad press but in no instance to any injury of workers or the public or to any adverse impact on the environment. We have also amassed considerable data on the technical feasibility of ultimately disposing of high-level radioactive wastes in underground salt formations. And finally, both the civilian nuclear industry and the military have moved significant quantities of special nuclear materials around the world without a single act of diversion coming to public attention.

What, then, is the problem? Why is it that after this experience and after industry has invested millions of dollars in reprocessing facilities, one reprocessing plant is having difficulties in getting a construction permit to expand its facilities and another virtually completed reprocessing plant is having difficulties in getting an operating license?

The answer in large measure, in my opinion, lies in the indecisions on the part of NRC, ERDA, and before them, AEC. Perhaps also the industry has not been sufficiently involved in coming up with answers for the questions that remain outstanding.

What are these unanswered questions?

First, let's look at what is already on the books in the way of regulatory guidance. A rule, published by the AEC in 1970, includes, among others, the following provisions: (1) a fuel reprocessing plant's inventory of high-level liquid radioactive wastes must be limited to that produced in the prior five years; (2) in compliance with this inventory limitation, such liquid wastes must be converted to a dry solid and put into sealed containers; and (3) all such canned dry waste must be transferred to a federal repository within ten years following initial separation of the fission products. Beyond this, the rule says that the dry solid form of waste must be chemically, thermally, and radiolytically stable and that equipment to convert liquid wastes to solid form must be installed in reprocessing plants at the earliest practicable date.

But the rule is not definitive on what wastes will be included within the high-level category. Nor does it indicate precisely what solid forms will be accepted by the federal repository. Under these circumstances, it is understandable that reprocessors have not yet committed the capital funds for facilities to convert the liquid wastes to solid form.

Another unanswered question is whether the solidified wastes should be disposed of in underground salt beds or as an interim measure, stored in surface engineered facilities. There has been much discussion on this question over the past five years both within and outside the nuclear industry. And it has proved difficult during the many debates that have taken place to keep political and emotional considerations from not completely masking technical issues and options. Currently, ERDA is opting for disposal in underground salt beds.

The frustration of not being able to deal with the problem on a strict technical rationale was reflected recently by former AEC Commissioner William O. Doub when he said: "For 15 years the issue has been studied. The technology and methodology for the handling of this problem is well known. There is simply no rational reason why the decision cannot be made, and I agree with every critic of nuclear power who is demanding an early announcement of the answer to this question."

Another thing holding up the closing of the fuel cycle is resolving the question of what to do with the plutonium. There is no question about the technical feasibility of using plutonium in mixed oxide as recycle fuel in light water reactors. The technology has been adequately established. There may be some question about the economic merits of plutonium recycle but it seems to me that the answer to this question is more a matter of timing than substance. Admittedly, a utility is not going to spend the money to have its irradiated fuel reprocessed and the recovered plutonium incorporated into recycle fuel unless it believes that it is going to get out of the fuel more value than it put into having the plutonium separated out and fabricated. Surely as the cost of uranium and enrichment continues to go up, reprocessing will become more and more attractive.

The principal problem here is one of safeguards. It is a problem that obviously will warrant increased attention as the use of plutonium in mixed oxide fuel becomes more widespread. It is also a problem that obviously has received a lot more attention as a result of the rash of terrorist activities that have taken place around the world in the last few years. But, it is also a problem that lends itself to satisfactory resolution if it is rationally defined. Like problems in the reactor safety area, however, it can be magnified beyond all reason by repeated unreal "what if" scenarios of speculation.

It was on the issue of safeguards that the Council on Environmental Quality challenged AEC's generic environmental impact statement on the use of mixed oxide fuel, the so-called GESMO. This led to NRC's interim decision of last May which said, in essence, that it would hold up all related licensing until mid-1978, by which time it would have completed an exhaustive study on safeguards, convened public hearings on its findings, and reached a final decision on the matter. Industry's immediate reaction, loud and clear, was that this degree of conservatism was totally unnecessary in view of the extremely small amounts of plutonium that would be in the pipeline up to the mid-1978 date and in view of the number of long lead time industry actions that would have to be held up pending the decision. NRC has now said it should be able to speed up its final decision to early 1977, and that in the interim it will proceed with the licensing review of applications for reprocessing plants and related facilities.

NRC's mid-November decision has since been challenged in the courts by the National Resources Defense Council and the Attorney General of the State of New York. Although no purpose would appear to be served by speculating on the outcome of that case, it might be noted that: (1) the NRC has already published the schedule and procedures for the hearings it will hold on the matter, thus answering, in part, one of NRDC's complaints; (2) the attorney representing NRDC has likened the NRC's mid-November decision to AEC's 1969 decision that resulted in the Calvert Cliffs court case, apparently without taking into account that the NRC decision on plutonium recycle was made in light of the Calvert Cliffs experience; and (3) the industry has evidenced its strong support of the NRC decision with two reprocessing firms, two NSSS manufacturers and two utility groups, representing more than a dozen individual utility firms, seeking to intervene. The court has adopted an accelerated schedule for the case; hence, it may not be too long before we have a decision.

The industry believes that current safeguards measures are adequate for today's circumstances, given the type and quantities of special nuclear materials now in use. It believes that future modifications of today's safeguards measures should be based on a graded system, that is, on a system that recognizes that measures appropriate for safeguarding low enriched U-235 do not need to be of the same type and same degree of sophistication as those used in safeguarding plutonium. The industry is fully prepared to accept its share of responsibility, along with government, in detecting and preventing theft, sabotage and proliferation of weapons capability. It looks to upgrading physical and personnel security measures, accountability and materials monitoring measures, and communications measures for providing the kind of safeguards circumstances may reasonably dictate.

Public Acceptance

We now return to what I identified earlier in this paper as the most critical problem confronting the nuclear industry at this time - winning public confidence in nuclear power. I say "winning" because I mean exactly that. There is in the states a small vocal minority with the avowed purpose of halting nuclear power within the next five years. This group, led by Ralph Nader who says that nuclear power is unsafe, unnecessary and uneconomic, is using a variety of tactics to accomplish its objectives.

Although I would be the first to admit that I don't understand their motivations, it is clear to me that if they succeed, the American public will be the loser. There is simply no way that we can meet our electric power requirements during the next 25 years without nuclear power. I am certain that the public will eventually become convinced of this. What is much less clear, however, is what irreparable damage will these critics have done to the cause of energy independence before that date arrives and what will they conclude they have accomplished in the process.

Today's critic is a different adversary than he was just a few years ago when he was intervening in individual licensing cases. At that time, he was attempting to convince hearing boards that a proposed reactor was not properly designed and that the public would be exposed to excessive amounts of radiation if the plant were allowed to be built and operate. Not having the facts on his side, he couldn't hope to achieve much other than to delay the proceedings and run up the cost of the nuclear plant. In some instances, he did succeed in doing that.

Next, the nuclear critic turned to the state legislatures, seeking the passage of nuclear moratorium bills at the state level. Again, his success was minimal. Although 36 anti-nuclear bills were introduced in more than 20 states during the past year, only two states, Vermont and New York, have passed restrictive legislation. Vermont now requires legislative approval of the construction of any power reactor and New York imposes specific restrictions on the location of nuclear facilities.

Rather recently, the critics have turned to a new strategy. The initiative process. In some 22 of the 50 states, it is possible with the collection of sufficient signatures to have an issue put to vote in a statewide referendum.

The first and most serious initiative threat is centered in California. The vote there will come in June and at this point it appears that it could go either way. A statewide survey made last November involving 570 personal interviews indicated that 45% of the registered voters were aware of the initiative. Of these some 19% favored the initiative, 18% opposed it, and 8% were undecided. The pollster who made the survey pointed out that a 45% awareness level is very high compared to other initiative efforts over the last 30 years.

In the next couple of months, we can expect to see an acceleration of activity on the part of those favoring as well as opposing the initiative. I would hope that before the citizens of California actually go to the polls they will give some further thought to the implications of the initiative if it were to pass. Among them are: (1) its potential economic and environmental effects are unknown; (2) contrary to what its proponents claim, there is a close relationship between energy, standard of living and jobs and this is particularly so in California which already imports about 58% of its energy, compared to the national average of 18%; and (3) if passed, it would be extremely difficult to reverse since the criteria that would have to be met to allow California utilities to opt for nuclear power in the future are so vague as to defy proof that they can be met.

An additional threat of the California initiative if passed is that before its adverse impact could be fully understood or felt, it would provide the impetus for other initiatives to be passed. And although it is difficult to believe that initiatives in other states will be as badly worded and for this reason as insidious and mischievous, this doesn't exactly classify them as being in the public interest. The initiative has already qualified to be on the ballot next year in one other state, signatures are being collected towards that objective in seven states, and initiatives are being drafted in three states. In only one state, thus far, were the critics unable to collect enough signatures, but this may prove significant because an all-out drive was made to reach the required 60,000 total.

The proponents of these initiatives are primarily using the arguments: (1) that radioactive waste management has not been demonstrated; (2) that full-scale safety systems have not been tested, won't work, and that if the industry thought they would there would be no need for Price-Anderson indemnity; and (3) that nuclear power is not economic and not needed and that we can meet our future energy needs by a combination of conservation and solar energy.

One of the facts that the initiative effort has tended to underscore is that the demise of the Atomic Energy Commission created an information vacuum that has not, and in the near-term probably will not, be filled. The Nuclear Regulatory Commission is functioning strictly as a regulatory agency. This is as it should be. The Energy Research and Development Administration has to be concerned with all energy technologies and hence, it can't be the nuclear champion the AEC used to be. The Federal Energy Administration recently set up a pro-nuclear group within its staff, but this move ran into the opposition of a Congressional committee and had to be disbanded. There also exists in Washington another vacuum created by the recent retirement of some of the most knowledgeable energy leadership in the Congress.

I would be remiss in describing the nuclear public acceptance problem if I failed to mention the all-important role being played by the news media, both written and electronic. Although the majority of the media makes an honest attempt to be neutral in the controversy, the American press -- and I suspect to some extent this applies to the media in other parts of the world as well -- operates on the working principle that "bad news" is newsworthy and "good news" is not. Too often, this rule of thumb doesn't permit extensive coverage of the routine "everything is going well" story.

The industry, through the Forum and with the assistance of a number of other associations, is taking a much more active role in generating and disseminating information. It is essential that the decision makers have all the information available, not just what pours in from the nuclear opposition. Our thesis is that the non-technical segments of our society, the public, the politicians and the press, who must ultimately make the broad policy decisions, should do so on the basis of the best and most complete information at hand. It is, therefore, the responsibility of the scientists, engineers and others who comprise the nuclear industry to speak out and we are urging them to do this.

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I am optimistic about the long term future of nuclear power if for no other reason than I believe in the innate intelligence of the average citizen to recognize what is in his own best interests. And although it wouldn't be unpleasant to return to "the good old days" to which I referred at the beginning of this paper, optimism and faith in our fellow man, along with a lot of hard work, should make it possible for us to meet the challenge ahead.

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

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未公表に付
取扱に注意

A YEAR OF NUCLEAR REGULATION UNDER THE U. S. ENERGY REORGANIZATION ACT

Remarks by
Edward A. Mason, Commissioner
U. S. Nuclear Regulatory Commission
Before the 1976 Annual Conference of the
Japan Atomic Industrial Forum
Tokyo, Japan

March 11, 1976

In view of the recent reorganization of the regulatory structure in Japan and the proposal submitted by the Prime Minister for splitting the Japan Atomic Energy Commission into two commissions, I would like to share with you our experience in the United States during the first year following the reorganization of our Atomic Energy Commission. I hope that my discussion of our experience will help you in deciding on the organizational structures needed to meet the regulatory objectives of your country.

The Energy Reorganization Act of 1974

As my colleague Commissioner Rowden described for you -- exactly one year ago -- the Energy Reorganization Act of 1974, which went into effect in January 1975, abolished the Atomic Energy Commission and divided its functions between two new independent agencies, the Nuclear Regulatory Commission (NRC) and the Energy Research and Development Agency (ERDA). The Act affirmed U.S. national policy, "to develop, and increase the efficiency and reliability of use of all energy sources to meet the needs of present and future generations." Consistent with this policy, the Federal Budget, proposed by the President and approved by the Congress, includes substantial support for nuclear energy development and regulation.

A basic intent of the law was to create a strong regulatory agency unimpeded by competing or conflicting responsibilities and indpendent of other governmental bodies. The law did not provide for either Exeuctive approval or veto of NRC decisions. As we interpret our mandate, NRC has no responsibility to promote the nuclear option or to assure that the nuclear industry is economically profitable, or to arbitrarily restrain governmental and industrial development. Our responsibilities are to be certain that NRC regulatory actions provide for the common defense and security, that licensed nuclear plants do not constitute an undue risk to the public health, and that their construction and operation satisfy environmental protection and antitrust laws. We believe our decisions have been made without bias, either towards promotion or restraint of nuclear energy developemnt and utilization.

In addition to creating an independent regulatory body, the Energy Reorganization Act, by dividing the functions of the former Atomic Energy Commission between two new independent agencies, created a more practical structure. Under the previously existing law, the Atomic Energy Commission has authority over a broad range of activities -- including research and development of nuclear energy sources, production of nuclear materials, support of certain military programs, regulation and licensing of nuclear facilities and materials, participation in international cooperation agreements. Ten years ago, when the nuclear industry was really first beginning, a single commission could deal effectively with all of these activities. Today, however, with 58 licensed nuclear power plants operating and about one hundred under licensing review, the Commission would find it difficult to be fully effective in discharging our regulatory responsibiities in the nuclear power field and still have sufficient time to devote to the other items in the former AEC agenda. Your recent decision to reorganize was probably stimulated by the same growth phenomena. According to published data, ten nuclear plants in Japan generated about 1.75 million megawatt-hours of electrical energy during the month of December 1975. With these operating units plus the many other units under construction or planned for Japan, your regulatory burgen is now substantial, and the need is apparent for considering modification of the organizational structure which has served for the early development of nuclear power in Japan.

The Reorganization Act transferred to the Nuclear Regulatory Commission all the licensing and related regulatory functions of the former Atomic Energy Commission as well as the responsibility for supporting research needed to perform these functions. The Act also required the NRC to submit, within one year, reports on nuclear energy centers and on the need for a Federal Security Agency. ERDA was made responsible for all other functions of the former AEC and for the direction of governmental activities relating to research and development of other energy sources -- activities which had been conducted by other agencies. To perform the latter functions, certain other governmental organizations were transferred to ERDA.

Careful study of the Reorganization Act reveals how it reflects public and congressional concerns over recent nuclear developments. Congress intended to create a strong and independent regulatory agency in the nuclear energy field, with no promotional functions. This intent reflected concerns over the apparent erosion of public confidence in nuclear regulation. It probably was also intended to be responsive to allegations of AEC bias in regulatory decisions.

The Reorganization Act also appears to have been responsive to public apprehension over increased terrorist and other anti-social acts. The Act mandated a specific NRC organization to direct nuclear safeguards activities. The NRC is assigned specific nuclear safeguards tasks -- including the development of contingency plans for dealing with threats, thefts, and sabotage relating to nuclear materials and facilities and the publication of a security agency study.

To assure that the NRC has the information needed to perform its regulatory functions, the Act provides for the NRC to engage in, or contract for, research which the Commission deems necessary for the performance of its licensing and related functions, -- called "confirmatory research." Moreover, ERDA and other governmental agencies are required by the Reorganization Act to cooperate with NRC in planning and conducting this confirmatory research. Another evidence of response to public anxieties over nuclear plant safety is the Act's requirement that the NRC submit quarterly reports to Congress on "abnormal occurrences" -- defined in the Act as "an unscheduled event or incident which the Commission determines is significant from the standpoint of public health and safety."

The Reorganization Act left intact many of the regulatory structures and activities from the former AEC. Proposed licensing actions are still considered in public hearings before an Atomic Safety and Licensing Board. The review of Licensing Board decisions by an Appeal Board and Commission reviews of Board decisions have not been changed by the Reorganization Act. The Advisory Committee on Reactor Safeguards continues to provide an independent review and assessment of nuclear safety and the licensing of nuclear facilities. In view of its probable interest to you, I should point out that the NRC was assigned the AEC's responsibilities for issuing licenses for export and import of nuclear materials, equipment and technology. We are carrying out these responsibilities in close consultation with other agencies, such as the Department of State, the Atomic Control and Disaramament Agency, and ERDA.

Nuclear Regulatory Commission Organization

The organizational framework established by the Energy Reorganization Act was described by Commissioner Rowden in some detail last year. The Nuclear Regulatory Commission has five Commissioners, as did the former Atomic Energy Commission. (Because of the difference between the organizational requirements for administering a research and development program and administering a regulatory body, the head of the Energy Research and Development Administration is a single individual, the Administrator.)

Day-to-day activities of the Nuclear Regulatory Commission are an Executive Director for Operations who has a staff of about 2000 employees organized into five major offices -- Standards Development (SD), Nuclear Materials Safety and Safeguards (NMSS), Nuclear Reactor Regulation (NRR), Nuclear Regulatory Research (RES), Inspection and Enforcement (I&E) -- plus technical support and administrative offices. This separation of responsibilities follows previous patterns. While we have made a few changes, my colleagues and I on the Commission are pleased with the general organizational structure as an effective means to accomplish the tasks we face. (A copy of the latest NRC organization chart is attached.)

During the past year, we have made a few changes in the organization within the five major offices. One which I believe may be of interest to you concerns the review and evaluation of proposed sites. As you know, each proposed site has to be considered in terms of safety and the environment. We ask two basic questions. First, can a nuclear plant be constructed on the site and operated safely, or are there natural conditions -- such as earthquakes, floods, tornadoes -- or nearby human activities - such as airports, refineries, transportation corridors, concentrations of population -- which may make the site unsuitable? Second, if a plant is constructed and operaed on the site, will its effects on the environment be unacceptable even when balanced against the benefits derived from the plant? In the past, response to the site safety question has been assigned to one organizational unit (Division of Technical Review) and the response to the environment question to another unit (Division of Reactor Licensing).

Now, all aspects of siting are reviewed and evaluated in one division within the Office of Nuclear Reactor Regulation, the Division of Safety and Environmental Analysis. We believe this is a more efficient organizational structure.

I should note that specialists in siting -- such as geologists, hydrologists, econogists, soil engineers, meteorologists, auqatic biologists, demographers, seismologists -- are concentrated in the reactor regulating part of the NRC because there are so many more reactors than other types of nuclear facilities. Moreover, power plant siting usually requires extensive analysis in view of the sensitivity of nuclear reactors to environmental factors.

The organization of a regulatory body must keep pace with changes in the activities that are being regulated. Because of the increasing number of operating nuclear power reactors, the NRC staff assigned to licensing activiteis for operating reactors doubled during the period from early 1974 through 1975. Last year, we responded to this growth by creating a Division of Operating Reactors. This division is devoted to assessing and assuring, on a continuing basis, the safety of operating reactors. In addition, it is responsible for seeing that information on operating experiences and incidents is fed back into the licensing program and to other operating plants. We consider this feedback function to be extremely important. The benefits of "learning from experience" are obvious.

Our organizational structure for safeguards functions may also be of interest. In NRC, we have combined within one organizational unit, the Office of Nuclear Materials Safety and Safeguards, the function of regulating facilities associated with the processing, transport, and handling of nulcear materials with the function of providing and maintaining safeguards against threats to those facilities. We believe this arrangement is more appropriate than placing the safeguards organization under the Office of Nuclear Reactor Regulation, because a nuclear power plant provides relatively few opportunities for theft or diversion of nuclear materials in comparison to the opportunities provided in transporting nuclear fuels, reprocessing spent fuels, and fabricating new fuels.

Before concluding my remarks on the organizational structure of NRC that handles technical issues, I should point out that even though most of the siting specialists are part of the reactor regulating organization, they do perform specific siting reviews and evaluation for other NRC offices such as fuel plants which are licensed by NMSS. Similarly, the safeguards specialists in NMSS perform safeguards reviews and evaluations for other NRC offices, such as nuclear power plants for which NRR has overall responsibility.

NRC Relationship with ERDA

The NRC has a useful and continuing relationship with ERDA. While the Energy Reorganization Act gives NRC authority to conduct confirmatory research, Congress indicated that the NRC should avoid duplication of existing governmental laboratories and should not develop its own facitilities. As a consequence, a large part of the NRC confirmatory research effort is conducted at ERDA-owned facilities. In addition to funding the work, we participate in the design of experiments and facilities -- all in close cooperation with ERDA and ERDA contractors. There have been some administrative problems in adjusting to this dual arrangement, but because of the technical sophistication required by many of the research projects which are needed to support regulatory functions, sharing facilities with ERDA should have both schedule and cost advantages.

NRC supports and participates in the technical supervision and work being carried out for us at ERDA-managed national laboratories relating to: research and engineering projects on light-water-reactor safety, environmental impact assessment of proposed nuclear facilities, research relevant to development of more effective safeguards and physical security measures, safety of advanced reactors for which we anticipate license applications in the near future, and studies to improve our basic understanding of safety and environmental issues relevant to our regulatory activities.

The Nuclear Regulatory Commission also has safety and regulatory responsibilities with respect to several of ERDA's functions. The NRC licenses many commercial plants that supply nuclear materials to ERDA activities, as for example, the fabrication of the nuclear fuels of the naval reactors program. Under the Energy Reorganization Act, we are specifically responsible for licensing each ERDA demonstration reactor, such as the Clinch River Breeder Reactor. ERDA is developing a long-term radioactive waste management program and NRC will be responsible for licensing projects which proceed past the research stage. Through these licensing responsibilities, the public is assured of an independent review of those actions of ERDA which may affect the commercial uses of nuclear power. We also participate with ERDA in many phases of international programs on civilian uses of nuclear energy.

NRC Relationships with other Federal and State Agencies

Because the construction and operation of a nulcear facility usually involves routine releases of waterborne and airborne effluents and, in the case of nuclear power plants, the release of heated water and air, the U.S. Environmental Protection Agency (EPA) is involved. EPA is part of the Executive Branch of our government and has broad authority over the control of air and water pollution and exercises this authority, in part, by establishing guidelines and standards for control of pollutants and by issuance of discharge permits. Without proper discharge permits, a plant licensed by the NRC would be unable to operated.

In some areas EPA's several responsibilities for protecting the environment from all types of plant effluents and NRC's responsibilities for effluents from nuclear plants appear to overlap, but we have made considerable progress during our first year in reducing the possible complications related to discharge permits. Specifically, we have concluded a second Memorandum of Understanding with EPA clarifying our respective regulatory and jurisdictional responsibilities. Our basic intent is to minimize overlapping reviews and duplicative public hearings. As an example, we are making every effort to see that applicants supply us with sufficient information on the proposed facility to meet the NRC requirements for environmental impact assessment and the EPA requirements for decisions on discharge permit issuance. Both NRC and EPA are examining the same proposed facility and the same environmental setting; the advantages of cooperation and joint efforts are obvious.

Similarly, the multi-faceted governmental structure in place at both the federal and state levels in the United States creates NRC interfaces with other governmental agencies. The proposal to construct offshore nuclear power stations, for example, brings us into contact with the Coast Guard and the Army Corps of Engineers. I won't go into detail concerning these interfaces, as they may not be particularly relevant to nuclear plant regulation in Japan. I will remark, however, that coordination of reviews and responsibilities through development of formal Memoranda of Understanding has required significant staff time during our first year of operation. We consider it time well spent. Other government agencies have different missions and different areas of expertise. Their participation in determining the acceptable characteristics of one plant, its effluents and its interaction with the environment, assures that the broadest range of public interests is served.

We also have 50 separate state governments in the United States. Each of these local bodies has some measure of control over facilities that are permitted to be constructed and operated within its boundaries. NRC preempts state authority over radiological public health and safety, but treatment of nonradiological aspects of public health and safety lies with the states. There are 25 "Agreement States" where the NRC has given specific authority to each state in the licensing of utilization of certain radioactive materials.

Nuclear power plants operating, under construction or planned (as of December 31, 1975) are now located or are to be located in thirty-seven different states. We have an increasing program of cooperation with the states. Our basic objectives are to prepare the states to take on greater responsibilities in controlling radioactive materials, to establish coordination in nuclear power plant siting, and to maintain channels of communication with each state for exchange of views and information on nuclear activities of mutual interest. Again, the details of these efforts are probably of secondary interest outside the United States. Nevertheless, in any country where there are overlapping jurisdictions, nuclear regulation by a national body may require coordination and cooperation with local or regional authorities.

During the first year of NRC operation, a single organizational unit -- the Office of International and State Programs -- handled NRC relationships with other nations as well as with other states in the United States. Because of the increasing involvement of the NRC in both domestic and international programs, we have recently decided to separate these functions and replace the single unit by two organizational units, the Office of International Programs and the Office of State Programs.

NRC Relationships with other Nations

As I noted earlier, the NRC issues licenses for the export and import of nuclear facilities and materials as one part of our international activities. We also participate in arrangements for exchange of information relevant to nuclear regulation and for cooperation in safety-related research. During the past year, we have concluded four bilateral arrangements for information exchange -- these are in addition to the five previously set up. The flow of information is in both directions. We know that we have been helped in our work by information we have received under these arrangements, and we hope that others have found useful the information we have supplied.

Perhaps the NRC's most important international activity is cooperation in reactor safety research. In addition to participating in a number of agreements with other nations for information exchange, we have specific agreements for cooperation in NRC research programs. The U.S. programs we consider of particular value for multi-national participation are: the Loss-of-Fluid Test (LOFT), the Power Burst Facility (PBF), the Plenum Fill Experiment (PFE), and the Heavy Section Steel Technology (HSST) project. The newly formed International Energy Agency (IEA) -- representing many European industrial nations and Japan -- provides a suitable framework for cooperation in these programs. In June 1975, the NRC and the Federal Republic of Germany signed the first cooperative agreement under IEA. The agreement included participation of technical experts in LOFT and a contribution to the program costs. We are particularly gratified that, under recently completed arrangements, Japan will participate in the LOFT and PBF projects.

The NRC has many contacts with the International Atomic Energy Agency (IAEA). During the past year, experts on our staff have participated in IAEA's program for the development of internationally acceptable guides and codes on nuclear power plant siting, safety and reliability. We have also actively supported efforts to strengthen international safeguards procedures and to improve training of the technical and administrative personnel needed for regulatory agencies.

Our first year's experience has reinforced our belief that nuclear regulatory bodies throughout the world must cooperate to assure that the production of nuclear energy is carried out in a safe manner. International cooperation should not only take the form of sharing experiences in the daily activities of regulating and licensing nuclear facilities and materials, but it should also include prompt international sharing of safety-related information derived from operating nuclear facilities. A nuclear power plant's performance is independent of its location in the world, and one country's problem becomes every country's concern. We strongly urge prompt international sharing of all information relevant to reactor safety.

NRC Staff Policies

There are almost 1200 technical and professional personnel on the staff of the NRC's five major offices. You may have read about the recent resignation of one of our professional staff, an engineer who participated in the technical evaluation of proposals to construct and operate nuclear power plants. Because his resignation has raised questions about our regulatory practices and personnel policies, I believe a few comments are in order.

Upon resigning the NRC engineer, at our request, submitted two reports summarizing his position and his allegations with respect to deficiencies in licensing procedures and regulatory management. We reviewed the material he presented and concluded that the safety issues raised were not new; they had been raised before and they had been -- and continue to be -- carefully considered in licensing reviews. There was no need for an immediate change in our regulatory procedures or any immediate action respecting plants already licensed.

We have always encouraged the free flow of information and views throughout our staff. As a regulatory agency, we expect there have been and there always will be some differences of opinion within our staff. In fact, we view such differences of opinion as a positive indication of the depth and thoroughness of our review. The technology we are regulating is complex and changing. The issues are not always simple, and decision-making usually requires mature engineering judgment. As a consequence, NRC procedures provide for resolution of differences of opinions within our staff and for referral to higher management when resolution is not possible.

Before leaving this subject, I should like to comment on our review procedures. We have published almost two hundred "Regulatory Guides," which are available to you. These describe the methods acceptable to the NRC staff of implementing specific parts of our regulations and the techniques used by the staff in evaluating specific problems or postulated accidents. The guides also provide guidance to applicants on such matters as the content of safety analysis and environmental reports and the application of industry codes and standards. We are convinced that issuance of these guides is essential to our operation.

In addition -- and this is particularly relevant to the possibility of diverse views within the regulatory staff -- we have published the "Standard Review Plans" describing how the staff reviews each subsection of the applicants' safety analysis reports. This 1400-page document details our acceptance criteria and evaluation methods. We believe the Standard Review Plans ensure that our reviews of proposed nuclear plants are complete and that each plant is evaluated in the same way and according to the same standards. It is, in a sense, a codification of regulatory staff licensing practices.

The Standard Review Plans were prepared by the regulatory staff and approved by regulatory management. Your regulatory body may find these plans of interest. I should emphasize that management approval is essential in view of the need to integrate the views of a staff including many different areas of expertise. During the past year, we have strengthened the role of management review by requiring that all proposed changes to NRC requirements and practices -- including changes to Standard Review Plans -- be reviewed and approved by a Regulatory Requirements Review Committee, a committee of senior NRC officials.

NRC and the General Public

From our first year's experience, I can confirm that nuclear regulation in the United States is strictly "public business." Public scrutiny of regulatory decisions and public participation -- primarily through the hearings NRC holds in connection with each major regulatory action -- is a tradition in the United States and is necessary, not only to assure public conficence, but to be certain that the public interest is considered in regulatory decision-making.

Public sensitivity to the nuclear industry has varied. Six or seven years ago, most public protestrations concerned the environment. Nuclear power plants were accused of damaging aquatic life in the rivers, lakes and estuaries and generally despoiling the natural environment. To a degree, these earlier protests were justified. Some of the first nuclear power plants were located in areas where environmental degradation could not be avoided. The designers of the plants had not given sufficient attention to preserving environmental values.

This situation was altered by enactment of the National Environmental Policy Act of 1969. The Act required the regulatory agencies to give adequate attention to environmental factors in their decision-making. The nuclear industry was then required by the regulatory arm of the AEC to select sites where the environmental impact of building and operating plants would be acceptable and to incorporate in plant designs engineering features to mitigate environmental impacts. The result was that objections to nuclear plants based on environmental considerations became less frequent.

The focus of public attention then turned from the environment to nuclear safety. Reactor safety has always been a matter of public concern, but never to the extent it is now. Prior to 1970 -- when only a few reactors were operating and most of these were in remote areas -- few sectors of the general public were affected by the reactors and few were even aware of their operation. Today, with fifty-seven large nuclear reactors operating in the United States, most of the public knows of their existence and an appreciable fraction of the public have had direct contact with nuclear power projects.

Unfortunately, reactor safety is a complex technical subject, and public understanding does not appear to have increased as the number of nuclear plants has increased; it is, at best, fragmentary. In the absence of understanding, the public becomes apprehensive. As a consequence, we now have political movements in a number of our states directed towards banning or suspending construction of new nuclear plants and operation of existing plants. We are following these local moves towards "nuclear moratoriums" with some concern because we find that public opinion is being influenced by erroneous information relative to the safety of licensed nuclear facilities. As a regulatory body of the Federal Government, we are not involved formally in these state activities. However, we are making every effort to provide all state bodies with the factual information they have requested in connection with their consideration of proposed nuclear moratoriums. Public opinion polls taken during the past year indicate only about 20% of the U.S. population are opposed to nuclear power; however, these polls also show that, on many specific issues, a large fraction of our population is uninformed and undecided.

During our first year, the Commission and the regulatory staff have exerted every effort to inform the public on nuclear safety. We and others have issued comprehensive technical reports relating to reactor safety and to the relative safety of alternatives to nuclear power. Although many of these will not be read by the general public, we expect their content will be transmitted to the public by the scientific and engineering community. I am optimistic that public understanding will increase, even though the rate of increase may be rather slow. In any case, because public understanding is essential to public confidence -- and public confidence is a prerequisite to a viable nuclear industry -- we must continue the efforts aimed at informing and educating the public.

Major NRC Reports

During 1975 and early this year, three important reports were issued. The final report of the Reactor Safety Study -- the "Rasmussen Report" -- was issued. This report is extremely valuable in putting reactor accident risk in a valid quantitative setting. Moreover, I believe it establishes a precedent for future studies that may affect regulatory criteria throughout the world. We want very much to make our regulatory requirements consistent with the risk reduction they achieve. At present, we compensate for any limitations in quantitative data by imposing conservative regulations. More studies of the scope and caliber of the Reactor Safety Study should enable us to improve our regulatory criteria.

The report of the Nuclear Energy Center Site Survey was published in January of this year. The general conclusion is that such centers are technically feasible, although the economic and environmental advantages are not decisive. The survey concluded that -- in some locations in the United States -- construction of centers of up to twenty 1000-MWe nuclear power units is feasible and practical.

The about-to-be-released security agency study evaluates the need for a Federal security force to perform safeguards functions. At present, safeguards measures at each nuclear facility are carried out by employees of the facility operator. The general conclusion of the study is that there is no clear advantage at this time to create a Federal security force for the nuclear industry.

Technical Problems During First Year

During the past year the Commission has faced many problems. A brief review of these may be useful to you in developing a perspective as to the range of issues which a nuclear regulatory organization must be able to cope with and to resolve.

Last year, Commissioner Rowden described to you the concern we had with the appearance of cracks in stainless steel pipes in certain boiling water reactors. The extent of cracking, although limited, had safety implications because it involved the reactor coolant system. An extensive investigation identified the cause. As a result, affected pipes have been replaced and a surveillance program instituted. NRC and ERDA are sponsoring continuing studies of the problem. The results of the studies are being made available to all BWR operators -- including those here in Japan where similar cracks have been observed.

Late in March 1975, there was a serious fire at the Browns Ferry nuclear plant. The fire itself was limited in extent but it involved the electrical cables under the control room -- shared by two 1098-megawatt units -- and one of the reactors. Because about 1600 electrical power and control circuits were affected, some operating and safety systems were deactivated. Although the units were safely shut down and maintained in a safe cooled condition and there were no radiation exposures to plant personnel or the public, the incident revealed weaknesses in fire prevention and fire control measures.

A special NRC review group has recently issued a detailed report on the Browns Ferry fire and has recommended certain NRC actions. The principal recommendations were: greater attention should be paid to fire prevention measures in nuclear plants; installation or upgrading of automatic, fixed fire-fighting systems, such as water-sprinkler systems, should be seriously considered in vulnerable nuclear plant areas; fire detection sensors that detect combustion products should be installed; the existing criteria for separation and isolation of redundant safety equipment need to be improved; quality assurance programs of all nuclear power plant licensees should be reviewed by NRC, and the NRC review should be upgraded to include explicit evaluation of fire protection, fire-fighting and provisions to maintain important functions in spite of a fire. Implementation of these recommendations should reduce the possibility of similar fires.

The Reactor Safety Study reviewed the consequences of the fire and concluded that, given the Browns Ferry fire occurred, there was only one chance in every five hundred such fires that a core meltdown would result. Their review indicated that the predicted potential accident risks from all causes were not greatly affected by consideration of the Browns Ferry fire. I should remark here that this is just one example of how the Reactor Safety Study and the methodology it presents can be used to evaluate the safety implications of various incidents.

Fuel box channel wear is another problem area that has continued during the past year. Basically, it is caused by hydromechanical effects. Coolant flow caused vibration in slender flux monitoring tubes in the reactor core, which hit against the outside of fuel boxes and resulted in wear. Corrective measures have been devised and implemented. Surveillance continues and reactor core designers are developing permanent solutions to the problem.

Another problem recognized last year related to the pressure-suppression type containments employed in some boiling water reactors. During NRC review of advanced designs of such containments, unforeseen structural loads were identified that could occur during certain large-pipe break loss-of-coolant accidents (LOCA). Consequently, the structural adequacy of nuclear power plants using the earlier designs was investigated by the plant owners, the vendor, and the NRC staff. The vendor (General Electric) conducted a series of 1/12-scale model tests and determined dyanmic loading and structural responses for each plant. The analyses of 19 containments -- concluded early this year -- revealed that in only one plant (Vermont Yankee) would there be unacceptable lifting forces during the postulated LOCA. The operator of the plant voluntarily shut down the plant January 26, 1976. Subsequently, the operator proposed to increase the pressure difference between the wet-well and dry-well to reduce the uplift forces and to install structural restraints to resist the uplift forces. These proposals were accepted and

and included as part of the restrictions set forth in the NRC's Order for Modification of License which was issued on February 13, 1976. On February 27, the other plants also increased the pressure difference between two containment vessels in order to increase the structural margin against downward forces.

The recent resignations of three senior engineers associated with General Electric's nuclear activities came as a surprise to us. They expressed few specific concerns on the safety of BWR designs; their concerns appeared to be rather general and philosophical. For example, they expressed fear over "the implications of a plutonium economy," maintenance of "the perfect human and technical control needed for the long periods of time necessarily involved in the highly toxic materials we are producing," "the high risk of political and human factors that will ultimately lead to the misuse of (nuclear power) byproducts," the inability to "prevent major accidents or acts of sabotage," "the ecological significance of the radioactive legacy," and "the technological requirement for 100% human perfection." They reassured a Congressional inquiry that specific technical problems in their specific areas of experience were solvable. In fact, you may find the extensive testimony prepared by the NRC on reactor safety and licensing and presented at this inquiry to be a valuable reference on nuclear power plant safety and regulatory procedures. The hearing record will be published by the U.S. Joint Committee on Atomic Energy in the near future.

Retrospect and Prospect

The first year of NRC has been eventful. Our just-issued Annual Report describes the issues that confronted us and the actions of the Commission and the staff in responding to these issues. I should like to conclude by offering a few comments that will reflect my personal views of the events of the NRC's first year.

First, nuclear regulation is demanding. Some statistics may indicate why. During 1975, almost an even one thousand formal items came before the Commission for consideration. Some of these were reports of information, others required consideration and formulation of policy, others required review and approval. Few were trivial and few were so routine that they could be scanned and filed. I don't have a score sheet for the regulations we promulgated, but I do remember one that occupied many Commission-hours -- the "as low as practicable" decision on routine releases of radioactive effluents from nuclear power reactors. You will recall that this was a landmark decision, one in which NRC required that an increase in cost of radioactive effluent reduction must be related to the reduction in population radiation exposure that is to be achieved. I hope that we will be able to base more of our regulations on such quantitative "cost versus benefits" criteria.

Second, the issues we must resolve are often mixtures of technical and nontechnical considerations. One that comes to mind is the plutonium recycle problem. Technically, solutions are available. Reprocessing spent fuels can be accomplished, and mixed oxide fuels can be fabricated and used in light-water-reactors. Plutonium can be handled safely in reprocessing and fuel manufacturing operations and can be transported safely. But the nontechnical problems are substantial. What safeguards measures must be taken to protect the recycled plutonium -- in the reprocessing plant, in the fuel fabrication facility, in transport? What measure of security must be achieved by the safeguards? Who are the terrorists or saboteurs against which the safeguards must be effective? Definite and adequate responses to these and many other questions are being prepared for presentation in public hearings and proceedings before a decision on plutonium recycle can be made. The Commission and the staff have spent many hours on the plutonium recycle question. Because of the urgency of resolving it -- the answer has a significant effect on nuclear resource plans -- we announced an accelerated schedule in November 1975. Both the draft safeguards supplement to the generic environmental statement on wide-scale use of mixed oxide fuels ("GESMO"), and the final generic environmental statement on all non-safeguards matters are in the final stages of preparation. The proposed rules for public hearings were published in January. We expect the public hearings to begin this fall and the final decision to be made early next year. It is a lengthy proceeding -- but then, plutonium recycle is an important decision.

A third impression I have of the first year is a succession of occurrences with sufficient safety implications to require careful Commission review, evaluation, and decision. I've mentioned some of these earlier. What I should like to point out here is that for many of these occurrences, the Commission must decide -- usually before the available evidence is substantial -- whether the occurrence is generic, that is, whether what has been observed in one reactor is likely to occur in others. Then we have to respond to such questions as: Should we shut down all reactors of similar design? Should we let them continue to operate but require prompt inspection and surveillance? Should we delay action until we have more information? The spectrum of possible responses is broad, and the responsibility of making the decision is challenging.

A final and most important impression I should like to pass on, is my feeling of optimism at the end of our first year. I am optimistic that nuclear regulation is effective and will continue to be effective in protecting the public health and safety and in preserving environmental values. All problems that we have encountered to date have solutions. In spite of some setbacks from time to time, I am optimistic that nuclear energy can be produced safely for the benefit of humanity.

3/11 (木) 14:00~
Session 3.

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未公表に付
取扱に注意

Nuclear Energy Administration
in the Federal Republic of Germany

by Dr. W.-J. Schmidt-Küster
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1. History

The importance of peaceful use of nuclear energy was recognized in Germany 20 years ago, initiated by the impression of the first Geneva Conference. Immediately after sovereignity had been regained in 1955 a Ministry of Atomic Affairs was founded and already in 1956 the construction of three nuclear research centers was initiated. During the initial period fundamental research was promoted generously. And only in the early 60ies Government funding was concentrated on those reactor lines which today are regarded throughout the world

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as being the most efficient and most promising for the immediate future. On the basis of licences from Westinghouse and General Electric it was possible to catch up with the initial lead of other industrialized nations. This has been demonstrated not only by the startup of the world's largest nuclear power plant, the 1200 MWe light water reactor Biblis A, but also by receiving orders from several other countries. German nuclear industry has developed a competitive position not only in the area of light water reactor construction but also in the delivery of components for nuclear power stations and to a certain degree in the entire fuel cycle - from uranium enrichment, fuel element fabrication and reprocessing to the safe handling of radioactive waste to the final disposal of radioactive wastes.

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Since 1955, the Government of the Federal Republic of Germany has spent about 16 billion German Marks on research and development in all sectors of peaceful use of nuclear energy.

Today, nearly 10.000 People are working in government-supported nuclear research centers. In industry the number of personell amounts to approximately 25.000.

2. Governmental Programs

The energy policy of the Federal Republic of Germany is outlined in the Government's Energy Policy Program. It was decided in 1973 and revised in October 1974. The program aimes especially at reducing the dependence on imported oil as fast as possible under economic

considerations. For the medium and long term procurement of energy two main measures are foreseen:

- the slowing down of the increase of energy consumption as far as possible without disturbing the economic growth and
- the reduction of oil consumption and the development of all promising alternative energy sources.

According to the Government's Energy Program nuclear power plants are expected to generate 45 % of the overall electricity supply in 1985. There is no doubt, that for the FRG only this source of energy combined with an increased consumption of natural gas can lead to a reduction of our dependence on oil from 55 % today to 44 % in 1985. In order to achieve this goal, an installed capacity of nuclear power plants of 20.000 MWe is foreseen at 1980 and 45.000 to 50.000 MWe at 1985, respectively.

In addition, particular efforts will be undertaken for the development of new energy sources as well as the introduction of new technologies for coal mining coal refining and energy conservation.

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The activities in the area of energy R&D are,at present,by a Nuclear Program for the period from 1973 to 1976 and a Skeleton Program for non-nuclear Energy Research 1974 - 1977. Both the programs will be combined during the course of this year in a new German Energy Research Program for a 4 year period (1977 - 1980). At the moment

we are preparing this program. In the nuclear field R&D activities in Germany are mainly concentrated on

- the development of two advanced reactor-systems including fuel cycle; the sodium cooled fast breeder reactor and the high temperature reactor,
- the nuclear fuel cycle for light water reactors,
- reactor safety research including radiation protection
- nuclear fusion, as a basis for long term mergy procurement.

The main objectives of the non-nuclear R&D are

- the development of new energy sources such as solar energy, wind energy, geothermal energy and others,

- coal gasification and liquefaction,
- coal mining engineering and coal handling technologies,
- development of technologies for prospection and production of oil and natural gas
- transformation, transport and storage of energy,
- rational utilization of energy.

3. Nuclear Energy Administration

In the FRG the development and introduction of nuclear energy was performed by three partners: Government, industry and nuclear research centers. What is the role of each of these partners? First the role of the Government. During the early years of nuclear energy a single ministry was responsible both for the promotion of nuclear

technologies and for regulatory questions.
But relatively early in 1972 we decided to separate these functions, because we expected more liberty of action and more credibility in the public. As a result of this reorganisation, today the responsibilities for development and licencing of nuclear energy systems are shared between two agencies: the Federal Ministry of Research and Technology for the promotion and the Federal Ministry of the Interior for regulatory questions. A development, which seems to be followed by other nations as for example the United States, where the AEC was split into ERDA and NRC.

The main task of the Federal Ministry of Research and Technology is the execution and implementation of R&D-programs whereas regulatory aspects of nuclear energy are being handled by the Federal Ministry of Interior and the regional State Governments.

This separation of Government's responsibilities with regard to nuclear energy has been predominated by two reasons: the public acceptance of nuclear energy and the necessety to make the conflict between promotors and regulators of nuclear energy more transparent. Today, there is unanimous judgement, that this concept has proven to be really valuable.

Nevertheless, the nuclear controversy plays an important role in

the Federal Republic of Germany. The Federal Government has therefore launched a major nuclear information program including public hearings, seminars and the distribution of a booklet describing all problems, advantages and disadvantages of nuclear energy.

Since all Federal Ministries have to submit their annual budgets for approval the Federal Parliament, the development and introduction of nuclear power systems into the market underlies an annual revision process. For example in our national Parliament an extensive debate on nuclear energy matters took place. There were, of course, expressions of concern and criticism against the fact or, at least, the speed, of nuclear energy introduction. But finally all political parties represented in the Bundestag voted in favour of nuclear energy, noting its necessity as well as its relative safety compared to other sources of energy and other risks of civilisation.

As far as the organisation within the Federal Ministry of Research and Technology is concerned, there is only a group of about 50 people working on the field of energy R&D. In some areas we get assistance from scientific and aministrative personell in our research establishments. In 1976 these few people have to administrate a budget of approximately 1,3 billion DM. Compared to other nations, such as France, the UK or the USA this is an extremely small group compared to the program, that has to be handled.

The money available goes approximately 50 % to industry and 50 % to research centers.

Industry as a major partner in the development and introduction of nuclear energy into the market includes both utilities and reactor manufactures. Both of them are private enterprises. As a result they have developed more independent views than similar companies in other countries, who are more dependent on Government operations. As a result the influence of Government agencies on the application of new technologies is based on the principles of a liberal market and therefore economic considerations dominate decisions to be taken.

This means, that only those technologies have a real chance of success, which promise economic advantages. In order to ease the introduction of new technologies into the market, industry must be involved in the development of new energy technologies from the very beginning. This includes financial participation to ensure real interest and all efforts to make the investment a success.

Examples for this cooperation between Government and industry are the development of advanced reactor systems or fuel cycle facilities, such as the 300 MWe prototype fast breeder reactor, SNR 300, the 300 MWe high temperature reactor of the pebble bed type, using the thorium fuel cycle, or reprocessing plant within the nuclear research center at Karlsruhe.

Whereas these prototype plants are being built and operated with the aid of the Government, the final construction of demonstration plants requires a large financial participation of industry. This means, that the next generation of reactors and fuel cycle plants will have to be financed completely or at least to a very high degree by industry.

Government influence on industrial activities financed by public funds is always guaranteed by conditions for granting fund and by project-committees. These committees take care of discussing programs and projects and giving advice for the realization of the different stages of the development.

The third partner in nuclear energy R&D are the nuclear research centers. Their major task within our development programs is to work between basic science and industrial cooperation in this area is mainly based on contracts between industrial groupings and research establishments. As an example I would like to mention our fast breeder development program, the high temperature reactor program and the technology for reprocessing of irradiated fuels. In addition, nuclear research centers are heavily involved in research and development in the field of reactor safety, in order to support of the Government in the continous effort to improve safety standards, to reduce the remaining risk and to improve licensing regulations. The results of these experiments are fully available to industry to improve their systems.

The high population density in the FRG gives rise to a particular interest to all the problems relating to nuclear safety. This fact has been demonstrated by increasing expenditures for R&D-activities for the safety of nuclear installation since 1974: 10 Mio DM in 1974, 90 Mio DM in 1975, 100 Mio DM in 1976. In addition to that we are trying to cooperate as close as possible with other nations in this area, to include findings of others, as appropriate, in our programs and standards and to convey our information to our partners, to improve their systems respectively.

Our nuclear research centers are generally financed 90 % by the

Federal Government, the remaining 10 % of the funds being contributed by the local Governments. The supervisory boards of these centers are controlled by the Government, so that an optimal link is guaranteed between the goals of governmental research programs and the industrial activities as well as R&D-programs of research centers.

At present 6 of these research centers are involved in the development of nuclear energy in Germany:

- the Karlsruhe Research Center, GfK, where the main activities of fast breeder reactor development, reprocessing, uranium enrichment by the nozzle process and reactor safety are concentrated,
- the Jülich Research Center, KFA, with its main activities in the area of high temperature reactor development, nuclear process heat application, reactor safety and nuclear fusion. This center is also

in charge of the project management of the Government's non-nuclear energy R&D program.
- the Geesthacht Research Center, GKSS, being specialized on nuclear ship propulsion and marine technologies,
- the Munich Research Center, GSF, cooperating with Karlsruhe and Jülich in the field of waste disposal and
- the Max Planck Institute of Plasma Physics at Munich (IPP), where activities in the area of nuclear fusion are concentrated.

4. Licensing of nuclear facilities

In a country like the Federal Republic of Germany with a very high population density the solution of safety problems requires greatest attention. For this reason the licensing procedure for construction and operation of nuclear facilities have to pass long and intensive studies of all relevant environmental and safety aspects. We are convinced that the German licensing procedure can be considered as one of the most rigid and accurate in the world.

Responsibilities and licensing procedures are organised in the following way: The Federal Ministry of Interior is responsible for the atomic law, the radiation protection regulations. The execution is delegated to the regional states acting on behalf and under supervision of the Federal Government. This procedure although being relatively complicated, has proved to work satisfactorily because the Federal Government in this way is able to take into account new aspects arising from experiments and operating experience or

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international relations and to guarantee, that all new standards be applied equally in all states of the Federal Republic. The states are responsible, inter alia, for granting licenses under the laws and regulations pertaining to water, energy economy, conservation, civil works and environmental impacts. During the licensing and supervisory procedures they act in close contact with the site personnel and in direct connection with the applicants.

The licensing procedure begins with an application, eg. by a utility, to the respective State Ministry for construction and operation of a nuclear facility. The State Ministry then asks for expertises on all nuclear aspects of the application from the technical supervisory agency (TÜV) and on non-nuclear aspects from other experts and agencies. In parallel the State Ministry submits the application to the Federal Ministry of Interior and informs other local state or federal authorities. It will also inform the public by publishing all necessary documents. At the same time the application will be announced publicly, so that interested people get the chance to study the reports and papers submitted with the application. They also have the possibility to ask questions and to file opposite views.

All remarks and interventions are then being dealt with in a public hearing.

The Federal Ministry of Interior after receiving the report of the

state government will submit the case to its top advisory committee, the Reactor Safety Commission for advice. Both, Reactor Safety Commission and the technical supervisory agencies are closely cooperating with the Institute of Reactor Safety and other independent experts.

Within this community of experts and authorities intensive discussions take place and very careful investigations are carried out taking into account, all aspects and details of the design and the possible impact on the environment. All questions and new problems arising during the course of these procedures have to be answered by the applicant.

It normally takes in the order of two years until all recommendations and reports are available. On the basis of these documents the Federal Ministry of the Interior will then formulate the necessary licensing conditions. The State Ministry has to apply these conditions and will in addition to that take into account recommendations of other local-, state- and federal authorities and as far as justified of intervenors before a "first partial construction license" can be granted, which authorises the applicant to start a limited amount of work at the site. All further steps have to follow similar procedures, so that corresponding to the progress of construction of the plant several successive partial licenses have to be granted before the commissioning of a nuclear facility can be started.

In view of the increasing importance that is being attached to nuclear energy to ensure our energy procurement and to reduce our dependance on oil some efforts are directed towards an accelaration of this licensing procedure. But this can only mean a streamlining of the administrative procedures and standardisation of components but under no circumstances any decrease of safety standards.

On these the contrary will be increased, taking into account results from safety research in order to reduce the still remaining risk of nuclear power.

The most important political aspect arising from the licensing procedure at present is question of the best way to organise a participation of the public in the licensing process. Because of the far reaching effects which technical and political decisions in the licensing procedure for nuclear plants may have, such decisions can only be taken and executed if they are widely accepted and supported by a majority of the public concerned. In order to get this public support the Federal Government has started an information campaign, which includes the distribution of a booklet about all problems of nuclear energy, the organisation of public discussions and seminars for all those, who are interested to participate.

It is hoped, that through better information unfounded worries and concerns can be reduced or even eliminated leading eventually to

a smooth and speedy but strict licensing procedure.

But there is no doubt, the all those involved and responsible will have to concentrate all their efforts to reach this goal. And it will not be an easy task.

5. International cooperations

Finally, I would like add a few words about international relations. The nuclear energy administration in the Federal Republic of Germany has always been open for international cooperation. The continous efforts in this respect have resulted in a number of well established international cooperations covering our main projects. For instance, the development and construction of the 300 MW prototype fast breeder power station SNR 300 - still the largest energy R&D project of the FRG - is carried out financed jointly by the FRG, Belgium and the Netherlands. The successful development of the gas centrifuge process for uranium enrichment has been carried of in close cooperation between Governments, industries and research establishments from Great Britain, the Netherlands and die Federal Republic of Germany. Also in other projects, successful international cooperation could be established. One of these is the multilaterial Eurochemic program, that has resulted in very valuable experience in reprocessing of irradiated fuel elements, and will, hopefully, lead to new and urgently required program for conditioning and management of radioactive waste. And we hope, that the discussion we are

having at the moment will also lead to a Japanese participation in this program.

Last year an important agreement for international cooperation has been concluded between the FRG and Brazil. It covers the whole range of all parts of the nuclear fuel cycle and of reactor technology and includes the Governments, research establishments and industries from both countries.

Within the European Communities many efforts for improved cooperation in the development of nuclear energy have been undertaken. But so far, it has been possible to establish only a substantive joint program in the area of nuclear fusion. At the moment the construction of a large fusion experiment, Joint European Torus, JET, is being considered within this framework. And we hope, that despite all the difficulties we have to overcome, to find agreement about the site, a decision can be taken before the end of this year.

A new and promising framework for multilaterial cooperation among the industrialized nations has been established in the International Energy Agency IEA in Paris. I have personally been involved in the preparation of this work, where cooperation is being considered in many areas of energy R&D including such important items as coal technology, solar energy, energy conservation and radioactive waste management. Extraordinary fast progress has been made in the coal

area, where a substantive program has been decided upon. At present, various other areas of new energy systems, such as wave energy or even ocean thermal gradients, are investigated.

According to my personal judgement, the most important area of international cooperation that we have initiated within IEA, is the field of safety of nuclear installations. Promising links for substantive cooperation in concrete projects have been established, particularly between the larger industrialised countries in the U.S., Japan and the FRG. I sincerely hope that - for the benefit of all nations utilizing nuclear energy for peaceful purposes - we will be able to achieve more progress by joint efforts. And I am convinced, that this important conference will contribute further progress in this area.