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Nuclear Energy and Non-Proliferation

Remarks at the 13th Annual Meeting of the
JAIF - March 4, 1980, Tokyo
by William C. Salmon
U. S. Department of State

The International Nuclear Fuel Cycle Evaluation was recently completed. Before I give you my own thoughts on its significant results and on next steps, I would like to make two observations.

First, societies work for a world at peace, a stable international political environment with no sudden significant disturbances to upset that stability. Reliable and adequate energy is a key factor today to world political stability. Nuclear energy for power production is necessary for adequate energy supply; but further expansion in nuclear explosive capability will significantly upset world stability. We must simultaneously work for both dependable, safe nuclear power as well as the absence of any increased potential for explosives. Each government responds to its public's preception of these two aspects. U. S. programs and policies are not exceptions.

Second, other concurrent energy activities are essential to our treatment of nuclear power. We must:

pursue all reasonable development of renewable energy sources, e.g.: solar, biomass; husband known non-renewable energy sources also permitting their long-term availability for non-energy uses; efficiently use the minimum energy we need; and keep our population growth under control We sometimes forget that while we look for technical solutions we are the source of our problems.

INFCE

INFCE brought together over 60 countries to study the realistic choices available in the further development of nuclear power - choices reflecting economics, safety and non-proliferation. President Carter welcomed the study, and appreciated the major efforts of so many people that went into the work of the evaluation. He said that the U. S. will take the results into account in U. S. domestic and international nuclear policies.

INFCE was not a victory for one side nor a defeat for another. It did not negotiate solutions to the future of the nuclear fuel cycle. I believe INFCE was successful in its assigned task of reflecting a wide range of prospectives, judgments and viewpoints on the several aspects of the fuel cycle. On most matters of substance a single view was agreed. On others differences were expressed in the report.

I should like to refer to a few INFCE matters that strike me as particularly useful and to mention a few areas where some caution is warranted.

First, INFCE has helped to remedy the tensions that were developing between suppliers and consumers. We now better understand each other's objectives, needs, and interests. We have a better appreciation of global nuclear energy needs and resources, worldwide concerns about nuclear proliferation, and the technical and institutional problems and possibilities that lie before us. There is broad agreement that there are proliferation risks associated with nuclear power and measures to make such risks more tolerable and manageable. Also, it is not appropriate to make broad generalizations about the comparative proliferation risks of different fuel cycles. However, we can all share the assessment that there are substantial risks associated with weapons-usable materials and the technologies that can produce them.

I believe that INFCE provides a good evaluation of the factors bearing on prospective availability of natural uranium. However, on the demand side, there will be a

need for periodic revision of the estimates developed in INFCE. The data is over two years old and there have been large reductions in reactor orders and lengthy delays in construction schedules. For the United States projections for 1995 nuclear capacity have dropped about 30 percent. As construction of additional fuel cycle facilities and the introduction of new technologies depend on demand-supply relationships, it is important that estimates be kept up-to-date.

Reprocessing, recycling of plutonium in light water reactors, and the need and timing for breeders were key issues in INFCE. From my perspective, several important insights emerged.

While reprocessing has been preferred by some nations as the way to deal with spent fuel, the Evaluation makes it clear that other choices are feasible. Spent fuel can be stored safely on an interim or long-term basis, and terminal disposal without reprocessing appears to be a realistic option for either economic or nonproliferation reasons.

The great majority of participants shared the view that, for economic reasons, when reprocessing plants are built they, like enrichment plants, should be large in scale. And, apart from economics, scale is an important consideration for nonproliferation reasons.

It is worth noting that all agreed that the economic advantage of plutonium recycle in light water reactors will at best be small.

Effective international safeguards are essential, particularly for enrichment, reprocessing, and fabrication of plutonium or highly enriched uranium. Safeguards planning should be at the earliest stages of plant design. High priority should be given to the testing and optimization of new improved safeguards methods for these sensitive fuel cycle steps. While safeguards alone will not minimize proliferation risks from sensitve fuel cycle activities, I am convinced that compresensive safeguards coverage will be necessary if nuclear power is to play its proper role in meeting global energy needs.

Constraints that now apply to reprocessing and to separated plutonium need to be reinforced by other protective mechanisms. For separated plutonium, it was recommended that special attention should be given to placing excess plutonium under international oversight. The U. S.

is prepared to work cooperatively for an effective international plutonium storage regime.

The need and prospects for breeders are given considerable attention. There is no question that over the long term breeders could extend uranium resources in a dramatic way. This accounts for the heavy investments that the U. S. and other nations are making in developing the breeder and in assessing the feasibility, economics, and proliferation implications of its technolgy. But the breeder is not without its costs, risks, and uncertainties. The need and timing of breeder development will vary among countries depending on their technical infrastructure, electric grid size, confidence in access to uranium resources, and other factors. Especially important is the relationship between demand for power and the availability and price of uranium.

In the area of nuclear supply, INFCE recognized that a country pursuing a nuclear power program needs to plan ahead with confidence regarding reactor fuel supply and disposition of spent fuel. It will be crucial to preserve a high degree of confidence and stability in nuclear supply relations if nuclear power is to remain a viable energy option and if the premature spread of sensitive facilities is to be avoided. There is a need for greater predictability in nonproliferation conditions and the prejudicial results of abrupt or unilateral changes in conditions of supply. Also, suppliers cannot be expected to freeze their policies or to ignore situations that might seriously aggravate efforts to prevent the spread of nuclear weapons.

Implications for U. S. Policy

The results of INFCE will be taken into serious account as we review our policy; we hope others will do this also. I note that many aspects of current U.S. policy are reinforced by the results of INFCE. These include:

-- fuel cycle development must balance energy needs with non-proliferation requirements.

-- IAEA safeguards should be strengthened and improved

-- Research reactors should be converted to the use of low enriched uranium.

-- There should be international control of excess civil plutonium.

-- The use of plutonium in light water reactors has little

if any economic benefit.

-- Reprocessing is not a prerequisite for managing nuclear waste, and international efforts to expand spent fuel storage capacity should be pursued.

-- Breeder reactors, while an important energy option for a number of states, are not likely to be attractive to states with modest nuclear programs.

There are then other aspects of INFCE conclusions which we will have to take into serious account in considering U.S. nuclear non-proliferation and export policy. Foremost among these is the concern voiced about reliability of supply and the exercise of bilateral rights in a manner that allows recipients to plan confidently the development of their nuclear fuel cycles.

Next Steps

One of the first orders of business is for key suppliers and recipient states to move toward agreement on the ground rules for the separation and handling of plutonium. Agreement on an effective IAEA International Plutonium Storage Regime (IPS) is a central element of this. In addition, agreement between suppliers and recipients on the exercise of prior consent rights with regard to plutonium separation and use will be needed. We are confident that we can reach agreement on arrangements and non-proliferation objectives.

A second important element is for greater reliability of supply of non-sensitive nuclear equipment and material for recipients who have accepted non-proliferation commitments such as the NPT or equivalent full-scope safeguards. Supplier states, including the U.S., can make greater efforts to improve the timeliness and reliability of their supply through such things as long-term licensing. A fuel bank and other back-up arrangements can also play a useful role in this regard.

There should also be increased political and financial support for improvement in IAEA safeguards, particularly advanced techniques for safeguarding sensitive facilities.

I also look toward increased attention to possible multinational arrangements for sensitive facilities to increase the barriers to misuse of such facilities. In addition, we should work toward agreement that development of new sensitive facilities should be in step with international requirements for enrichment and plutonium for

economically justified programs and that such facilities should be designed to enhance the effectiveness of safeguards and to incorporate other barriers to proliferation.

INFCE produced a common factual background and a sound base for further development of peaceful nuclear power. That development will require the full and close cooperation of nations with signficant commitments to nuclear power. Each nation will bring to that cooperation the beliefs and commitments of its own people. The enduring strength of that future development will depend on the ability of that cooperation to meld the differing beliefs and needs of the nations involved. Patience and understanding will be essential to success.

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EMBARGO UNTIL
3/5 p.m. 18:00

13TH ANNUAL CONFERENCE OF
JAPAN ATOMIC INDUSTRIAL FORUM

PROVISION OF NUCLEAR FUEL SERVICES WITH SAFEGUARDS

(SPOKEN VERSION)

by

C. Allday, CBE, B.Sc. C.E. F.I.Chem.E
Managing Director, British Nuclear Fuels Limited

I AM BOTH PLEASED AND HONOURED TO HAVE BEEN INVITED TO PARTICIPATE IN THIS PANEL DISCUSSION THIS AFTERNOON.

I WILL KEEP MY INTRODUCTORY REMARKS BRIEF. I SHOULD MAKE IT CLEAR THAT AS MANAGING DIRECTOR OF BRITISH NUCLEAR FUELS LIMITED, A STATE-OWNED COMPANY IN THE U.K., I AM NOT A CIVIL SERVANT OF HER MAJESTY'S GOVERNMENT, AND DO NOT SPEAK FOR HER MAJESTY'S GOVERNMENT. THE OPINIONS I OFFER ARE MY OWN AND CARRY NO OFFICIAL WEIGHT AT ALL.

THE SMALL GROWTH OF CIVIL NUCLEAR POWER PROGRAMMES IN RECENT YEARS IS A SERIOUS CAUSE FOR CONCERN, BUT IT CANNOT BE ATTRIBUTED TO A SINGLE FACTOR, ALTHOUGH POLITICAL UNCERTAINTIES AND VACILLATIONS HAVE PLAYED AN IMPORTANT PART.

INFCE HAS NOW HAD ITS FINAL SESSIONS AND THE RESULTS HAVE BEEN WELL PUBLICISED HERE DURING THE LAST WEEK.WITH YATABE SAN AND TAMIYA SAN WHO WERE BOTH IN VIENNA LAST WEEK AND HAVE BEEN HEAVILY INVOLVED WITH INFCE, SITTING WITH US ON THIS PANEL IT WOULD BE IMPERTINENT FOR ME TO ATTEMPT TO SUMMARISE THE FINAL DISCUSSIONS OR CONCLUSIONS. HOWEVER IT SEEMS TO HAVE BEEN WELL ESTABLISHED THAT TECHNICAL FIXES CAN HAVE ONLY A LIMITED INFLUENCE IN REDUCING THE RISK OF PROLIFERATION, ALTHOUGH SOME OF THEM MIGHT HELP TO REDUCE THE RISK OF THEFT. IN ADDITION ALTERNATIVE

FUEL CYCLES OFFER NO SUBSTANTIAL NON-PROLIFERATION ADVANTAGE.

THE INTERNATIONAL DEBATE SHOULD, THEREFORE, BE CENTRED ON WAYS OF ADEQUATELY ACCOMMODATING ALL SYSTEMS RATHER THAN ON THE QUESTION OF WHETHER ANY ONE CAN BE BETTER JUSTIFIED. THE NEEDS OF INDIVIDUAL COUNTRIES DIFFER WIDELY AND IT IS IMPORTANT FOR NATIONS WHO RELY HEAVILY ON IMPORTED ENERGY RESOURCES AND ARE ESPECIALLY VULNERABLE TO EXTERNAL FACTORS TO PRESERVE THEIR OPTIONS FOR REPROCESSING AND FAST BREEDER TECHNOLOGY. NO INTERNATIONAL POLICY SHOULD BE ACCEPTED THEREFORE WHICH WOULD RESTRICT ANY NATION'S RIGHTS TO DETERMINE THE DETAILS OF ITS OWN ENERGY AND NUCLEAR POLICIES.

IT IS NOW IMPORTANT TO SET A POLITICAL FRAMEWORK IN WHICH NUCLEAR POWER AND ITS FUEL CYCLE CAN OPERATE INTERNATIONALLY.

IT IS ESSENTIAL THAT THERE WOULD BE A SINGLE COMMON SET OF INTERNATIONAL CONTROLS AND CRITERIA DEALING PRIMARILY WITH PROLIFERATION, BUT PREFERABLY ALSO COVERING SAFETY AND WASTE MANAGEMENT. SUCH RULES ONCE AGREED SHOULD REMAIN STABLE AND SHOULD ONLY BE ALTERED BY MUTUAL AGREEMENT AMONGST ALL CONCERNED. THEY MUST BE ACCEPTABLE TO GOVERNMENTS, THE MAJOR SUPPLIERS AND CUSTOMERS, AND TO THE PUBLIC - A BIG ORDER PERHAPS, BUT IT MUST BE THE TARGET, AND IT WILL NOT BE ACHIEVED OVERNIGHT. IN THE MEANTIME NUCLEAR TRADING MUST CONTINUE - AS IT WAS SUPPOSED TO DO DURING INFCE - AND WE MUST AVOID THE TEMPTATION TO UNDERCUT EACH OTHER ON THE NON-PROLIFERATION CONDITIONS APPLIED TO SUPPLIES OF MATERIALS AND TECHNOLOGY.

I WOULD LIKE TO EMPHASISE THAT I DO NOT WISH TO UNDERMINE THE PRESENT CONTROLS AS EMBODIED IN SUPPLY AGREEMENTS, NUCLEAR SUPPLIERS GROUP GUIDELINES AND NON-PROLIFERATION TREATY SAFEGUARDS BECAUSE THEY INDEED PROVIDE A SOUND BASIS ON WHICH TO BUILD FOR THE FUTURE.

IN AN INDUSTRY WITH LEAD TIMES AS LONG AS OURS IT IS NOT POSSIBLE FOR MAJOR GROWTH IN INTERNATIONAL COMMERCE TO OCCUR WITHOUT BOTH SUPPLIERS AND CUSTOMERS HAVING REASONABLE CONFIDENCE IN A COHERENT SYSTEM WHICH DOES NOT PERMIT THE RULES TO BE CHANGED UNILATERALLY DURING THE PERIOD OF EXECUTION OF CONTRACTS. ONE BASIC DIFFICULTY IN THE PRESENT CLIMATE IS THAT THE HALF-LIVES OF GOVERNMENTS IN DEMOCRATIC COUNTRIES IS A LOT SHORTER THAN THE INDUSTRY'S LEAD TIMES.

WHEN WE HAVE AGREED RULES THERE MUST BE MONITORING BY AN INTERNATIONAL BODY; NOT BY NATIONAL GOVERNMENTS WHO MAY THEMSELVES HAVE, DIRECTLY OR INDIRECTLY, AN INTEREST IN THE SUPPLY CONCERNED.

IF AN INTERNATIONAL CONSENSUS ALONG THE LINES I HAVE DESCRIBED IS NOT ACHIEVED, INDIVIDUAL NATIONS WILL CONTINUE TO SPECIFY THEIR OWN RULES WITH THE INEVITABLE DANGER, ALREADY REFERRED TO, OF "UNDERCUTTING" FOR COMMERCIAL ADVANTAGE. THERE WILL ALSO BE STRONG INCENTIVES FOR EVERY COUNTRY TO DEVELOP FUEL CYCLE FACILITIES IN ORDER TO BE FREE FROM RESTRICTIONS IMPOSED UNILATERALLY BY SUPPLIERS. THIS WILL HARM RATHER THAN HELP THE CAUSE OF NON-PROLIFERATION.

SAFEGUARDS

THE POLITICAL FRAMEWORK I HAVE OUTLINED MUST OF NECESSITY RELY UPON INTERNATIONALLY AGREED AND APPLIED FUEL SCOPE SAFEGUARDS, PREFERABLY EXERCISED BY THE IAEA OR SOME SPECIAL BRANCH OR ADJUNCT OF IT.

I KNOW MANY PEOPLE ARE CRITICAL OF IAEA AND DO NOT WANT THEM TO HAVE THAT RESPONSIBILITY, BUT WE HAVE TO HAVE SOMETHING AND SOME BASE. A BODY SPONSORED BY THE UNITED NATIONS SEEMS TO ME TO BE SENSIBLE.

HOWEVER WE NEED TO UNDERSTAND WHAT SAFEGUARDS ARE FOR AND WHAT NEEDS TO BE DONE TO STRENGTHEN THEM. IT HAS TO BE RECOGNISED THAT THEY CANNOT AND ARE NOT INTENDED TO BE A COMPREHENSIVE DETECTIVE SYSTEM FOR IDENTIFYING STATES WHO HAVE EMBARKED UPON A CLANDESTINE ROUTE TO PROLIFERATION. THAT IS A JOB FOR INTELLIGENCE AGENCIES.

SIMILARLY, SAFEGUARDS ARE NOT DESIGNED TO COMBAT TERRORISM, ALTHOUGH BY THEIR CONTROL AND DETECTION TECHNIQUES THEY MAY ASSIST NATIONAL SECURITY FORCES WHO HAVE THAT ASSIGNMENT.

THE PURPOSE OF SAFEGUARDS IS TO GIVE A SUFFICIENTLY HIGH PROBABILITY OF DETECTION OF DIVERSION FROM THE CIVIL FUEL CYCLE TO PROVIDE AN EFFECTIVE DETERRENT FROM SUCH ACTIVITY. I SUGGEST THAT THE REQUIRED PROBABILITY OF DETECTION CAN BE SIGNIFICANTLY LESS THAN 100% (WHICH IS IMPOSSIBLE) PROVIDED THAT THE INTERNATIONAL COMMUNITY IS PREPARED TO REACT POSITIVELY AND APPLY SOME FORM OF SANCTIONS AGAINST DEFAULTERS.

FOR SAFEGUARDS TO BE EFFECTIVE WE NEED FOUR THINGS:

(a) FIRST TO DEFINE THE CRITERIA WHICH THE AGENCY SHOULD ADOPT REGARDING THE PROBABILITY OF DETECTION OF DIVERSION OF SIGNIFICANT QUANTITIES OF SPECIAL NUCLEAR MATERIALS. WE IN BNFL HAVE TAKEN ACCOUNT OF IAEA GUIDELINES IN SETTING OUR INTERNAL DESIGN AND OPERATIONAL CRITERIA, BUT GOVERNMENTS HAVE NOT YET FORMALLY ADOPTED THEM; AND THERE NEEDS TO BE A CONSENSUS.

(b) SECOND; TO AGREE ON THE BOUNDARY LINES FOR THE AGENCY'S ACTIVITIES, THUS CONSERVING THE AGENCY'S RESOURCES FOR ITS MAIN TASK.

(c) THIRDLY TO EXPAND THE AGENCY'S PRESENT RESOURCES; 150 INSPECTORS IS CLEARLY INSUFFICIENT FOR ITS WORLD-WIDE TASK. AN INCREASED BUDGET AND TECHNICAL CAPABILITY MUST BE PROVIDED WITH THE SUPPORT OF GOVERNMENTS AND INDUSTRY ALIKE, OTHERWISE NUCLEAR POWER MAY NOT GROW AND THE TECHNICAL BASE FROM WHICH PROMOTION OF NUCLEAR ENERGY CAN BE PROVIDED WILL DISAPPEAR. THOSE WHO SEE A COMPETITION BETWEEN FUNDS FOR SAFEGUARDS AND FUNDS FOR PROMOTING NUCLEAR ENERGY, IN THE UNDERDEVELOPED WORLD ARE I BELIEVE BEING UNREALISTIC.

AND

(d) FOURTHLY; AND PERHAPS MOST IMPORTANT; WE MUST DESIGN OUR PLANTS FROM THE VERY BEGINNING WITH THE REQUIREMENT OF THE THREE BASIC ELEMENTS OF SAFEGUARDS IN MIND - MATERIAL ACCOUNTING, CONTAINMENT, AND SURVEILLANCE. IF THIS IS DONE COSTS MAY NOT EXCEED A FEW PER CENT OF FUEL CYCLE CAPITAL COSTS. AND MORE IMPORTANTLY THE DAY TO DAY INTERFERENCE AND DELAYS TO PRODUCTION ACTIVITIES CAN BE MINIMISED. INDEED WE HAVE TO INSIST THAT THEY ARE.

PROVIDING REQUIREMENTS ARE TAKEN IN AT THE DESIGN STAGE, COSTS MAY NOT BE GREAT - EQUIVALENT PERHAPS TO A FEW PER CENT OF FUEL CYCLE CAPITAL COSTS. AND REMEMBER, ONE PER CENT OF FUEL CYCLE COSTS IS ONLY ABOUT 0.3% ON GENERATING COSTS.

IN ALL THIS IT WILL BE IMPORTANT TO TRY AND MAINTAIN COMMON STANDARDS, AND ENSURE THAT THE DIVISION OF COSTS BETWEEN GOVERNMENTS AND INDUSTRY IS BROADLY THE SAME THROUGHOUT THE WORLD.

OTHER NON-PROLIFERATION MEASURES

WHAT ELSE SEEMS TO HAVE COME OUT OF INFCE? A SATISFACTORY SYSTEM OF SAFEGUARDS, IN LOGIC SHOULD BE ENOUGH, BUT TODAY LOGIC IS NOT ENOUGH. BUT THERE ARE TWO MAJOR ADDITIONAL SUGGESTIONS WHICH ARE LIKELY TO HAVE SOME IMPACT - INTERNATIONAL PLUTONIUM STORAGE (IPS) AND INTERNATIONAL SPENT FUEL MANAGEMENT (ISFM).

CUSTODY OF PLUTONIUM STOCKS ON AN INTERNATIONAL BASIS HAS MANY ATTRACTIONS. MUCH WORK ON THIS HAS ALREADY BEEN DONE BY THE IAEA. THERE ARE CLEARLY PROBLEMS, MAINLY RELATING TO THE CRITERIA FOR RELEASE: AT MINIMUM THESE MUST PROVIDE THAT MATERIAL IS ONLY RELEASED FOR A DECLARED END-USE AND IS SUBJECT TO SAFEGUARDS APPLIED BY THE CONTROLLING BODY.

IF A SUCCESSFUL SCHEME CAN BE ESTABLISHED, SUPPLIERS SHOULD BE ENCOURAGED TO RELINQUISH THE CONTROLS THEY AT PRESENT APPLY UNILATERALLY TO THE USE AND TRANSFER OF PLUTONIUM, AND WE MAY THUS ACCOMPLISH A SIGNIFICANT STEP TOWARDS A SINGLE COHERENT SET OF RULES.

REGARDING INTERNATIONAL STORAGE OF IRRADIATED FUEL, IT IS CLEAR THAT WHATEVER DECISIONS ARE TAKEN ON REPROCESSING, SUBSTANTIAL STOCKS OF SPENT FUEL WILL BE IN EXISTENCE FOR LONG PERIODS. THERE IS AT PRESENT A CONSIDERABLE LACK OF KNOWLEDGE CONCERNING THE STORAGE OF IRRADIATED FUEL IN THE LONG TERM OR IN PERPETUITY, ALTHOUGH IT IS CLEAR THAT WITH THE PASSAGE OF TIME THESE STOCKS WILL BECOME PROGRESSIVELY LESS RADIOACTIVE AND, THEREFORE, THE PLUTONIUM AND RESIDUAL URANIUM 235 WILL BECOME PROGRESSIVELY MORE EASILY ACCESSIBLE. THEREFORE, OVER A PERIOD OF YEARS THE ONCE-THROUGH FUEL CYCLE IS IN ITSELF NO MORE PROLIFERATION-RESISTANT THAN ANY OTHER, INDEED IT MAY BE LESS SO.

AS WE, COLLECTIVELY, HAVE FAILED TO PROVIDE ADEQUATE REPROCESSING FACILITIES, IT IS PERHAPS SENSIBLE FOR US TO PROVIDE INTERNATIONAL IRRADIATED FUEL STORAGE CENTRES UNDER IAEA SUPERVISION. THE MAIN PROBLEM WILL UNDOUBTEDLY BE TO FIND HOST COUNTRIES: ALTHOUGH HER RISKS IN TERMS OF DANGER OF EXPOSURE TO IRRADIATION AND DISCHARGE OF ACTIVITY TO THE ENVIRONMENT ARE TRIVIAL, WORLD OPINION HAS BEEN INDOCTRINATED TO BELIEVE OTHERWISE, AND NO ONE NOW WANTS TO TAKE OTHER PEOPLE'S RADIOACTIVE WASTE.

TRANSFER OF TECHNOLOGY HAS BECOME A PARTICULARLY SENSITIVE ISSUE IN THE CONTEXT OF NON-PROLIFERATION. IT IS TO BE HOPED THAT THERE WILL EVOLVE AN INTERNATIONAL CONSENSUS ON THE CONDITIONS TO BE APPLIED TO SUCH TRANSFERS. MULTINATIONAL OWNERSHIP OF SENSITIVE PLANTS SUCH AS FOR ENRICHMENT AND REPROCESSING, AND MULTINATIONAL FUEL BANKS, IS ALSO SUGGESTED, BUT THIS SHOULD NOT BE NECESSARY IF THERE ARE ADEQUATE CONTROLS AND INSPECTION OF NATIONAL PLANTS. NEVERTHELESS THE IDEA HAS ATTRACTIONS IN THE CONTEXT OF CREATING INTERNATIONAL CONFIDENCE. IF SUCH SYSTEMS ARE ADOPTED I HOPE THEY WILL NOT BE IMPOSED BY POLITICAL DECREE, WHICH WOULD BE THE KISS OF DEATH. AS IS WELL-KNOWN, THERE HAVE BEEN SEVERAL SUCCESSFUL MULTINATIONAL COLLABORATIVE VENTURES IN THE FUEL CYCLE FIELD, E.G. UNITED REPROCESSORS, EURODIF, URENCO, CENTEC, PNTL, NTL, AND SEVERAL URANIUM EXPLORATION VENTURES. ALL HAVE BEEN SUCCESSFUL TO A DEGREE BECAUSE THE CEMENT WAS ESSENTIALLY COMMERCIAL AND NOT POLITICAL. I WAS PLEASED TO BE IN TOKYO WHEN YOUR NEW REPROCESSING COMPANY JNFS WAS ESTABLISHED LAST WEEK AND I WISH IT EVERY SUCCESS.

SAFETY AND WASTE MANAGEMENT

INFCE HAS BEEN CONCERNED PRIMARILY WITH NON-PROLIFERATION, AND MY REMARKS HAVE BEEN DIRECTED MAINLY TO THAT TOPIC. HOWEVER, ONE BENEFICIAL OUTCOME OF THE COMING TOGETHER CATALYSED BY INFCE WILL, I HOPE, BE A GREATER

DEGREE OF INTERNATIONAL CONSENSUS ON SAFETY ISSUES AND WASTE MANAGEMENT.

FOR SAFETY WE NEED AGREED CODES AND STANDARDS. WE ALL OF US HAVE TO TAKE A RESPONSIBLE ATTITUDE TO SAFETY, AND I BELIEVE NONE WOULD WISH TO TRY AND SECURE COMMERCIAL ADVANTAGE BY CUTTING CORNERS. ON THE OTHER HAND, WE MUST ALL STAND TOGETHER AND RESIST RIDICULOUS STANDARDS AND DEMANDS CREATED BY OVER-REACTION TO A VOCAL BUT MINORITY PUBLIC OPINION AND POPULAR MISCONCEPTION OF RELATIVITY OF RISKS. AT WINDSCALE, WE IN BNFL ARE SPENDING OVER A HUNDRED MILLION POUNDS TO REDUCE THE RISK OF ABNORMAL DISCHARGES OF RADIOACTIVITY FROM THE SITE. WHILST I ACCEPT THAT DISCHARGES SHOULD BE LOWER THAN THEY PRESENTLY ARE, THE EXPENDITURE PRESENTLY INVOLVED IS COMPLETELY NON-COST EFFECTIVE COMPARED TO BUILDING SAY, A TEACHING HOSPITAL, OR EVEN BETTER CONVENTIONAL SEWAGE PLANTS. SIMILARLY, WITH WASTE MANAGEMENT, WE IN THE U.K. ARE CRUCIFYING OURSELVES OVER FINDING ACCEPTABLE "FINAL DISPOSAL" REPOSITORIES FOR FISSION PRODUCT WASTE. PUBLIC OUTCRY AGAINST TEST DRILLING IN THE U.K. HAS BECOME PARANOIC. BUT WHY DO WE WANT TO BURY THE STUFF BEYOND MAN'S ENVIRONMENT? ONCE WE HAVE IT AS A GLASS IT IS ADEQUATELY SAFE AND MANAGEABLE, AND WILL PROGRESSIVELY DECAY SO THAT IN ABOUT 500 YEARS ITS ACTIVITY WILL EQUATE TO THAT OF THE MINED URANIUM FROM WHICH IT WAS DERIVED. OPPONENTS OF REPROCESSING, WHO FAVOUR ONCE-THROUGH FUEL CYCLES AND STORAGE OF SPENT FUEL, DO NOT SEEM TO HAVE SUCH QUALMS ABOUT STORING UNREPROCESSED FUEL ON THE SURFACE OF THE EARTH FOR VERY LONG PERIODS. NOR DO THEY SEEM CONCERNED THAT IN FINAL DISPOSAL THEY ARE COMMITTING LARGE QUANTITIES OF PLUTONIUM TO THE ENVIRONMENT.

HAVE WE THE SAME CONCERN ABOUT LONG TERM CONTAINMENT OF FISSION PRODUCTS ARISING FROM UNDERGROUND BOMB TESTS (2 REPORTED LAST WEEK) AND WHAT ABOUT DISPOSAL OF Pu FROM ALL THE WEAPONS IN THE WORLD WHICH HOPEFULLY ARE NOT GOING TO BE USED.

I HOPE THAT THE RENAISSANCE CREATED BY INFCE WILL BE IMMENSELY HELPFUL. REPRESENTATIVE EXAMPLES OF THE GROWTH OF INFOMRED OPINION ALREADY CREATED ARE THE REPORT OF THE WORKING GROUP - FUTURE US-JAPANESE NUCLEAR ENERGY RELATIONS, SPONSORED BY THE NATIONAL INSTITUTE OF RESEARCH ADVANCEMENT, TOKYO, AND THE ROCKEFELLER FOUNDATION, AND THE REPORT OF THE INTERNATIONAL CONSULTATIVE GROUP ON NUCLEAR ENERGY, SPONSORED BY THE ROCKEFELLER FOUNDATION AND THE ROYAL INSTITUTE OF INTERNATIONAL AFFAIRS. BOTH ARE FIRST CLASS STUDIES WELL WORTH READING. I AM SURE COPIES OF BOTH ARE FREELY AVAILABLE HERE IN JAPAN BUT I HAVE A FEW COPIES OF THE LATTER AVAILABLE.

MR CHAIRMAN, I BELIEVE THAT PROVIDED GOVERNMENTS ADOPT THE INFCE CONCLUSIONS WE UNFORTUNATELY CANNOT CALL THEM RECOMMENDATIONS, THINGS CAN START TO MOVE AGAIN TO OVERCOME THE WORLD'S ENERGY PROBLEMS ON A MULTINATIONAL COLLABORATIVE BASIS OF WORLD TRADE. WE WILL THEN BE ABLE TO SAY THAT INFCE SHOULD NOT HAVE BEEN NECESSARY, BUT THAT IT WAS, AND IT WAS WORTHWHILE.

2/29 入手稿の改訂版　　3/13 テープで発表分確認

EMBARGO UNTIL
3/4 a.m. p.m. 18:00

13th ANNUAL CONFERENCE OF JAPAN'S ATOMIC INDUSTRIAL FORUM

TOKYO, MARCH 4th, 1980

THE ENERGY OPTION IN FRANCE

by Rémy CARLE, Director,
ELECTRICITE DE FRANCE

— 歓迎挨拶 —

The sharp rise in the price of oil - and perhaps tomorrow, its scarcity - is a problem which must be faced by all those in charge of energy in every country : Means must be found to preserve and increase energy consumption, which is a basic factor of our economies, without jeopardizing our financial equilibrium.

Japan and France share many similarities in regard to this problem :

- there are limited domestic sources of energy : limited amounts of coal at a high cost ; hydro-electrical resources which have already been harnessed, with limited scope for further extension.

- the natural rate of growth of energy and electricity consumption remains high.

- a large nuclear programme was undertaken at the beginning of the 70's ; it seems to be the only fullscale solution to our problems, but it is meeting resistance of various kinds.

I am thus particularily glad that this conference offers a new opportunity to exchange our experience in this "struggle for

.....

energy" to which each one of us is committed I will set out our efforts in France, covering three main aspects : energy conservation, the return to the use of coal, and the nuclear energy programme.

I - FIRST OBJECTIVE : SAVING ENERGY

The first reaction when a product becomes scarce or expensive is doubtless to save it. The French Agency for Energy Conservation was created in 1974, to find ways to ~~work to this end~~ do so.

It is not an easy task, as France is not a particularily heavy energy user. Its consumption in 1979 was 190 million of tons oil-equivalent (toe) and 236 billion KWh, which corresponds to 3,5 toe and 4500 KWh per capita (our population is 53 million). This is similar to Japan, but far below such countries as the United States, Canada or Sweden. It is therefore difficult to reduce consumption further. Its level, after all, is quite reasonable.

The target set by the public authorities for 1985 is to reduce consumption below the initial forecast by 35 million toe. 18 million toe were saved in 1979. The first savings are of course the easiest to achieve, but meeting the target will call for both investment and creativity. Notwithstanding, it seems that the movement has now begun ; for several years it has been possible to limit the tonnage of consumed oil to approximately 110 millions tons.

Electricity has a major role to play in this effort.

First and foremost, waste must be done away with. Electricité de France, in collaboration with the Agency for Energy conservation, has undertaken a campaign to sensitise users to save electricity, and to transfer some consumption away from the morning and evening peak hours. This campaign, coming after the national grid breakdown on December 19th, 1978, has had ~~considerable~~ a good impact.

....

It is clear that the raise of electricity prices by the government has also had an influence on consumer " behaviour. In 1978 the average price of ~~low-voltage~~ electricity was approximately 10 % below its 1973 price in constant francs (before the four fold increase in the price of oil). (In 1979 and in 1980) There have been three increases ~~since that date, of 7.5 %, 7.5% and 11% respectively (on all low, medium and high voltage tariffs)~~ (of about approximately totally 30%), to catch up with and stay abreast of oil prices.

This shock treatment is salutary : it is important to sell electricity at its true price, to avoid distorting the decisions made ~~taken~~ by consumers. This of course does not fully eliminate the risk of massive recourse by consumers to electricity, should domestic fuel or gas become scarce (in which case a breakdown of the system would be inevitable), but it should reduce its probability.

Actually, in 1979, the increase in electricity consumption slowed down markedly. If allowance is made for the temperature, consumption increased by 6.6% compared to 1978, which corresponds basically to the fall in the rate of increase of low voltage supplies to only 7%, compared to 11% in the preceding years.

In addition, Electricité de France has over the past few years undertaken a major programme of research into energy-saving processes in the industrial field. Many have been studied and tested in operation in various sectors of industry : metallurgy, agrofood processing industries, mechanical industries. These developments prove, were there any need to do so, that electricity is far from being an inappropriate way to use primary energy (because of Carnot's theorem) but can, quite to the contrary, often very advantageously replace traditional fuels, given its properties of flexibility, regulation and adaptability. A kilowatt-hour can replace 10,000 Btu and sometimes 20,000 or even 40,000. Modern drying processes, induction furnaces and chemical processes by inverted osmosis illustrate this point. Unfortunately these processes involve some ~~Large~~ investments, which has slowed down recourse to them in the present economic situation. The fact remains that they are available and warrant the attention of all industrialists who are concerned with their energy balance.

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Energy conservation may thus mean increasing electricity consumption.

Furthermore, bearing in mind that the present crisis is not an energy but an oil crisis, electricity is at present the optimum medium through which the oil constraint can be relieved, and which allows other sources of primary energy to be developed.

There is heated debate in France as to the outlook for consumption in 1985 and 1990 (which governs the investments being made now) It is clear that in the modern world, the forecaster has a hard time of it. Granted, it is not the role of the electricity producer to settle a debate that relates to social choice, but it is my belief that using electricity - if it is produced using a source other than oil - should enable us to free ourselves from reliance on a precarious and expensive product.

It is worth comment that just now 20% of the new housings built in France are still heated by fuel oil. It is certainly a better solution to heat a certain percentage of them by electricity, providing that the calculation is related to the supply potential of electricity-producing plants. ~~In agreement with the government, it has been decide that 2 million new housings would be equipped with electric heating by 1985 ; 1 million housings had been equipped in this way as of 1980.~~

In aggregate, from 1973 to 1978, there was a 14% rise in French GNP, a 28 % increase in demand for electricity and a rise in total demand for primary energy of only 4.2%.

This reflects the fact that there has been a significant increase in the share of electricity in national energy consumption - from about 22% to 27% ~~21.8% to 26.9%~~ in five years - i.e, an extra percentage point each year. Electricity can coexist with substantial energy savings, and may reasonably be claimed to account for them at least in part.

And what I want to try to express by ~~This is what is meant in the slogan which expresses~~ the commercial policy by a slogan ~~of our c o m p a n y~~ : "more uses for electricity, less electricity for each use".

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2 - RETURN TO THE USE OF COAL

Of course The needed electricity will have to be produced, using as little oil as possible.

In 1975, when the park of the production plants was still the same as before the oil crisis, roughly one third of the electricity produced in France was hydro-electricity, one third was produced from oil and one third from coal, gas and nuclear energy.

In 1979, hydro-power had declined to one fourth of production and thermal output (including nuclear power plants) was composed as follows :

coal : 41% (and lignite)	oil : 32%	gas : 4%	uranium : 23%

Broadly speaking, oil, which today represents only 24% of the total is burnt at a constant rate of about 12 million tons. By contrast, whereas 12 million tons of coal were burnt to produce electricity in 1974, the current figure is 24 or 25 tons (i.e, 16 Mtoe) - an absolute record.

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This was achieved by operating coal-burning plants to the maximum, and also through the conversion of a certain number of plants. ~~A few were designed initially for coal and were converted to oil ; some were designed to use either fuel, and still others had never used any other fuel than oil (for some plants in this class, it is absolutely out of the question to switch to coal as the boiler would have to be entirely renewed).~~

In ~~sum,~~ since 1976, fifteen units with a total production of 3500 MWe have been or are being converted into coal burning plants.

This effort was costly : coal necessitates additional conditioning, loading and handling installations. It also requires more staff, because plant operation, and especially maintenance, is more complex

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than in an oil-burning plant : we estimate that additional staffing of 30 is needed for two 250 MWe units. Finally, this changeover is not particularily ecological : the work is certainly more tiresome, and the risks of atmospheric pollution higher. In France, as in most other countries, anti-pollution norms have been strengthened in the last few years ; in consequence, we were obliged to reinforce the filters and dust-catchers in our installations, as well as to introduce environmental surveillance procedures and equipment.

Nevertheless, this conversion programme had to be implemented; it has now been completed and as a result, we have available a set of robust plants capable of following the load curve - in particular the weekly load curve - and they will be in service until the 1990's.

This move to coal continues in the construction of new plants. A 600 MW rated power plant burning low-quality products available at the mine bankhead is under construction at Carling, ~~sponsored by the "Houillères du Bassin de Lorraine" (Lorrain Basin Coal-mines)~~. Another 600 MWe unit has been decided recently ~~upon at Gardanne~~. ~~This will burn coal mined by the "Houillères du Centre-Midi" (South-Central Coal-mines)~~. Both plants will ~~thus~~ burn French-mined coal. ~~Finally~~, a further three 600 MWe units, essentially burning imported coal, will be realized ~~at Le Hâvre~~ on the estuary of the Seine and ~~at Cordemais~~ on the estuary of the Loire. Correspondingly at least 4 coal-powered 600 MWe units should enter into service between 1983 and 1984.

France is thus relying ~~banking~~ on coal. The difference in price between oil and coal justifies this fully. The experts are debating which way the difference will move in the future. Because we are unable fully to develop our domestic production, we are seeking the maximum diversification of our sources of supply ; this raises no problems in the present state of the market.

Allow me to say just a few words, in the fiels of conventional power production, about the development of our hydro-electric potential. With the arrival of nuclear power, installations for storing

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energy by pumping will become of considerable interest, which explains the systematic search for appropriate sites now being undertaken. Given its flexibility (rapid start-up, daily load variations), hydro-electricity is a very precious complement to nuclear power, whose supply is maybe less flexible.

A large mixed hydro-plant (gravity and pumping) was put into service ~~on the Arc and Isère rivers~~ in 1979 by Electricité de France. It comprises two 240 MW sets and has an annual gravity production potential of 650 million KWh. Another station, of national significance as it will have an installed power of 1800 MW is under construction in the Alps ~~at Grand'Maison~~ and will enter into service in 1984/85.

These examples show that besides the nuclear programme, France remains attached to a policy of diversification. It is a prerequisite for an electricity producer to have available a diversified range of facilities with complementary characteristics, whenever this is possible ~~; and it certainly is possible in France~~.

3 - THE NUCLEAR PROGRAMME

The preceding considerations should not obscure the fact that the heart of the French energy programme remains the PWR nuclear plants programme.

This programme has already been discussed in many fora including the present audience, and I will limit the generalities to noting that :

- In the 1960's, France's first experience was with graphite-gas (and heavy water) plants. These are still operating regularly (2200 MW).

- The PWR programme was launched in 1970 and extended in1974. It was based on a single 900 MW reactor model, a plant being composed of two or four reactors.

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- A 1300 MW model was introduced in 1976, and is the basis of current commitments.

The status of this PWR programme is as follows :

- 6 units are in regular operation
- 25 900 MWe and six 1300 MW units are under construction.
- The last three 900 MW units will be launched before 1982, and over the next few years, annual commitments will be of 3 or 4 (large units of) 1300 MWe ~~unit~~
- The units installed or to be installed up to 1981 are distributed among 15 sites (~~in~~ one instance, the authorization procedure is still in progress). / you see on this map. All these (site) are now authorized except (for)

a) The operating record of the first 6 units is very satisfactory. In the first year of industrial service, the availability factors of the two Fessenheim units were 78% and 81.5%. The corresponding output is much higher than had been allowed for in the economic calculations. During the winter 1979-80, the 6 units were practically working permanently at nominal power and contributed to cope with the coldest-weather load without any problems.

In 1979, the 2 Fessenheim units were stopped for the first time for refuelling and maintenance. According to French law, this first period involves complete inspection of the primary coolant loop and of the vessel, and the repetition of all non-destructive controls made before start up (in order to detect any possible evolution). The shutdown periods were accordingly long ones-130 and 100 days respectively.

It was found that the fuel had behaved extremely well. As a general rule, no major equipment disorder was discovered, no anomalies inside the vessel, and no traces of denting in the steam generators ; and the turbo-generating sets, which were completely inspected, were in good condition. By contrast, the number of working hours necessary was much higher than we had expected, due to the many activities of a mechanical nature, ~~e.g.~~ on feedwater pumps and above all, on the nuclear and conventional valves. No extra-normal radiation was recorded, and

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the cumulative collective dose was 375 men-rem on one unit and 368 on the other. Some 500 persons worked on each unit. The overall out-turn is thus satisfactory, even though much more work was involved than had been forecast initially. This confirms the need for very strict preparation of operations and for perfect training of personnel. In the light of this experience we believe that the annual shutdown of a plan should normally last 6 to 8 weeks.

b) The construction of the following units is under way satisfactorily. Naturally, the size of the programme has raised many problems concerning the main components shops, the coordination of work on site, and the staff training. In addition, the growing concern for safety (allowance made for increasingly severe accidents, improvement of calculation codes, etc...) and the experience derived from the start-up of the first units led to some changes and adjustements which had repercussions on both studies and site works. The most recent example is the studies programme induced by the accident at Three Mile Island. It did not lead to real changes in the equipment, but indicated a few improvements needed in the surveillance of installations, in the information provided to ease the work of operators, and in the methods of processing this information.

We are nevertheless very concerned to preserve the identity of the successive units (thirty-four 900 MWe units) which seems to us to be a basic element in safety and reliability.

This has involved some postponement of the forecast dates of start up of less than a year, and which should decrease perceptibly as we advance in the series.

Among other difficulties in 1979, there was an incident, which had a major impact on public opinion : defects were detected under the lining of the vessel piping. These defects - which were minimal (a few mm on 25 cm thick piping) - appear to be associated with the fabrication of the stainless steel lining. A relatively easily imple-

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mented change of practice will enable these defects to be abolished on all vessels built in future.

~~By contrast~~ But their elimination in the existing vessels raises a problem ; in addition, there was a doubt whether doing so would really improve the condition of the equipment. We preferred to show that a possible further extension of these defects could never lead to a serious accident; while simultaneously we developed control devices to monitor their possible evolution. This approach of course involved much discussion with the safety authorities and delayed the start up of the three units in Tricastin, Gravelines and Dampierre ~~I units~~ until last month, but 2 of them have now started, and the 3rd one will follow in a few days.

The first 1300 MWe unit under construction at Paluel is scheduled to enter into service by end-1982.

The difficulties met, such as the defects in under-linings must not overshadow the many reasons for satisfaction :

- our operating experience with the first units proves that the power-plant model we are using has a high availability potential,

- the ~~set of~~ tools now available after 10 years of research, development and testing enables us ~~thoroughly to~~ understand the technological and operating problems arising with this type of plant. We will pursue active collaboration in all fieldswith the American license holder and between all French organisations,

- the French power industry is now drawing benefit from its investment efforts of the years 1974 to 1976 and can supply components subjected to full quality control at a rate of 6 units per year.

- in parallel, an effort in manpower training, in particular operators, has been made for the past 5 years, on the basis of theoretical and practical training courses on simulators and of posting in plants in operation,all this for a duration (for each man) ~~of about~~ 2 years ; so can we face the upcoming period of intensive entry into service at a rate of 6 new units per year.

These are the assets at our disposal to meet the objectives decided by the government, wich are :

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オリジナルテープNo.3 カウンター 500～506

- to produce more than half of French electricity from nuclear power by 1985, ~~i.e, the equivalent of 45 Mtoe~~
- ~~to raise this~~ the percentage ~~to the neighbourhood of~~ of protection of electricity by nuclear power should be arise) 75% by 1990 in order to relegate oil-fired plants to a marginal role in our production system.

c) As you know, we are actively developing the fast breeder reactors for the longer term.

Our prototype, Phénix, is working well. It has produced 7 billion KWh up to now. Its availability ratio in 1979, excluding programmed shutdowns for refuelling, was 94%.

The construction of Superphénix, which is a 1200 MWe demonstration reactor is going on in collaboration with our Italian (ENEL) and German (RWE) colleagues.

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スライド8 オリジナルテープNo.3 529～536

The civil engineering is almost complete, and the mechanical fitting stage is now starting ; the first vessels of the reactor structure should be in place by March. ~~As this is a prototype, caution is in order as regards the date of entry into service~~ (many tests will have to be performed beforehand) ; but 1983 seems a reasonable expectation.

~~As of now,~~ the preparation of the following step is under way. ~~Obviously,~~ the main objective is to obtain a less costly product than (principal 1) Superphénix ((of course) without sacrificing either reliability or safety) ; an additional investment cost compared to light water plants can be tolerated, but it should not exceed a certain percentage. Study of this matter is under way. Series effect will be a cost-reducing element, ~~so that~~ and after Superphénix, (we intend to launch) a short series of 2 or 4 units ~~has been projected~~.

Fast breeder reactors can only be designed in close association with the reprocessing of spent fuel. The next phase will begin only when we have achieved confidence in the reliability and the economy

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of the plant and the associated fast fuel reprocessing plant. The study of this plant is under way on the basis of the experience gained at Marcoule and La Hague. Our review process will no doubt come to precise results about 1982 ; so we could have a decision to commit two units and a reprocessing plant after 1983, which is the date of entry into service of Superphénix, but before 1985. This timetable seems to be justified less in terms of an urgent need for industrialisation of fast breeder reactors, which will not arise before the 1990's, but by the need for a logical approach to a development process which will inevitably take a long time.

We are ~~utterly~~ persuaded that although the slowdown of nuclear programmes worldwide makes the introduction of fast breeder reactors less urgent, they will be indispensable in the long term and are the necessary complement to the effort undertaken with the light water plants.

d) Last year, Mr PECQUEUR dwelt at lenght on the advantages France will derive from having available every link in the fuel cycle from the mine to waste treatment. I will not rehearse this in detail, but whish to stress two particularily important points :

スライド9 → 1 - As regards uranium enrichment, the EURODIF factory at Tricastin, which uses the gaseous diffusion enrichment process, was operating at 25% of its nominal capacity at end-1979. The projected costs and construction timetable have been met up to now.

スライド10 → Its full capacity, i.e, 10,8 million UTS per year, will be achieved by early 1982. The annual needs for enrichment in the French electro-nuclear programme will represent 5 million UTS in 1985, which will be met by the French share in the output of the EURODIF plant. In 1982, the Tricastin plant will account for almost one-third of the world's enrichment capacity.

Among the other techniques, the chemical enrichment process created by C.E.A., among other techniques, has been the subject of an

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initial cooperation agreement between the CEA and the American DOE which was signed on September 4th, 1979. In parallel, studies of this process have made progress. For the future, French industry and its partners have the choice of building a new enrichment plant either using an improved gaseous diffusion technology, which could be ready within 2 to 3 years, or the chemical exchange process, if the present improvements of this technique fulfil their promise.

2 - As regards the reprocessing of irradiated fuel assemblies, I need only mention that large quantities of fuel ~~withdrawn~~ coming from light water plants have already been reprocessed in the High Oxyde Activity plant which is twinned with the UP2 plant at La Hague. The annual capacity of the COGEMA UP2 plant should be raised to 800 tons around 1985. The entry into service of another unit (UP3A) of similar capacity is scheduled for 1986. This is ample coverage of EDF requirements for PWR plant oxide fuel reprocessing and the use of the plants at full capacity is guaranteed by the additional reprocessing of foreign fuels, for which contracts have already been signed, with Japanese industry among others.

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Similarly, further experience of irradiated fuels in fast breeder reactors has been gained from the several tons of oxide which have been reprocessed at Marcoule and at La Hague : ~~the Rapsodie cycle has already been closed several times, and the same is beginning to apply for Phénix~~. A pilot plant for reprocessing spent fuels from breeders (TOR), with a capacity of 30 kg per day, is under construction at Marcoule and should be in operation in 1983. It has already been mentioned that the COGEMA has projected the construction of a high-capacity industrial unit for reprocessing fuels from commercial fast breeder reactors : the entry into service of this plant PURR is scheduled ~~at earliest for~~ in 1989.

e) We are often asked why France still has a nuclear programme, while most other countries have introduced a de facto or a de jure moratorium. The answer is simple : for us there is no alternative, and in the light of this, the government has been conducting a firm and constant

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nuclear policy since 1974. This is the only ~~real~~ true answer. ~~It should also be noted that the political cleavage in France between the majority and the opposition does not coincide with the division of the pro and anti-nuclear camps ; this has helped avoid the exacerbation of the problem.~~

The fact remains that in 1980, in France or anywhere else in the world, nothing is possible without a minimum of consensus. We are doing our utmost to secure it by an information campaign : brochures publications and the media ; also, through associations, such as the French Nuclear Energy Society, which seeks a dialogue with the circles which are generally quite hostile, such as the teaching or medical professions ; and last but not least, through visits to our plants. In 1979, our nuclear power plants in operation were visited by 70,000 persons ~~of whom 21,000 at Saint-Laurent-des-Eaux and 18,000 at LE BUGEY~~; this is a major burden and perhaps also a risk. It is nevertheless the best way to inform and sometimes to convince. It is true that we are assisted in this by the existence of the earlier nuclear power plants, which incidentally were built in the 60's in an atmosphere of general enthusiasm, and which have been operating for many years.

I strongly believe - and polls confirm my belief - that the majority of French people is not against nuclear energy today. The man in the street considers it as a "necessary harm". Some debate has taken place recently on the comparative risks of different energy sources, including a seminar in Paris on this topic. Recent events, Iran in particular, have certainly had a considerable effect on public opinion (much greater than in 1973-74) and the perception of the "risks of non-nuclear energy" has grown considerably in the last few months. Three Mile Island of course had a negative effect, but I believe that it was quite small. It was considered as being an essentially American event, in a different context , and as being of more concern to the mass-media or the public authorities, rather than as a technical problem. ~~Its main result in France was the publication of emergency plans in case of an accident, and in the final analysis, the psychological impact was not all that unfavourable.~~

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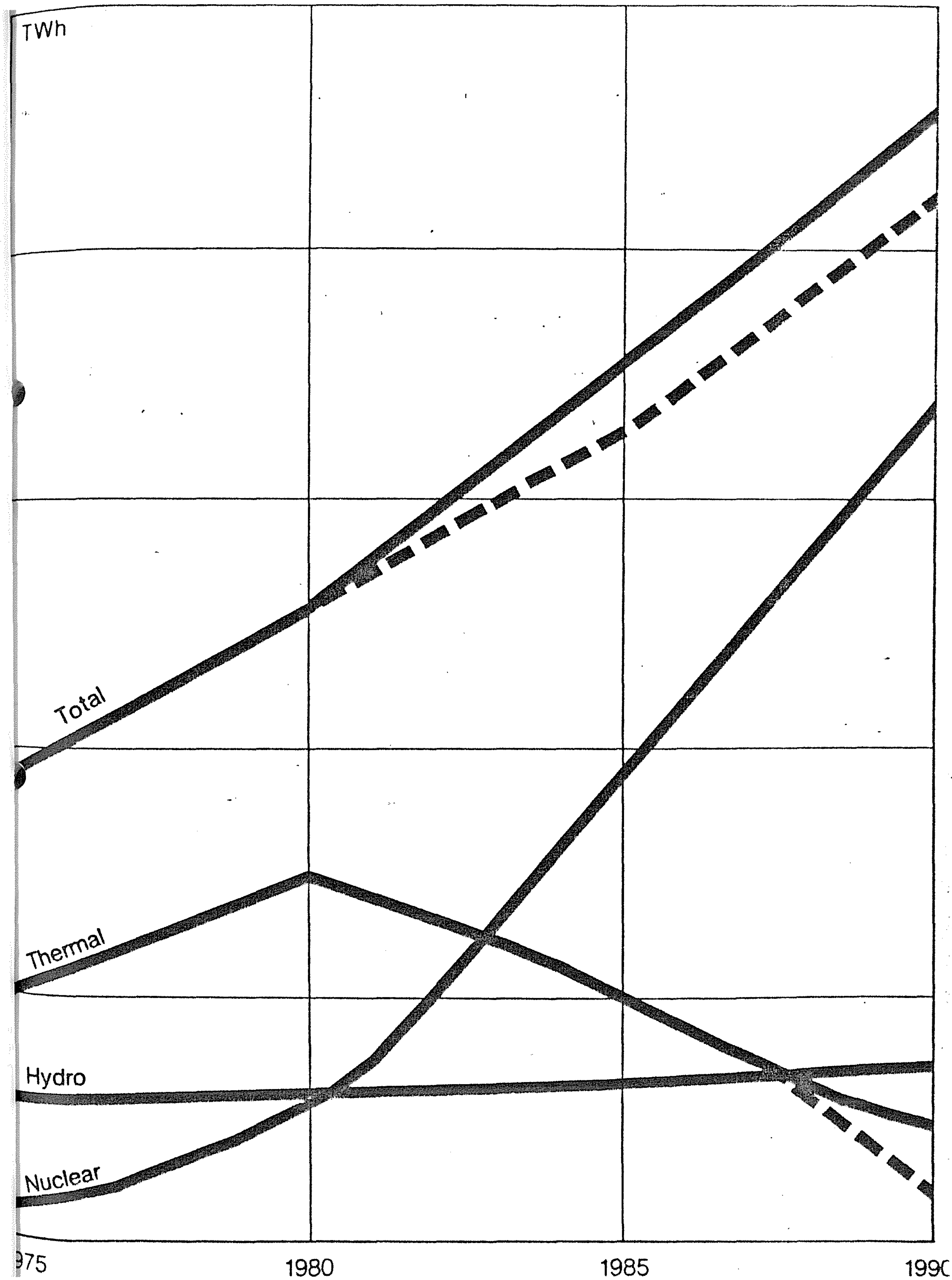
Actually, the major difficulty lies in the choice of sites. Nuclear power ? yes, if we have to, but better in the neighbour's back garden than in mine. This is not new, and some may recall the grave debates in the 1950's in connection with ~~particular~~ hydraulic projects. This problem recurs in the nuclear field, but amplified by the general campaign orchestrated by the mass-media. This is undoubtedly an issue of national solidarity and civic conscience, a battle which the public authorities must wage. Electricité de France is attempting to counterbalance the effects of local nuisances - which are evident, independently of nuclear aspects - by a certain number of advantages : rapid construction of infrastructures (roads, schools, housing), local taxes paid during operation, and discounts in electricity tariffs in the neighbourhood of plants. ~~These advantages must be distributed with care, lest they create more problems than they solve.~~ Once the first psychological barrier has been overcome and the site opened, the atmosphere has always relaxed and work done in a calm atmosphere until now.

It is not my purpose to suggest ready-made solutions to these tremendous difficulties ; even in France, a solution which is appropriate for one region can be unsuitable in another. We continue to make progress ~~while maintaining~~ in a fragile equilibrium.

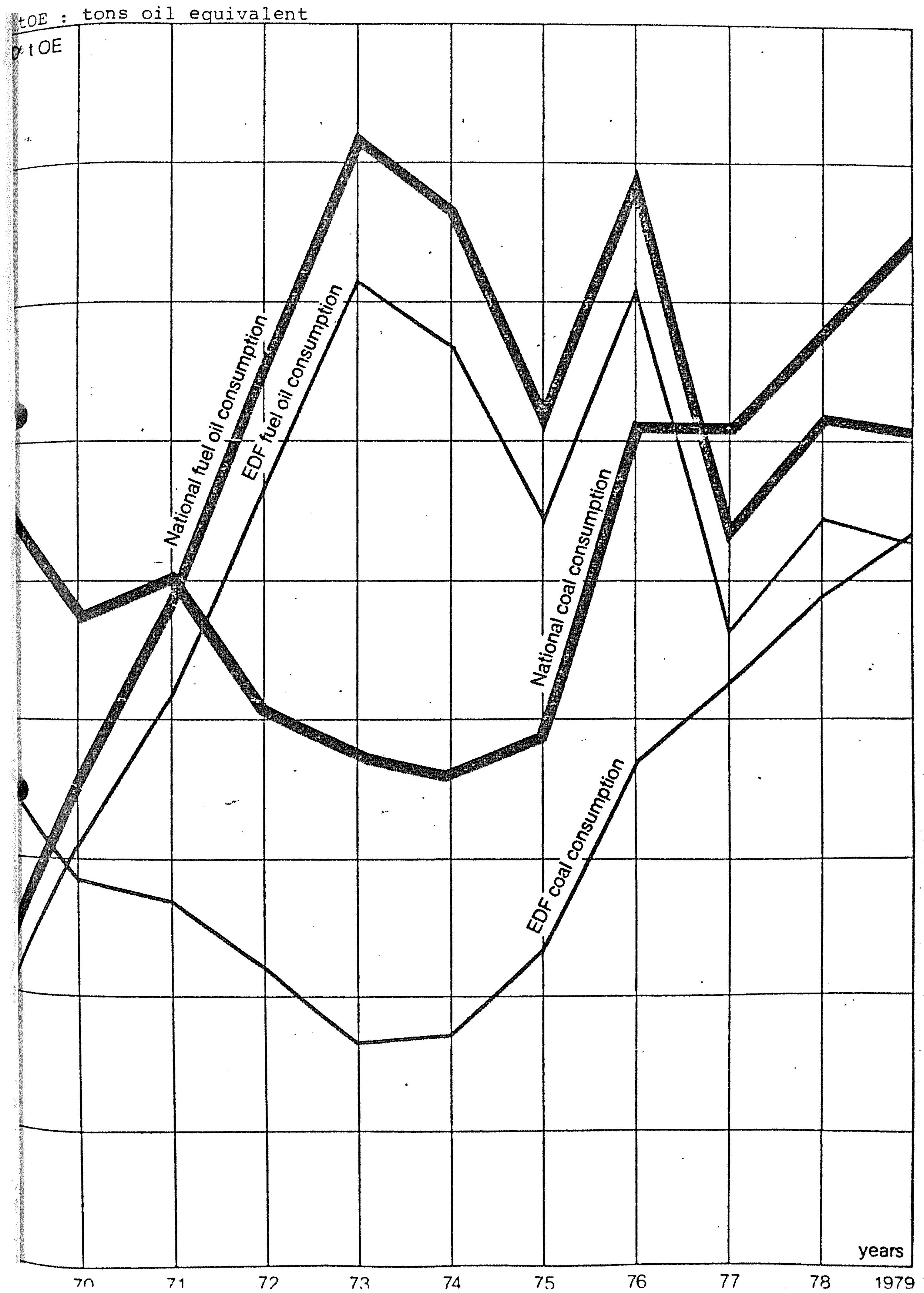
Opposition to nuclear power is undoubtedly international ; it is basically an imported product in France. Utilities must be prepared jointly to defend their viewpoint : exchange information to better build and operate our plants ; and also to issue a rapid denial of an untruthful news item, to shed light upon an accident which has just occured in another country ; and to demonstrate the consistency of our approach. This is a duty for each of us. I can assure you that ~~Electricité de France is~~ we are prepared to do ~~its~~ our part in this international "struggle for energy".

~~These were the points which I whished to outline as regards France's energy policy. I will be glad to answer any questions you may have.~~

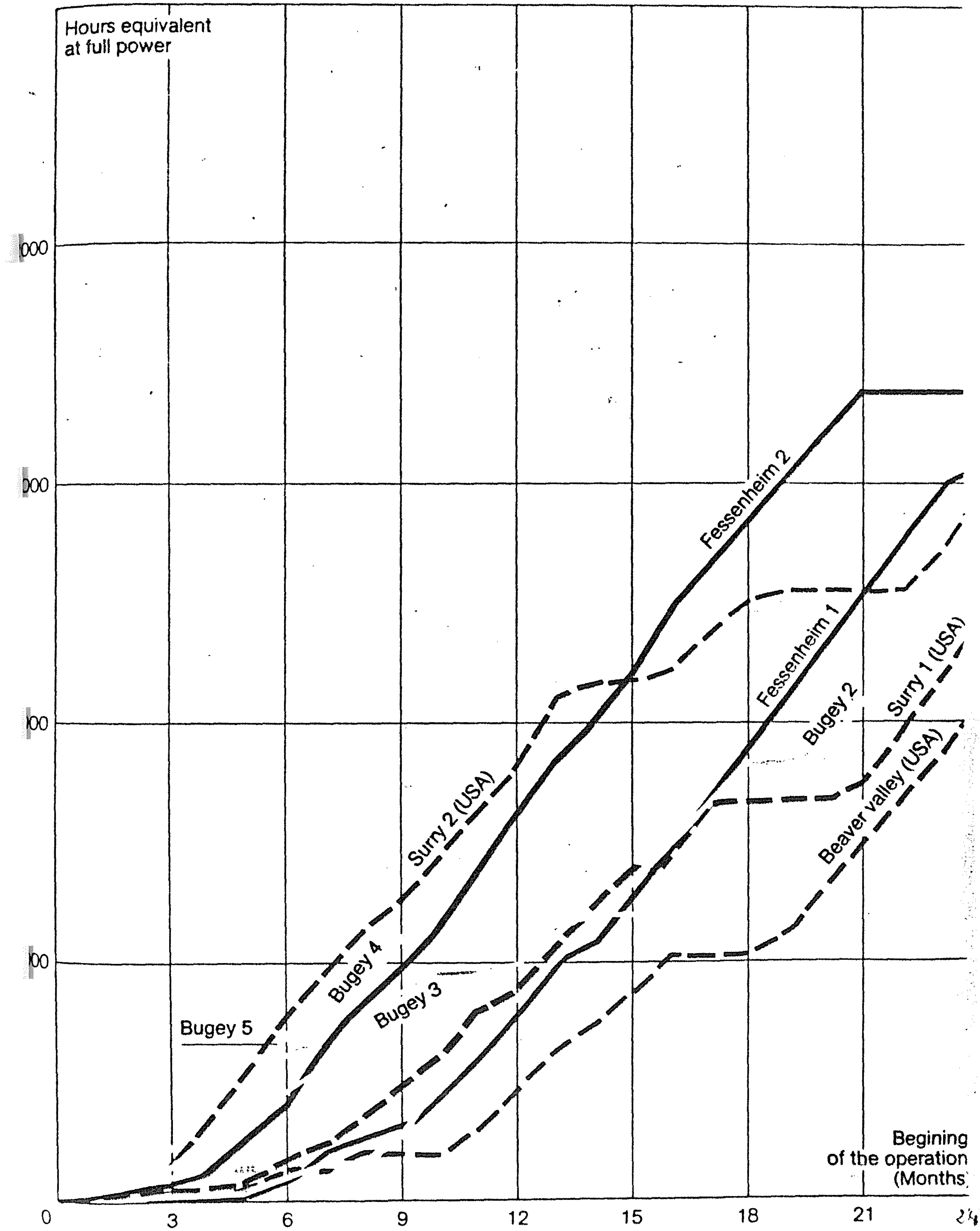
France
Production of electricity



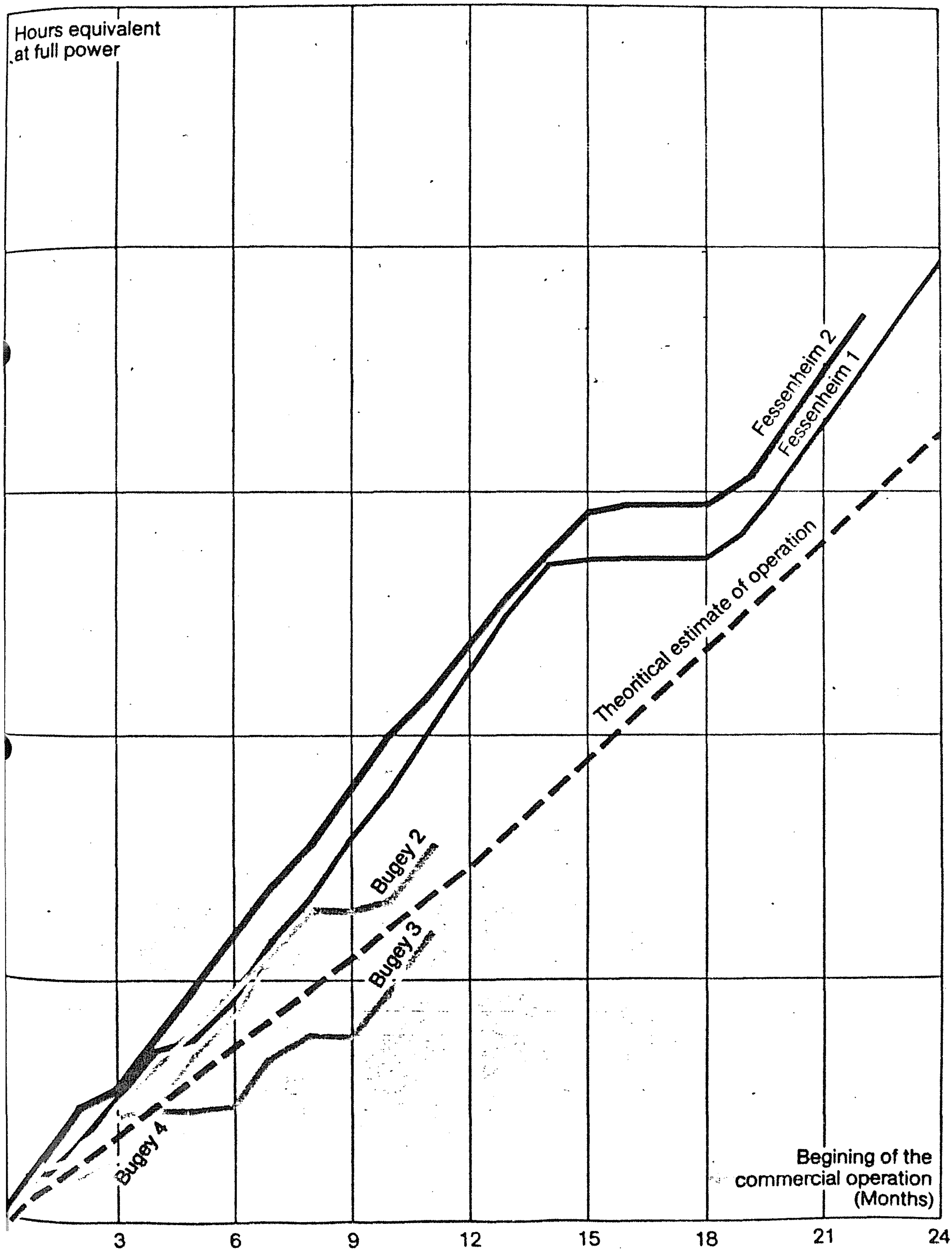
Evolution of the coal and fuel oil consumption for the generation of electrical power in France



Comparison of various french PWR units (~ 900 MWe) since their first coupling to the network



Comparison of various french PWR units since their commercial operations



EMBARGO UNTIL
18:00 a.m. p.m. 3/5

13TH ANNUAL CONFERENCE OF
JAPAN ATOMIC INDUSTRIAL FORUM

PROVISION OF NUCLEAR FUEL SERVICES WITH SAFEGUARDS

by

C. Allday, CBE, B.Sc. C.E. F.I.Chem.E.
Managing Director, British Nuclear Fuels Limited

The small growth of civil nuclear power programmes in recent years is a serious cause for concern but it cannot be attributed to a single factor, although political uncertainties and vacillations have played an important part. This paper - Provision of Nuclear Fuel Services with Safeguards - has been written in the context of the impending conclusion of INFCE and the hope expressed by many that INFCE findings will contribute significantly not only to increased political stability but also to a more general worldwide confidence in the future viability of civil power programmes. I should make it clear that as Managing Director of British Nuclear Fuels Limited, a State-owned Company in the U.K., I am not a Civil Servant of Her Majesty's Government, and do not speak for Her Majesty's Government. The opinions I offer are my own and carry no official weight at all.

Although it is not possible to be authoritative about the outcome of the final sessions of INFCE, a number of conclusions in the context of the fuel cycle can, I think, be drawn.

It has been, I believe, well established that technical fixes can have only a limited influence in reducing the risk of proliferation, although some of them might help reduce the risk of theft. Alternative fuel cycles offer ~~ing~~ no substantial non-proliferation advantage.

The international debate should, therefore, be centred on ways of adequately accommodating all systems rather than on the question of

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whether any one can be better justified. No international policy should be accepted which would restrict any nation's rights to determine the details of its own energy and nuclear policies, because ~~since~~ the needs of individual countries differ widely and it is important for nations who rely heavily on imported energy resources and are especially vulnerable to external factors to preserve their options for reprocessing and Fast Breeder technology.

If these conclusions are endorsed by INFCE, and I hope they are, then the next task will be to set a political framework in which nuclear power and its fuel cycle can operate internationally.

It is essential that there should be a single common set of international controls and criteria dealing primarily with proliferation, but preferably also covering safety and waste management. Such rules once agreed should remain stable and only altered by mutual agreement amongst all concerned. They must be acceptable to Governments, the major suppliers and customers, and to the public - a tall order perhaps but it must be the target, and it will not be achieved overnight. In the meantime nuclear trading must continue - as it was supposed to do during INFCE - and we must avoid the temptation to undercut each other on non-proliferation conditions applied to supplies of materials and technology.

I do not wish to undermine the present controls as embodied in supply agreements, Nuclear Suppliers Group guidelines and Non-Proliferation Treaty safeguards since they indeed provide a sound basis on which to build for the future.

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In an industry with lead times as long as ours it is not possible for major growth in international commerce to occur without both suppliers and customers having reasonable confidence in a coherent system which will not permit the rules to be changed unilaterally during the period of execution of contracts. One basic difficulty in the present climate is that the half-lives of Governments in democratic countries, or their speed of response to domestic pressures whilst in office, is a lot shorter than the industry's lead times.

When we have agreed rules there must be monitoring by an international body, not by national Governments who may themselves have, directly or indirectly, an interest in the supply concerned.

If an international consensus along the lines I have described is not achieved, individual nations will continue to specify their own rules with the inevitable danger, already referred to, of "undercutting" for commercial advantage. There will also be strong incentives for every country to develop fuel cycle facilities in order to be free from restrictions imposed unilaterally by suppliers. This will harm rather than help the cause of non-proliferation.

SAFEGUARDS

The political framework outlined must of necessity rely upon internationally agreed and applied full scope safeguards, preferably exercised by the IAEA or some special branch or adjunct of it.

/I know .....

I know many people are critical of IAEA and do not want them to have the responsibility, but we have to have something and some base. A body sponsored by the United Nations seems to me to be sensible.

We need to understand what safeguards are for and what needs to be done to strengthen them. It has to be recognised that they cannot and are not intended to be a comprehensive detective system for identifying states who have embarked upon a clandestine route to proliferation. That is a job for intelligence agencies.

Similarly, safeguards are not designed to combat terrorism, although by their control and detection techniques they can assist national security forces who have that assignment.

The purpose of safeguards is to give a sufficiently high probability of detection of diversion from the civil fuel cycle to provide an effective deterrent from such activity. I suggest that the required probability of detection can be significantly less than 100%, provided the international community is prepared to react positively and apply some form of sanctions against defaulters.

For safeguards to be effective we need four things:

(a) To define the criteria which the Agency must meet as regards the probability of the detection of diversion of significant quantities of special nuclear materials. We in BNFL have taken account of IAEA guidelines in setting our internal design and operational criteria, but the U.K. and other Governments have not yet formally adopted them, and there needs to be a consensus.

(b)

(b) To agree on the boundary lines for the Agency's activities, thus conserving the Agency's resources for its main task.

(c) To expand the Agency's present resources; 150 Inspectors is clearly insufficient for its world-wide task. An increased budget and technical capability must be provided with the support of Governments and industry alike, otherwise nuclear power may not grow and the technical base from which promotional assistance can be provided will disappear. Those who see a competition between funds for safeguards and funds for promoting nuclear power in the underdeveloped world are being unrealistic.

(d) Fourthly, and perhaps most important, we must design our plants ab initio with the requirement of the three basic elements of safeguards in mind - material accounting, containment, and surveillance. If this is done costs may not exceed a few per cent of fuel cycle capital costs.

The nuclear industry must work closely with the Agency in defining standards, and must be prepared to meet the extra costs which adequate systems may involve.

Providing requirements are taken in at the design stage, costs may not be great - equivalent perhaps to a few per cent of fuel cycle capital costs. Remember one per cent on fuel cycle costs is only about 0.3% on generating costs.

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In all this it will be important to try and maintain common standards, and ensure that the division of costs between Government and industry is broadly the same throughout the world. We should avoid a situation whereby differentially hidden subsidies interfere with normal competition.

OTHER NON-PROLIFERATION MEASURES

What else can we expect to come out of INFCE? A satisfactory system of safeguards, in logic should be enough, but there are two major additional suggestions which are likely to have some impact - International Plutonium Storage (IPS) and International Spent Fuel Management (ISFM).

Custody of plutonium stocks on an international basis has many attractions. Much work on this has already been done by the IAEA. There are clearly problems, mainly relating to the criteria for release: at minimum these must provide that material is only released for a declared end-use and is subject to Safeguards applied by the controlling body.

If a successful scheme can be established, suppliers should be encouraged to relinquish the controls they at present apply unilaterally to the use and transfer of plutonium and we may thus accomplish a significant step towards a single coherent set of rules.

Regarding international storage of irradiated fuel, it is clear that whatever decisions are taken on reprocessing, substantial stocks of spent fuel will be in existence for long periods. There is at present a considerable lack of knowledge concerning the storage of irradiated fuel in the long term or in perpetuity, although it is clear that with the passage of time these stocks

/will.....

will become progressively less radioactive and, therefore, the plutonium and residual Uranium 235 will become progressively more easily accessible. Therefore, over a period of years the once-through fuel cycle is in itself no more proliferation-resistant than any other, indeed it may be less so.

As we, collectively, have failed to provide adequate reprocessing facilities, it is perhaps sensible for us to provide international irradiated fuel storage centres under IAEA supervision. The main problem will undoubtedly be to find host countries: although the risks in terms of danger of exposure to irradiation and discharge of activity to the environment are trivial, world opinion has been indoctrinated to believe otherwise, and no one wants to take other people's radioactive waste.

Transfer of technology has become a particularly sensitive issue in the context of non-proliferation. It is to be hoped that there will evolve an international consensus on the conditions to be applied to such transfers. Multinational ownership of sensitive plants such as for enrichment and reprocessing, and multinational fuel banks, has also been floated but this should not be necessary if there are adequate controls and inspection of national plants. Nevertheless the idea has attractions in the context of creating international confidence. If such systems are adopted I only hope they will not be imposed by political decree, which would be the kiss of death. As is well-known, there have been several successful multinational collaborative ventures in the fuel cycle field, e.g. United Reprocessors, EURODIF, Urenco, PNTL, NTL, Centec, and several uranium exploration ventures. All have been successful to a degree because the cement was essentially commercial and not political.

SAFETY AND ......

SAFETY AND WASTE MANAGEMENT

INFCE has been concerned primarily with non-proliferation, and this paper has been directed mainly on that topic. However, one beneficial outcome of the coming together catalysed by INFCE will, I hope, be a greater degree of international consensus on safety issues and waste management.

For safety we need agreed codes and standards. We all of us have to take a responsible attitude to safety, and I believe none would wish to try and secure commercial advantage by cutting corners. On the other hand, it behoves us all to stand together and resist ridiculous standards and demands created by over-reaction to a vocal but minority public opinion and popular misconception of relativity of risks. At Windscale, we in BNFL are spending over a hundred million pounds to reduce the risk of abnormal discharges of radioactivity from the site. Whilst I accept that discharges should be lower than they presently are, this expenditure is completely non-cost effective compared to building say, a teaching hospital, or even better conventional sewage plants. Similarly, with waste management, we in the U.K. are crucifying ourselves over finding acceptable "final disposal" repositories for fission product waste. Public outcry against test drilling in the U.K. has become paranoic. But why do we want to ~~buy~~ bury the stuff beyond man's environment? Once we have it as a glass it is perfectly safe and manageable, and will progressively decay so that in about 500 years its activity will equate to that of the mined uranium from which it was derived. Opponents of reprocessing, who favour once-through fuel cycles and storage of spent fuel, do not seem to have such qualms about storing unreprocessed fuel on the surface of the earth for very long periods. Nor do they seem concerned that in final disposal they are committing large

/quantitites .....

quantities of plutonium to the environment.

We have to wait to see what will be the results and influence of INFCE. It is to be hoped that the renaissance created by it will prove to be immensely helpful. Typical examples of the growth of informed opinion are the Report of the Working Group - Future US-Japanese Nuclear Energy Relations, sponsored by The National Institute of Research Advancement, Tokyo, and The Rockefeller Foundation, and the Report of the International Consultative Group on Nuclear Energy, sponsored by the Rockefeller Foundation and The Royal Institute of International Affairs.

Provided Governments adopt the INFCE recommendations, things can start to move again to overcome the world's energy problems on a multinational collaborative basis of world trade, and all should be well. We will then be able to say that INFCE should not have been necessary, but it was, and it was worthwhile.

Keynote Address by

H. Arisawa, Chairman

Japan Atomic Industrial Forum

before the

13th JAIF Annual Conference

Tokyo, Japan

March 4, 1980

On the occasion of the opening of the 13th Annual Conference of the Japan Atomic Industrial Forum, I am most pleased to have this opportunity to say a few words.

At this important juncture at the start of the 1980s, I think it is most significant that those who carry on their shoulders the responsibility for nuclear energy development, both in Japan and other countries, are gathered here today to discuss various problems.

Last June, the Tokyo Summit issued the "Declaration" which set forth the intentions of the industrially advanced countries to strengthen energy conservation activities such as the setting of crude oil import targets and the developing of alternative energy sources to oil. Subsequently, OPEC raised the crude oil price further and expressed intentions to cut back production. This had such a serious effect on the economy not only of Japan but of the whole world as to be called the second oil crisis. We must expect this situation not merely to continue but also to become even more serious.

The decade of the 1980s whose curtain went up in this manner will be decisive in determining whether the world will be able to carry over into the 21st Century today's industrial vigour and affluent life.

As great as its impact on the world economy may be, it would not be an exaggeration to say that the effect of the second oil crisis on Japan will be the greatest because of our high dependence on oil for our energy needs. Japan, therefore, is compelled to, initiate powerful and large scale measures to lessen the dependence on oil and set an example for the rest of the world.

Lessening of the dependence on oil has two facets -- energy conservation and development of alternative energy sources. In Japan, energy conservation is being pursued in every field under the guidance of the Government. Although the results of these efforts are gradually appearing, I feel that we must ask the people to display even greater determination to save energy.

As for the development of alternative energy sources, many projects have been drafted and are being carried out. One of these is the joint development project being pushed by Japan, the United States and Federal Republic of Germany on coal liquefaction. The target is to put into operation in 1985 a demonstration plant with a daily coal processing capacity of 6,000 tons. It is envisaged that a commercial plant will be in operation in the early 1990s. It is also planned to have in operation around 1990 a demonstration plant of 100 MWe for solar power generation, a development project which the Ministry of International Trade and Industry started immediately after the first oil crisis.

These development projects must be pushed forcefully as long-term measures. However, they do not serve as measures bringing immediate relief. The alternative energy which is already a practical reality and which can be put to immediate use is none other than nuclear power. In France, all power generation plants to be built in future will be nuclear plants. In Japan's case, we should draw up a program which goes further than just making nuclear the new power plants to be built. We must include in our program the replacement of oil-burning power plants now in operation by nuclear plants.

In Japan last year, three new nuclear power plants with a total capacity of 3,450 MWe went into operation. With these additions, Japan now has 21 nuclear power plants in operation. Their capacity is roughly 15,000 MWe or 12% of Japan's total power generation capacity. Although the nuclear power plant construction program is slightly behind schedule, we must consider ourselves fortunate indeed to have at this time nuclear power plants to generate 15,000 MWe of electricity.

Unfortunately, however, the average capacity factor of these plants in 1979 was less than 50%. This was because of general inspection of plant safety of the PWR as a result of the accident at the Three Mile Island nuclear power plant in March last year and of the series of troubles that occurred at nuclear power plants here. If the capacity factor of the present nuclear power plants could be raised by 20%, we will be able to save

6 million kℓ of oil annually. Our agricultural industry consumes 5 million kℓ of oil annually and our fishing industry 6.2 million kℓ. When these facts are considered, it is easy to see the great significance of raising the capacity factor of the nuclear power plants which are already in existence.

In order to raise the capacity factor of the plants, reactor components must be improved, quality control must be strengthened, training of operators must be improved, and safety research must be extensively pursued. In addition, an inspection system by third parties must be set up in order to rationalize and speed-up periodical inspections, and a system for collecting and analyzing nuclear reactor operation data must be established. Both the Government and private industry will have to grapple with these matters more energetically and more seriously than ever before.

The securing of the safety of nuclear power plants and the raising of their capacity factor under safe operation is a matter of technological development and application of strict control. It is not a difficult matter which involves dealing with another party as in the case of obtaining crude oil. It is a goal which should be attainable on the strength of our own determination and efforts. We have absolutely no excuse if the blame for the low capacity factor of nuclear power plants is placed on the lack of effort by those engaged in the field of nuclear power.

The mainstream of energy alternative to oil lies in the use of atomic energy and coal. In order to push nuclear power generation at a faster pace, the thing which Japan must urgently do now is to secure sites for nuclear power plants. The seven new nuclear power plants authorized by the Electric Power Resources Development Coordination Council and awaiting the permission of the Nuclear Safety Commission and MITI are all additions to plants on existing sites.

In order to accelerate the construction of nuclear power plants, it is necessary to secure new sites as well as to increase the number of plants at existing sites. For this, new approaches and renewed efforts are necessary with respect to obtaining the consensus of local residents and the cooperation of local organizations. Also, the siting of nuclear power plants must be tied up with measures such as systematic development of local industries in order to bring prosperity to the neighboring community.

Regarding safety, we already have technical evaluation of safety according to criteria set by the Government. However, from now on the concept of safety from the social standpoint is increasingly important. Thus, security measures from the standpoint of the local community, taking into consideration the psychology of local residents, such as radiation monitoring system and emergency preparedness program, will have to be bolstered.

In this context, the two public hearings at Takahama and Fukushima held under the auspices of the Nuclear Safety Commission for the first time under a new regulatory system constitute an important procedure by which the Commission responded to the public. I look forward to this system taking root because by reflecting the local residents' views in nuclear power administration, I believe that their understanding and trust in nuclear power generation will be enhanced.

Japan is pushing the development of the fast breeder reactor (FBR) as the future power reactor. As you know well, we are also energetically pushing the development of an advanced thermal reactor (ATR) as the intermediary reactor in the transition from the light water reactor (LWR) to the FBR which will take some time.

As for the FBR, the experimental reactor "JOYO" has increased its thermal output from 50 MW to 75 MW and has been undergoing a continuous operation since February. Aside from this, the construction of the prototype FBR "MONJU" with output of 300 MWe is scheduled to begin in fiscal 1980. The development of the FBR must be accelerated in order to make effective use of uranium resources.

The ATR "FUGEN" with an output of 165 MWe has been operating smoothly since it went into operation in March last year. By December 31, its capacity factor has gone up to 85.6%. The 600 MWe class demonstration reactor, which is the next stage to "FUGEN", will undergo check and review for ATRs to be conducted in fiscal 1980. It will be necessary to obtain the positive cooperation of industry and to clarify the body which will be in charge of the construction of the demonstration reactor.

Many things still need to be done to promote nuclear power generation today and in the future. Of the problems, the one on which little progress has been made throughout the world is that of what to do with radioactive waste. Measures to manage radioactive waste must be worked out with sufficient attention given to its effect on future generations of mankind. Research and development on high level radioactive waste in Japan is behind that of the other advanced countries. It is vital to establish a powerful research and development system by enlisting cooperation of various academic fields concerned with radioactive waste management.

If the thinking on waste treatment and disposal differs from country to country, it would leave a cause for concern about the future. Therefore, measures for the management of radioactive waste should be undertaken from a global standpoint. For this, an international philosophy and guidelines must be established at an earlier date. The International Atomic Energy Agency and the OECD Nuclear Energy Agency are studying the matter, but it is indispensable for all countries to cooperate more positively in this study.

Next, on the subject of the nuclear fuel cycle, from the outset of atomic energy development program, Japan has been conducting research and development on the nuclear fuel cycle. Last year Japan made a great advance in nuclear fuel cycle. First, the uranium enrichment pilot plant at Ningyo Toge started operation in September and in December it produced 300 kg of 3% low enriched uranium. Future plans call for the start of operation by this summer of 3,000 centrifuges in addition to the current 1,000 units. In the summer of 1981, another 3,000 units will go into operation and an enrichment pilot plant with 7,000 centrifuges will then be in full operation.

Repair work that took about one year at the Tokai reprocessing plant has been completed and the plant resumed operation in November last year. Up to now, this plant has processed 32 tons of spent fuel. On March 1, the Japan Nuclear Fuel Services Co., Ltd. which will build Japan's commercial reprocessing plant was established. This marks a big stride forward for Japan's nuclear industry.

Thus, we can say that Japan's nuclear fuel cycle has been completed, although it may not be so large in scale. All that remains to be done is to expand its scale. Let me emphasize here that Japan is not thinking of achieving sufficiency of nuclear fuel cycle only for our own country. We believe that in this field, too, mutual collaboration with other countries is necessary.

Just last week, INFCE ended two and a half years of study at its final plenary session. The fact that greater understanding was achieved of the peaceful use of atomic energy and that effective measures can be taken to minimize the danger of nuclear proliferation without jeopardizing the development of atomic energy for peaceful purposes was confirmed in an international forum is of great significance.

Of course, nuclear non-proliferation is an indispensable condition. Japan is in a position to cooperate positively in technological development for the purpose of strengthening international safeguards against nuclear proliferation. Japan will also offer positive cooperation for the establishment of the International Plutonium Storage as a means to prevent nuclear proliferation.

It is said that the 1980s will be a period of change in world politics and economy. No matter what the changes, in order to cope with them, international cooperation is absolutely necessary. International cooperation should not be destroyed by a country's insistence on national policy. I do not deny that every country needs to have a national policy. However, I also believe that it would be possible to harmonize national policy with international cooperation if each country would apply resourceful thinking to adjust its national policy. The same thing can be said of atomic energy. In fact, I firmly believe that positive international cooperation in the development of atomic energy itself will strengthen nuclear non-proliferation and at the same time enhance energy security. To heighten international cooperation in this field, I think we should consider the establishment of an international network for nuclear fuel cycle services, including enrichment and reprocessing services.

Japan, having completed its own nuclear fuel cycle, must fully realize that we now have an obligation as an advanced nuclear power country. That obligation is to take initiative at home and abroad to prevent nuclear proliferation, and at the same time to participate vigorously in international cooperation regarding the peaceful use of atomic energy. As one of the concrete measures in this respect, Japan should provide nuclear fuel cycle services to other countries if requested.

In August this year, the 2nd NPT Review Conference will be held. Nuclear proliferation, naturally, means an increase in the number of countries possessing nuclear weapons. However, it also covers so-called vertical nuclear proliferation which means increase in nuclear arsenal and upgrading of nuclear weapons by those countries already possessing nuclear arms. The nuclear weapon countries should recognize this fully and should grapple earnestly with nuclear disarmament in accordance with Article 6 of NPT.

In order not to allow the review of NPT to result in a weakening of NPT itself, ample consideration should be given to the need for atomic energy development of the non-nuclear weapon countries, particularly the developing countries, as provided for in Article 4.

In pursuing atomic energy development while preventing nuclear proliferation, the role of the IAEA becomes increasingly important. IAEA's role and responsibility will increase in such fields as technological improvement of safeguards, study of international institutions for effectively guaranteeing non-proliferation and coordination of international cooperation which is expected to become more vigorous. Together with other countries sharing the same perceptions, Japan must cooperate and support IAEA's activities even more vigorously than in the past and work to strengthen IAEA's functions.

I firmly believe that the IAEA will be able to contribute greatly to the smooth promotion of future atomic energy development.

The basic theme of our 13th Annual Conference is "Nuclear Power Development: Challenging the Energy Crisis". Under this theme, authorities of Japan and of other countries will exchange views on how to push atomic energy development in an atmosphere of mounting tension surrounding the international energy situation. As in the past, we are honored to have many participants from other countries. I would like to take this opportunity to express my heartfelt appreciation in particular to those persons whom we have asked to present views in order to make this meeting significant.

I trust that your vigorous participation in the discussions will make this a fruitful meeting.

Thank you.

§1. L. ウィリアムズ (L. Williams) confidential up to 4.3.80

25 February 1980

EMBARGO UNTIL 12:00 noon 3/4

THE INTERNATIONAL ENERGY SITUATION AND NUCLEAR DEVELOPMENTS IN EUROPE

I am very pleased to have this opportunity to address your Conference on its first day, and to renew my acquaintance with the city of Tokyo.

It is important that Japan, the European Community, the United States and other industrialised countries should keep closely in touch on energy planning and policy. The Tokyo Summit provided an outstanding occasion for this, and of course there are continuing close contacts through the International Energy Agency. But meetings like the present one give us a valuable opportunity to look more closely at some of our common problems.

I shall try to analyse frankly our successes and failures in the energy field, and then talk about the future. The future is dark, and I believe that continued (but judicious) expansion of nuclear energy is one of the ways we must use to light it up.

Like Japan, the European Community is heavily dependent on oil imports, which now represent 47 % of the total energy requirement. In 1980 these imports will cost $ 100 billions. This represents a massive transfer of wealth to the producing countries, and a corresponding decrease in our power to make adequate investment in substitutes for imported oil.

By 1990, the aim is to reduce oil import dependence to 35 %. This does not represent real security, and continued efforts will be needed to reduce dependence further - to less than 30 % by the end of the century. This is fully in line with the policies of OPEC countries, who wish to prolong the life of their oil resource.

The Community has had some success so far in tackling the energy problem. Our overall import dependence in all forms of energy, which was 63 % before the first oil crisis in 1973, is now 54 % (thanks mostly to nuclear, North Sea oil, and increased use of gas). In the five years from 1973 to 1978, we achieved 12 % economic growth without increasing energy consumption. We are meeting in Tokyo goal to hold oil imports at or below the 1978 level.

The price regime is particularly important to the success of energy policy. The average price of premium gasoline in the Community, expressed in dollars and including taxes, has been increased by 135 % since 1973 and is roughly 2.5 times higher than in the United States. (Japan has also increased its price sharply). The comparable figures for diesel oil are 160 % and 2.2; for heating oil 330 % and 2.0; for fuel oil 310 % and 1.3. Comparisons are not always easy, but it is clear that in Europe the consumer pays a higher price for his oil than anywhere else in the industrialised world.

There are some areas where progress is less marked.

Firstly, the nuclear programme in some of our member States has slipped by several years and it is now urgently necessary to give it renewed impetus. In this, of course, we must pay due regard to legitimate public concern over safety; but equally we must show to the public, to Parliaments, and to trade unions that some of the concern which is expressed most vociferously is exaggerated, is the voice of small minorities, and disregards the great dangers which our society will encounter if energy supplies run short. Nuclear policy must also include adequate provision for waste disposal. Work in the Community is continuing on this, particularly on identifying suitable sites, and I have no doubt that satisfactory arrangements can be made in due time.

Secondly, although present energy saving measures have reduced overall demand by over 10 %, very great efforts are needed to improve this performance both in industry, buildings, and in motor transport. The car manufacturers have told us that they will save at least 10 %, as compared with current models, by 1985; I hope that it will be possible to do substantially better than this in the longer term.

Thirdly, although (as I have said) consumer prices in the Community are high, they have not always been maintained in real terms. In some countries (and the Community is not alone in this) you have to work fewer hours now to buy 100 gallons of gasoline than in 1973. Within the Community, there are still wide differences of consumer prices between one country and another, mostly because of historic differences in the pattern of taxation. Clearly, we should strive for a policy of harmonising prices and maintaining them in real terms.

In summary therefore, the Community can take some credit for its successes in tackling the energy problem, but a great deal more remains to be done.

I should now like to look more broadly at the world scene.

There is no doubt that the future energy policy of all consuming countries should be based on the assumption that OPEC oil production is unlikely to increase substantially above present levels, and in some periods may even decline. Can the world adjust to this quickly enough, without having a major and prolonged recession which will hurt developing and developed countries alike ?

The energy policy of the United States remains of course a major factor in all forecasts. The United States Government hopes to reduce oil imports to no more than 4 ½ million barrels a day by 1990 (on previous trends, imports might well have reached 12 mbd, which we now know would be a virtually impossible figure). Achievement of the lower target will require full exercise of the powers which the administration has now been given to bring oil and gas prices up to world levels; it involves an ambitious target for coal (more than twice the present production). Most importantly, it involves continued reliance on nuclear energy. The United States already generates 12 % of its electricity from nuclear energy, which is slightly higher than the Community or Japan.

It would be presumptuous for me to comment on this programme, but in its recognition of the dangers which America faces, and in the solutions proposed, it is both far-sighted and courageous. It is very important for all our countries that it should be carried out successfully.

The policies which have been, or are being adopted by the Community, Japan, and the other industrial States will demand substantial effort by the public sector, by industry, and by private individuals. Our publics have to believe that there is reasonable equality of effort and sacrifice. For this reason, it is necessary that, in future industrial Summit meetings and in the official contacts which follow them, the participating countries (and for this purpose I include the European Community) continue to provide each other with hard evidence of their commitment to oil saving, and hard evidence of their progress in achieving agreed goals.

When we discuss whether the target for country "X" should be 5 million barrels of oil a day or 6 million barrels, Governments tend at present to put in high figures in the hope that they will then be able to meet their goal more easily and also encounter less criticism at home. This, if I may say so, is quite the wrong attitude. Lower, rather than higher, oil targets improve security of supply and save vast amounts of foreign currency. And the policy measures by which oil consumption is reduced - more investment in alternative sources, in energy saving, in house insulation etc. - themselves generate economic growth and provide much needed employment. High oil consumption and imports certainly mean that economic growth in the future is going to be energy-constrained. It is the responsibility of Governments to escape from that constraint.

We appreciate, of course, the special problems of Japan - very heavy dependence on oil, and an industrial demand which takes 60 % of all energy consumed. These problems are shared by several of the countries of the Community, and we must work together to overcome them.

There is much discussion now of new dialogues with the oil producers and with developing countries in general. I have not sufficient time today to deal with this great subject, which in any case lies somewhat outside the sphere of this Conference. I will say only three things - firstly, all our Governments appreciate the need for an effective dialogue, on a United Nations basis and on a regional basis as opportunity offers.

Secondly, our position in this dialogue will be strong and constructive to the extent that we have, internally, a strong and constructive energy policy. Thirdly, close consultations about the dialogue and about bilateral contacts must continue. The dangers of one group of countries seeking to outbid another in their approaches to the oil producers are too obvious to need further emphasis.

Energy aid to the oil-importing developing countries is now of over-riding importance; the oil which they had to import in 1979 cost them some $30 billions, over 40 % more than the previous year. The Community already accounts for nearly 20 % of ~~total~~ Energy aid to developing countries (other figures are World Bank nearly 60 %, United States 7 %, Japan I believe less than 1 %); our 1979 total was about $ 700 M, The total will increase to some $ 1000 M in 1980. Here again, our actions must be closely coordinated to yield the best results, and to ensure that the developing countries get the sort of help which they really need.

I should now like to turn in more detail to nuclear energy in the Community.

At present, some 30 Gigawatts of nuclear power plants are in operation - PWR^s 45 %, BWR^s 16 %, Gas cooled reactors 36 %, other types 3 %. Nuclear accounts for 11 % of electricity and about 3 % of all energy. We plan 75 Gigawatts in total by 1985 and 125 Gigawatts by 1990; this would mean that about 30 % of electricity was nuclear. In fact, this level is already within reach in some parts of the Community; but, for the Community as a whole, this 1990 target will not be an easy one; it means a substantial increase in building programme in the next few years.

Our latest studies show that, after making full allowance for all the associated costs, nuclear remains far cheaper than oil and, in most circumstances, significantly cheaper than coal.

I have already referred to the public acceptability of nuclear energy. There are now some 230 reactors in operation in the world, and they have built up a total of 1800 reactor-years of experience. Not a single fatality or even serious injury can be attributed to radioactivity from a civilian nuclear plant. Compare this with other industries. Even though safety in the coal industry has been vastly improved, every 2 million tons of coal costs the life of a miner, and many more injuries. As Edward Teller has said: "Three Mile Island has cost $500 millions [probably an underestimate, by the way!], but not a single life. We must pay for safety and, even after we have paid for it, nuclear energy is the cheapest source of electrical power. It is most remarkable that, in the case of nuclear energy, we are paying for our lessons in dollars, not in lives".

How, in the face of all this, we can persuade the Press and Television to give a balanced presentation of the facts? Governments have rightly decided that "incidents" in nuclear plants should be made public, but it is quite difficult to do this without exaggerating their importance in the public mind. Clearly the debate must continue; hopefully, it can be conducted against the background of an acceptance by the majortiy of the public that nuclear energy must play a role in our energy supply. Some of the smaller industrial countries may have the option of rejecting nuclear energy (at the cost of dearer electricity for their consumers); but that option is simply not open to the industrialised world as a whole.

In their heavy reliance on external supplies of uranium, Japan and the European Community are in a similar position. We therefore seek stable supplies on acceptable terms. The INFCE studies have shown that, taking account of the slow-down in nuclear programmes, there should be adequate uranium at least to the end of this century. The United States (whose views and actions

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closely influence other major suppliers) have said at the highest level that they wish to continue as reliable suppliers of uranium; and recognise that some countries (notably Japan and the Community) will wish to reach their own policy decisions about reprocessing and fast breeders. Unfortunately in the past, despite such policy statements, implementing negotiations, and the detailed administration of supply contracts have sometimes been complex, uncertain and slow. The uranium supplying countries must appreciate that the purchasers cannot accept a situation where decisions about supply are uncertain or arbitrary.

We must of course accept legitimate concern about the need to avoid "proliferation", but the provisions of the Non Proliferation Treaty, together with international safeguards, and the further actions which are likely to follow from the review of that Treaty and from the INFCE report, should provide a fully adequate international framework for nuclear trade, and should enable the uranium supplying countries to avoid applying new conditions unilaterally to their supply contracts.

For the longer term future - looking into the next century - the Community (like Japan) is uneasy about having to rely on imports for around 80% of its uranium needs, and believes that we cannot assume today that there will be adequate supplies of uranium in the next century. So we believe that we must reprocess spent fuel, and, through the development of industrial-scale Fast Breeder reactors, keep open the <u>option</u> to decide to build numbers of them in a few years time.

There is still some difference of view in the Community about the part which Fast Breeders will ultimately play, but Ministers have recently agreed new arrangements to coordinate work on Fast Breeders, as well as on reprocessing and waste disposal. These difficult technologies, which require such heavy investment, are particularly suited for treatment on a Community basis.

What are the Community's main lines of action for the future? I would list the following as the most important:

(1) increased reliance on coal and nuclear, together with energy saving, to reduce reliance on oil;

(2) hence increased investment (not forgetting the need for the development of solar and other "new" energies);

(3) further development of our energy pricing policies, on a harmonised Community basis, so that they serve the aims of energy policy;

(4) at the more detailed level, a determined attempt to reduce the consumption of oil in all aspects of our life - in the motor car, in the home, in factories and (perhaps most easily, because there are substitutes) in power stations; and a policy for the management of oil stocks, so as to reduce disorder in the market;

(5) the continuation of efforts, jointly with our industrial partners, to establish constructive relations on energy with the oil producing countries, and to find ways to help all the developing countries to solve their energy problems.

I have mentioned the need for increased investment. The Commission is now working out a proposal to member Governments to raise some new form of energy tax or levy which would both help the basic policy aim (of reducing oil use) and which would generate the revenue we need to increase energy saving investment and to speed up investment in alternative energy sources. If such a proposal is explored within the European Community, we should hope to discuss it with the United States and Japan as well, and of course to explain its purposes to the oil producing countries.

I feel that I must end on a pessimistic note. Despite the earlier sharp warning of the 1973/74 oil crisis, despite the stopping of Iranian production at the beginning of 1979, the industrial countries are not yet giving energy policy the high domestic political priority which it must have. As a result, we have not been quick enough to curb our thirst for oil, and we are faced with continuing rises in its price, which are doing great harm to the prospects for world economic growth. Since 1st January, OPEC countries have been able to increase their average official prices by nearly $3 per barrel. Present prices are about 120% higher than in December 1978. Japan has been particularly exposed to the problems of high-priced oil, and the disorder of world oil markets.

The year 1980 may appear relatively comfortable - oil supplies may well be ample, and prices may soften a bit. But these will be false signals. This year may be our last chance to put our house in order, and to lay the foundations of a policy which cuts our growth in energy, and speeds up the transition away from oil. Japan and the Community face the same problem.

At an international discussion a few days ago, a senior representative of one of the countries present said that during the rest of this century energy would represent the greatest economic problem, the greatest national security problem, and the greatest foreign policy problem which Governments would have ~~to~~ face. If this is perhaps an exaggeration, it is a very salutory one.

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EMBARGO UNTIL
3/14 a.m. p.m. 12:00

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The Energy Market from the Near to the Long Term as Viewed from IEA

James W. Reddington

Japan Atomic Industrial Forum
Tokyo, 4th March 1980

I have been asked to speak to our assessment of the near-term as well as mid to longer term outlook for the energy market and its implications for nuclear energy and alternative energy sources. This is a tall order, but before I go further, may I introduce my organisation - the International Energy Agency?

The International Energy Agency

As most of you know, IEA was founded 5 years ago, as an autonomous unit of OECD, in the wake of the large energy price increases and oil supply crisis of 1973-74. The (now) 20 Member countries of the Agency have sought to spur expansion of all forms of energy and to introduce rational management of energy demand. This effort from the beginning was directed at ~~toward~~ achieving a transition toward a new equilibrium in the energy market that would be compatible with sustained, although reduced world economic growth. While a mechanism for resolving potential conflict in the allocation of oil among Member States in the event of a supply emergency has been achieved and tested, supply expansion and demand management has been an arduous and unremitting task. The effort has been beset by geological bad luck; political turmoil in the Middle East; the Three Mile Island accident; consumer skepticism about the energy crisis; and calls for the shielding of consumers from higher energy prices. These and other factors have combined to lend support to the higher administered oil export prices of today, which in nominal terms are eight times higher than five years ago and two times those of a year ago.

The Record of the Past 5 Years

Despite the formidable problems, progress has been made on the energy front, most notably in slowing the growth in energy demand. Energy demand has grown a good deal more slowly since 1973, mostly - and sadly, given the high cost - as a consequence of slower economic growth, but also as a reflection of better energy utilization. Even before 1973, the efficiency of energy use was increasing in IEA countries, primarily because of new technology that accompanied faster economic growth. This increase in productivity was strengthened and accelerated after 1973 when higher energy prices made former practices and older equipment costly and obsolescent. From 1973-78, this increased productivity is reflected in the fact that total energy use by IEA countries grew on the average less than 1 per cent annually even though GDP growth of 2.5 per cent was maintained. The growth rate for oil consumption was even lower, 0.7 per cent per year.

Progress in expansion of indigenous energy supply, on the other hand, has produced mixed results in the past five years. Lead times required to bring new resources on stream have lengthened; and the existence of restrictive leasing of public lands, the uncertainty bred by frequently amended environmental standards, and unfavorable rates of return on investment have caused further delays in energy supply opportunities. While oil supply has significantly increased from the North Slope and the

North Sea and - outside OECD - in Mexico, other, more costly, regions have not yielded oil reserves sufficient to replace the depletion of existing producing regions. The outlook for natural gas is much more promising and there is substantial scope to expand the use of both natural gas and coal, once logistical or regulatory constraints are overcome. However, as this audience well knows, nuclear expansion plans have been deferred and reduced considerably over the past five years, primarily because of more realistic assessment of future load requirements and the high cost of borrowing money, but also because of heightened public concern about inadequate safety and management systems have raised the prospect of escalating costs of allying this concern with new designs and measures.

There are important distinctions in progress, however, when regions are compared. In North America, where more efficient usage of energy has been achieved, overall energy conservation has been greater than that of oil. This situation reflects in part the substitution of oil by natural gas which took place in the United States after 1975. Europe appears to have been successful in substituting oil imports as well as conserving total energy use; however, a substantial portion of imported oil has been replaced by oil produced from the North Sea rather from switching to non-oil fuels. Finally, oil import dependence in the Pacific region has also decreased, and especially in Japan heavy industry has achieved considerable efficiency although a potential exists for improvement in the residential sector.

Near-Term Outlook

One could summarize the present near-term market, dominated by the current unstructured OPEC pricing system, as unique (some say, chaotic) in that at their Caracas meeting in December producers, failing to agree to an official minimum or maximum price, were freed to price oil at what they thought the market would bear. They promptly raised prices sharply, by an average of 33 per cent from early December to mid-February, or from an $22 to $29 f.o.b. for the composite OPEC barrel. But unlike earlier meetings of OPEC, which in every case when the price was raised, the market signals were favorable to a price rise, at present the contrary is true: demand is declining, oil liftings are increasing, stocks are high and prices on the spot market are declining. The sharpest decline in demand has been in the United States where the first quarter of 1980 may be 1.3 m/bd below a year earlier. At the same time reduced oil liftings previously announced by producers generally have not been carried out; we can only hope the same can be said of the assertion of an anonymous Saudi official last week that Saudi Arabia will reduce its liftings by a million barrels daily later this year. Mexico and other non-OPEC countries, on the other hand, have increased their liftings by more than a million from a year ago but this has been partially offset by a reduction of more than 300,000 b/d in net exports for Communist countries to other regions. As a consequence, non-Communist oil importing regions may have experienced a supply increase of over 2 m/bd above the first quarter of last year.

Unlike the producer-set prices, prices on the spot market have accurately reflected ~~the~~ this year's expected modest surplus in the world market; the differential above the official contract price has since late last year declined by half to the current $10 premium. Prior to the Caracas meeting, one would have thought that producers would not have increased their official prices as sharply as they did nor have continued to ignore market signals in further raising contract prices in January and February.

What explains this unaccustomed behavior of producers to seemingly turn a blind eye to the market? It might be that producers, unlike buyers on the spot market, believe that the much heralded recession in the United States will be considerably shorter and milder and consequently demand for oil will hold up. Or it could be that individual producer countries, some of which experienced large current account deficits recently, have chosen oil revenue targets and are discovering that they have it within their power in the near term, when demand for oil is quite inelastic, to increase price and sustain revenues levels despite a slight reduction on demand. Other commentators (mostly journalists) have speculated that petroleum ministers of certain countries are vying for a leadership role within OPEP and are assuming an aggressive policy toward price to gain support of other OPEP members, and that they can do this with impunity when there is very little excess capacity available for any country to spoil price rises by increasing production and expanding their market share.

Others, less infatuated by personal politics, emphasize what they perceive to be important structural changes (even "trends") in the market which enhances the power of producers. Among those suggested :

(1) the diversion of more oil once marketed by the major oil companies, to more direct sales by government agencies to independent or new buyers on the world market;

(2) the anxiety of buyers, whose supply contracts have been curtailed by the majors, about assured access to crude oil that has caused them to bid higher for direct purchases of crude oil;

(3) the more frequent reference to the spot price by producers in negotiating the contract price; and

(4) the inflation of contract official prices by some producers who charge exportation fees or seek to ty crude sales to product sales, or even to equality positions in downstream facilities in consumer countries.

My tentative view is that this jumble of observations frequently confuses causes with consequences of the changing tone and balance of the oil market and that some of these so-called structural changes may recede in importance and traditional market forces working through familiar international marketing apparatus will reassert their influence upon price decisions of OPEC ministers when they next meet on price questions in June.

To sum up, for this year - always assuming no unforeseen shocks that might destabilize some producer region or mishaps that might disable some productive or logistic facilities, even temporarily - I would expect producers to consolidate their price position, perhaps reconcile the many tiers of prices and reduce differentials. I expect that producers will await, before advancing prices further, evidence of the resumption of economic growth, hopefully accompanied by diminished inflation, as well as evidence of greater energy conservation or the substitution of oil by other fuels. At OECD initiatives are being taken to brake inflation before resumption of accustomed economic growth rates. And at IEA we are following up the Tokyo summit meeting of Western heads of state by devising more realistic individual country ceilings on oil imports for 1980, as well as for 1985. With good luck, and policies based on enlightened self-interest by consumer and producer countries, we may see an oil price pause this year.

Mid-Term Outlook

The mid-term as we use the phrase has to do with response time - a period sufficiently long for demand to adjust to changed energy prices (where price controls are absent) rather than - as in the short term - to be driven almost solely by changes in levels of consumer income or economic activity. We usually speak of a 10 year period when referring to the mid-term. The more effective policy instruments are likely to be, not quick fixes employed in the short term (temporary excise taxes, curtailments, allocation) but more those designed to alter energy usage patterns of consumers and investment choices of energy suppliers and industrial users, decisions which require a greater time to be adopted and carried through. While a large excise tax on gasoline may make a limited reduction on automobile usage within months, new fuel efficiency standards in autos may change total energy demand significantly only after a few years as old autos are replaced. Accelerated amortization of equipment made obsolescent by higher energy prices can speed the placing of more energy-efficient equipment by several years. And an example of decisions requiring the longest lead time are thos of a utility which will get delivery of a coal-fired generating plant only 10 to 15 years after its planners have placed an order in reaction to higher price or investment policy stimulus.

But two points should be made. First, this traditional approach of evaluating programs according to the time needed to achieve ultimate physical outcome - the delivery of another ton of coal or saving a gallon of gasoline - leads to a frequent understatement of the more immediate potential of new policy utterances, because it ignores the changed perception of the future, the altered expectations, that can be generated by the very initiation of important, effective energy policies. If tomorrow Norway were to initiate a large scale exploration of its offshore waters above the 62 degreeeparallel, or if Britain were to license greater production from proved fields, if the United States were to grant export licenses for Alaskan crude or moderate or make more predictable environmental standards on coal-burning, the expectations of their ultimate impact could in sum possibly moderate producer-set prices of crude oil - and well before the delivery of the new supplies or the ultimate ~~damaging~~ dampening of demand. And secondly, we should not forget that the mid-term allows more than enough time for policies and programs assumed to be working well, to go wrong through complacency, neglect or otherwise. Corrective actions may be needed from time to time when scheduled decontrol of prices is deferred, leasing of government lands halted, or regulatory interventions permitted to lengthen lead times.

Our mid-term to longer-term analysis, to be published later on as the World Energy Outlook to 2000, is in something like the tenth iteration and the second draft. Nearly every parameter of our earlier published analyses of future energy market have been assigned new values - although interestingly, the original assumed demand price elasticities drawn from the literature in the first study in 1974 are not far from the mark of those we have measured econometrically from data series that include the first 4 years since the price rises of 1973-74. We are pleased to see oil company officials - many once snug in the knowledge that their consumers would not reduce their demand when faced with higher price - have been "born again" in belief in long-term demand price elasticities do bite against demand. For those interested ~~by~~ in income and price elasticities, I have attached as an annex the results of our econometric exercises we have recently conducted at IEA with an interpretive note on estimates for Japan.

Now for a few specific results of our projection analysis. Compared with the <u>Outlook</u> published in 1977 (WEO I), our first draft of the new <u>Outlook</u> (WEO II) foresees a reduction of indigenous supply of fuels ~~down~~ in every case except natural gas (essentially unchanged by 1985 and up 4 per cent by 1990); ~~while~~ oil produced within OECD is down from earlier expectations throughout the period to 1990, and even coal - despite greatly improved economics - is down modestly in the 1990 estimate from a <u>Coal Prospects to 2000</u> published a little more than a year ago.

But as you doubtlessly anticipated, our projection in nuclear in the current draft of WEO II - although the estimate has been unaltered for more than a year, is down from two years ago by about 120 GW or the equivalent roughly of 3.8 million b/d of imported crude oil. While the nuclear energy reduction does reflect delays in delivery of new capacity as well as curtailments as a deferral of new orders, much of this reduction reflects the expected showing of growth in the power generation sector, from 5.2 per cent presently foreseen in WEO I for the period 1978-1990 to 3.1 per cent foreseen at present in the latest draft of WEO II. Here we see the uncoupling of the growth rates for electricity expansion and GDP; the average electricity was previously foreseen as one percentage point higher than that for GDP in the period 1978 to 1990. We now estimate, in light of the latest crude oil prices and their implication for energy prices generally, that the growth for electricity may actually be slightly slower than for the economy of the OECD region as a whole. These growth rate comparisons are displayed below.

Comparison of Growth Rates for GDP and for Average Electricity Production (OECD)

	WEO I (1979)	Coal Study (late '78)	WEO II (Nov.'79)	WEO II Revision (Jan.'80)
1978	434.6	434.6	434.6	434.6
1985	637.4	615	500	480
1990	800	746	660	630
Growth rate electricity production (1978-1990)	5.2%	4.6%	3.5%	3.1%
Economic Growth assumption(period)	4.2% (1976-90)	3.8% (1976-90)	3.3% (1978-90)	3.2%-3.3% (1978-90)

This leads us to our changed perception of energy demand. As mentioned earlier, we have observed a considerable improvement in energy productivity as a consequence of higher energy prices and the imposition of higher standards of energy efficiency. Besides the price effect, a considerable reduction in energy demand is attributable to the income effect, or slower economic growth. As a result, our latest (but still tentative) estimate of total primary energy requirements for OECD is 4345 MTOE for 1985 (or 520 MTOE less than foreseen only a year ago) and 4772 MTOE for 1990 (or 820 MTOE less than viewed a year ago). While the total reduction in energy demand exceeds that for indigenous fuels, leaving us with an OECD-wide excess supply, this was totally offset by a reduced availability of OPEC crude oil for exports to OECD after meeting demands for other regions for OPEC oil. Of course, this balancing of total energy demand and supply among world regions was a required result in selecting compatible values for OECD economic growth and real oil price growth rate assumptions.

We, like other observers, are concerned in the wake of the Three Mile Island accident about the public acceptance of continued expansion of nuclear power. But we have not yet lowered once again our estimates for nuclear capacity expansion, although most other projections for the United States, especially for the period after 1990, have lower capacity estimates than we. But suppose the pessimists are right and we are wrong, what then? We have done an exercise posing the question : If the current suspension of new orders for reactors in North America and Germany, (to take two large economies where nuclear expansion is meeting resistance), were to continue another 5 years to 1985, what consequences would ensue? Assuming that on the average 13 years are required after placement of an order till the plant is licensed to operate, the total reduced nuclear capacity in North America and Germany would be, beginning in 1993 but accumulating to 2000, the equivalent of 175 MTOE, or 126 GW, or 3.5 Mb/d of imported of crude oil. This amount of nuclear energy would require a substitution by coal of some 250 million tons of coal yearly; even in the United States, with abundant coal reserves, the coal industry would be severely taxed to supply an additional 25 per cent more coal, for a total of some billion tons annually, which is more than may be achievable. If coal were not available for complete substitution, some combination of end use substitution of energy (beyond what we have already assumed through better insulation, heat-pumps, etc.) would be required; otherwise, economic growth might slow further. But as we have already gone beyond 1990, let me speak of our preliminary assessment of some of the new, untested energy technologies that have received wide attention in this area of rising energy price expectations.

New Energy Sources

Projections of the current evolving energy market, which is experiencing unprecedented price rises that may be expected to not merely alter consumer habits and preferences but to significantly alter the structure of the economies of the industrial as well as developing regions, must appear to many as foolish to undertake as they are to read. Yet, as we have seen, industry and government must make investment plans that have long lead times and long pay-off times, so forward planning - admittedly speculative - must be done to avoid uncalculable costs of acting with no view of either the desired or likely ~~the~~ economy or energy market of tomorrow. Uncertainties are large - we still have a notational "gap" or excess energy demand of 5 Mb/d by 2000; this we hope can be closed partially with an important contribution from new energy sources. Fortunately, we now have in hand a useful IEA-supported study of these potential energy sources.

Fifteen member countries of IEA have supported a systems analysis of energy R and D strategy for the past 3 years at Brookhaven Laboratories in New York and at Juelich in Germany. This effort was to systematically review several score of new energy technologies directed to the supply, conversion, and end use of energy, with the purpose in view of assessing the relative potential effectiveness of each in impacting upon in the future energy market. Supply and conversion were emphasised; however, conversion technologies were not explicitly considered but were merely factored into the reduced estimates of energy demand. Finally, the report characterised the technologies according to the priority of financial support they should receive by the Member countries and to what stage of development they should be publically funded, with the more advanced technologies carrried to commercialization, and the less advanced to demonstration plant, pilot scale testing, or simply exploratory research. Among the technologies recommended for support for commercialization were heat pumps, coal liquefaction, and enhanced recovery of oil and gas. An additional important feature of the study was inclusion of technologies to assist the full utilization of existing productive or conversion systems that are operated in a setting of ever more restrictive regulation intended to assure environmental protection and public safety (leading candidates here are atmospheric fluidised bed to assist cleaner burning of coal, and both nuclear reactor safety and nuclear fuel cycle).

For energy projections, we look to this study mostly for judgment about the engineering feasibility of each technology, the possible lead time for testing its commerciability, and the type of markets might it best compete. The report is less useful for our purposes in estimating the total potential market penetration of these technologies; the reason is that the three oil price cases have no measured effect on energy demand or economic growth, thereby creating some uncertainty as to whether a market exists. And the supply cost of these technologies are in most cases admittedly sketchy. Nevertheless, we were surprised to see that the authors of this study generally agreed with us that under the reference or minimum cost case no significant contribution from these technologies could be expected before 2000. Only under the maximum security case, where governments are willing to pay a premium to accelerate the commercialization of technologies is there likely to be a meaningful contribution. But this report is but a starting point for Member countries to do more sorting out, probing, of these technologies, especially as to their ultimate supply costs, before selecting some for R and D subsidization.

For our part, we find little here to reassure us - beyond those more advantaged technologies that we had already allowed for - that much of our notational gap of 5 Mb/d in 2000 will be filled by a few leading technologies that we can identify with much confidence. The forced acceleration of a few technologies is even more dicey without some estimate of the "shadow price" of the oil that hopefully to be displaced by the new process. Some analysis of these "shadow prices" done in Washington produce starting prices even when compared to the trajectory of projected oil prices. One way, of course, to relieve governments of the large risk of backing suboptimal technologies would be simply to pledge government purchase of a fixed quantity of the lowest-cost new energy developed by a certain date.

ANNEX I

Price and Income Elasticities for Final Energy Demand

	Estimation Period (1960-1978)(*)		
	Income Co-efficient	Price Coefficient	
		Short run	Long run
United States	0.77	- 0.16	- 0.47
Japan	0.97	- 0.13	- 0.47
Germany	0.87	- 0.18	- 0.51
France	0.96	- 0.14	- 0.39
United Kingdom	0.43	- 0.18	- 0.25
Canada	0.96	- 0.15	- 0.41
Italy	1.06	- 0.11	- 0.34
TOTAL	0.83	- 0.16	- 0.45

(*) From "Energy Modelling : The Economists Approach". Paper presented at IISA Conference on large scale energy systems, Vienna, February 24-29, 1980.

Note on Results for Japan

The empirical results on Japan suggest that the price elasticity of demand for final energy in the short run is somewhat smaller (-0.13) than the average elasticity for the seven major OECD countries (-0.16). By contrast, the income elasticity in Japan is found to be higher (0.97) than that of the major OECD countries (0.83). These differences reflect the predominance of the output effect on energy for countries like Japan with a large industrial sector as well as the diminishing possibilities for conservation in oil-based economies with relatively new stock of capital equipment. In the long term, the relation of energy to prices in Japan is slightly stronger than the major OECD countries average (-0.47 as against -0.45).

3/3 午前入手

EMBARGO UNTIL
3/4 p.m. 18:00

ENERGY POLICY AND THE ROLE OF NUCLEAR ENERGY IN THE U.S.A.
JOHN W. CRAWFORD, JR.
DEPUTY ASSISTANT SECRETARY FOR NUCLEAR ENERGY
U. S. DEPARTMENT OF ENERGY
REMARKS AT THE THIRTEENTH ANNUAL MEETING OF THE
JAPAN ATOMIC INDUSTRIAL FORUM
MARCH 4, 1980, TOKYO, JAPAN

THANK YOU MR. CHAIRMAN. IT IS AN HONOR FOR ME TO ADDRESS THIS DISTINGUISHED INTERNATIONAL AUDIENCE TODAY ON THE OCCASION OF THE THIRTEENTH ANNUAL MEETING OF THE JAPAN ATOMIC INDUSTRIAL FORUM. I AM PLEASED, MOREOVER THAT IT GIVES ME A FIRST OPPORTUNITY TO FULFILL MY LONG-STANDING WISH TO VISIT YOUR BEAUTIFUL AND MOST INTERESTING COUNTRY.

DISCUSSING NUCLEAR ENERGY HAS A SPECIAL ATTRACTION FOR ME, AS I HAVE SPENT THREE DECADES OF MY PROFESSIONAL LIFE IN THE U.S. NAVAL AND CIVILIAN NUCLEAR POWER PROGRAMS. DURING THIS PERIOD NUCLEAR POWER HAS BEEN DEVELOPED BY MANY COUNTRIES AND SUBSTANTIAL PROGRESS HAS BEEN MADE IN NUCLEAR TECHNOLOGY SEVERAL TYPES OF NUCLEAR POWER PLANTS HAVE ACHIEVED COMMERCIAL STATUS, AND ADVANCED SYSTEMS ARE NOW BEING DEVELOPED AND EVALUATED THAT OFFER THE POSSIBILITY OF SIGNIFICANTLY EXTENDING MAN'S NUCLEAR POWER HORIZONS.

WORLD ENERGY CONCERNS

FOR A LONG TIME ALL HAVE BEEN AWARE THAT THE AVAILABILITY OF OUR OIL AND GAS RESOURCES WOULD BECOME MORE LIMITED AS WE APPROACHED THE TWENTY-FIRST CENTURY. WHILE WE RECOGNIZED THE END OF THE LIQUID FOSSIL FUEL AGE AS INEVITABLE, FEW FORESAW THE RAPIDLY CHANGING CONDITIONS UNDER WHICH FUEL SHORTAGES WOULD OCCUR. CERTAINLY FEW OF US REALIZED THAT MARKED CHANGES IN PLANNING ASSUMPTIONS WOULD BE NEEDED IN DETERMINING OUR FUTURE OPTIONS AND THE PACE OF OUR PROGRESS.

CURRENT AND FUTURE U.S. ENERGY SITUATION

IN THE UNITED STATES TODAY OUR ENERGY POLICY IS AIMED AT ONE MAJOR OBJECTIVE: TO SHIFT AS RAPIDLY AS PRACTICABLE FROM AN OIL-DEPENDENT ECONOMY TO ONE THAT RELIES HEAVILY ON OTHER FUELS AND ENERGY SOURCES. LET ME BRIEFLY REVIEW THE PRESENT SITUATION. IN 1979, OUR ENERGY DEMAND INCREASED ONLY SLIGHTLY ABOVE THAT OF 1978, PRIMARILY BECAUSE OF A SLOWDOWN IN GROWTH AND HIGHER ENERGY PRICES. GASOLINE CONSUMPTION WAS ABOUT 5 PERCENT BELOW 1978 LEVELS. CONSUMPTION OF OTHER PETROLEUM PRODUCTS REMAINED NEAR 1978 LEVELS. NATURAL GAS CONSUMPTION WAS ABOUT THE SAME AS IN 1978; COAL CONSUMPTION GREW IN 1979 BY ABOUT 50 MILLION TONS, MAINLY DUE TO INCREASED USE BY THE ELECTRIC UTILITIES.

IN 1979 CONSUMPTION OF ELECTRICITY GREW BY ABOUT 3 PERCENT. ABOUT 40 PERCENT WAS USED IN THE INDUSTRIAL SECTOR, 23 PERCENT IN THE COMMERCIAL SECTOR, AND 33 PERCENT IN THE RESIDENTIAL SECTOR.

Energy produced by solar devices, hydro electric power, wood, and others remained about the same as in 1978.

The United States energy supply situation is relatively stable, for the present. However, as all will acknowledge, we have not made sufficient use of our abundant domestic resources. As shown in Figure 1, we produce about 78 percent of our energy needs. Although oil imports represent only 21 percent of our energy consumption, we cannot continue to rely on this uncertain source of supply. A portion of the burden of replacing it must be borne by nuclear power. As stated in the communique issued at the seven nation Economic Summit Conference in Tokyo on June 29, 1979, "Without the expansion of nuclear power generating capacity in the coming decades economic growth and higher employment will be hard to achieve."

Note that nuclear energy is already an essential element of our supply. In 1978 about 13 percent of U.S. electrical generation was from nuclear plants, with some regions as high as 30-50 percent nuclear. This average of 13 percent was slightly lower in 1979, due to the shutdown of nuclear capacity in response to safety and other concerns which were underscored by the Three Mile Island accident. At the end of 1979 there were 71 nuclear reactors with a combined capacity of 52,000 megawatts in operation or in

START-UP. CONSTRUCTION OF AN ADDITIONAL FOUR STATIONS WITH A TOTAL CAPACITY OF 4000 MEGAWATTS WAS COMPLETED BY THE END OF 1979.

ENERGY CONSUMPTION IN THE UNITED STATES IS EXPECTED TO REMAIN AT NEAR CURRENT LEVELS FOR THE NEXT FIVE YEARS. ECONOMIC GROWTH IS NOT EXPECTED TO INCREASE ENERGY CONSUMPTION AS MUCH AS IN THE PAST BECAUSE HIGHER PRICES ARE PREDICTED TO BRING ABOUT IMPROVEMENTS IN EFFICIENCY. THE DEMAND FOR ELECTRICITY IS EXPECTED TO GROW AT ABOUT 4 PERCENT PER YEAR BETWEEN NOW AND 1985.

OUR OBJECTIVE IS TO REDUCE IMPORTS OF FOREIGN OIL BY 50 PERCENT BY 1990 WHILE MAINTAINING A STRONG ECONOMY. THIS MUST BE DONE THROUGH REDUCTION OF DEMAND AND INCREASED USE OF ALTERNATIVE FUELS. DEMAND WILL BE CONSTRAINED BY MEASURES SUCH AS CONSERVATION, DECONTROL OF ENERGY PRICES, AND LIMITATION OF OIL IMPORTS. EMPHASIS ON CONSERVATION IS REFLECTED IN THE DEPARTMENT OF ENERGY'S FY 1981 BUDGET OF $1.067 BILLION FOR CONSERVATION. THIS COMPARES WITH $1.165 BILLION FOR FOSSIL ENERGY AND $0.925 BILLION FOR NUCLEAR ENERGY.

NATIONAL ENERGY PLAN

THE NATIONAL ENERGY PLAN, WHICH WAS PUBLISHED IN MAY 1979 PRESENTS AN INTEGRATED PROGRAM TO REARRANGE OUR ENERGY PRODUCTION AND CONSUMPTION PATTERNS. IT APPROACHES THE PROBLEM IN THREE TIME FRAMES: THE NEAR-TERM (1980-85), THE MID-TERM (1985-2000) AND THE LONG-TERM (2000 AND BEYOND).

IN THE NEAR-TERM, AS AN IMMEDIATE OBJECTIVE, CONSERVATION MUST BE EXERCISED. CONSERVATION IS THOUGHT OF IN TWO PERSPECTIVES. FIRST, BY PRICING OIL AND GAS AT THEIR TRUE REPLACEMENT COST, CONSUMERS WILL BECOME BETTER PREPARED FOR THE PRICE INCREASES WHICH CAN BE EXPECTED IN THE LONGER TERM. ADDITIONALLY, PRODUCTION AND CONSERVATION WILL BE STIMULATED. SECONDLY, IN A LONGER TERM CONTEXT, INVESTMENTS IN NEW ENERGY PRODUCING AND CONSUMING EQUIPMENT MUST BE MADE TO REFLECT THE NEW REALITIES OF ENERGY SUPPLY, CONSTRAINTS AND COSTS. EXISTING STOCK AND EQUIPMENT MUST BE USED IN THE MOST EFFECTIVE WAY. ADDITIONALLY, THE REMOVAL OF BARRIERS TO NEW PRODUCTION WILL ELIMINATE REGULATORY DELAYS THAT NOW STRETCH OUT CONSTRUCTION SCHEDULES OF NEW ENERGY PROJECTS.

IN THE MID-TERM, WE EXPECT TO SHIFT FROM OIL AND GAS TO NEW AND, MOST LIKELY, HIGHER COST FORMS OF ENERGY. IT IS NOW ENVISIONED THAT ENERGY CONSUMPTION GROWTH WILL PROCEED MORE SLOWLY THAN PREVIOUSLY ANTICIPATED. THE INTRODUCTION OF NEW TECHNOLOGIES WILL BEGIN TO MAKE AN IMPACT, BUT EVEN WITH THE MOST SUCCESSFUL OF EFFORTS, ADVANCED TECHNOLOGIES WILL NOT BE AVAILABLE IN SUFFICIENT QUANTITIES TO MEET OUR EXPECTED REQUIREMENTS. HEAVY RELIANCE WILL HAVE TO BE PLACED ON COAL AND PRESENT-DAY NUCLEAR POWER PLANTS AS

THE TWO PRINCIPAL ENERGY SOURCES CAPABLE OF PROVIDING FOR THE SUBSTITUTION OF OIL IN THE GENERATION OF ELECTRICITY.

In THE LONG-TERM, THE "ULTIMATE" TECHNOLOGIES INCLUDING THE RENEWABLE AND ADVANCED NUCLEAR TECHNOLOGIES SUCH AS BREEDER REACTORS WOULD BEGIN TO DISPLACE TRADITIONAL SYSTEMS AND FUELS.

WHILE DISCUSSING ENERGY PLANNING IT SEEMS APPROPRIATE TO MENTION THE NATIONAL ACADEMY OF SCIENCES HAS JUST RELEASED ITS REPORT ENTITLED, "ENERGY IN TRANSITION 1985-2010," THE FOCUS OF THE REPORT* IS ON:

(1) THE PRIME IMPORTANCE OF ENERGY CONSERVATION,

(2) THE CRITICAL NEAR-TERM PROBLEM OF FLUID FUEL SUPPLY,

(3) THE DESIRABILITY OF A BALANCED COMBINATION OF COAL AND NUCLEAR FISSION AS THE ONLY LARGE-SCALE, INTERMEDIATE-TERM OPTIONS FOR ELECTRICITY OPERATION,

(4) THE NEED TO KEEP THE BREEDER OPTION OPEN, AND

(5) THE IMPORTANCE OF INVESTING NOW IN RESEARCH AND DEVELOPMENT TO ENSURE THE AVAILABILITY OF A STRONG RANGE OF NEW ENERGY OPTIONS SUSTAINABLE OVER THE LONG-TERM.

THE REPORT STRESSES THE IMPORTANCE OF SIGNIFICANTLY INCREASING THE ECONOMY'S ENERGY EFFICIENCY AS WELL AS REDUCING THE

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*PREPARED BY THE COMMITTEE ON NUCLEAR ALTERNATIVE ENERGY SYSTEMS (CONAES)

GROWTH OF ENERGY DEMAND. HIGHEST PRIORITY IS RECOMMENDED FOR THE DEVELOPMENT OF A DOMESTIC SYNTHETIC FUELS INDUSTRY. AS FLUID FUELS ARE PHASED OUT FOR ELECTRICITY GENERATION, A BALANCED MIX OF COAL AND NUCLEAR SHOULD BE EMPLOYED TO PRODUCE THE ANTICIPATED ELECTRICITY GROWTH REQUIREMENTS TO THE YEAR 2010. THE REPORT FURTHER STATES:

> "AT RELATIVELY HIGH GROWTH RATES IN THE DEMAND FOR ELECTRICITY, THE ATTRACTIVENESS OF A BREEDER, OR OTHER FUEL EFFICIENT REACTOR IS GREATEST, OTHER THINGS BEING EQUAL. AT THE HIGHEST GROWTH RATES LOOKED AT IN THE STUDY, THE BREEDER CAN BE CONSIDERED A PROBABLE NECESSITY. FOR THIS REASON THIS COMMITTEE RECOMMENDED THE CONTINUED DEVELOPMENT OF THE LMFBR, SO THAT IT COULD BE DEPLOYED EARLY IN THE NEXT CENTURY, IF NECESSARY."

THE REPORT CONCLUDES WITH THE POINT THAT AN ADVERSE PERCEPTION OF THE PUBLIC MAY WELL BE MORE DIFFICULT A HURDLE TO SURMOUNT THAN THE TECHNOLOGY ITSELF. THE NAS REPORT STATES THAT THE ENERGY PROBLEM DOES NOT ARISE FROM THE PHYSICAL SCARCITY OF RESOURCES, BUT RATHER IN EFFECTING A SOCIALLY ACCEPTABLE AND SMOOTH TRANSITION FROM THE GRADUALLY DEPLETING RESOURCES OF OIL AND GAS TO NEW TECHNOLOGIES.

NUCLEAR POWER POLICY

ON APRIL 7, 1977, PRESIDENT CARTER ISSUED A POLICY STATEMENT ON NUCLEAR POWER COMMITTING THE UNITED STATES TO A STRONG NUCLEAR NONPROLIFERATION POSITION. THE POLICY CALLED FOR REDIRECTING U.S. NUCLEAR RESEARCH AND DEVELOPMENT

PROGRAMS TO ACCELERATE RESEARCH INTO ALTERNATIVE REACTOR SYSTEMS AND FUEL CYCLES THAT DO NOT INVOLVE DIRECT ACCESS TO MATERIALS USABLE IN THE PRODUCTION OF NUCLEAR WEAPONS. THE POLICY ALSO CALLED FOR A REEXAMINATION OF ALTERNATIVE REACTOR SYSTEM CONCEPTS* IN TERMS OF RESOURCE UTILIZATION, ECONOMICS, PRACTICALITY AND RELATIVE NONPROLIFERATION STRATEGIC VALUE. THE PRINCIPAL VEHICLES FOR THIS REEXAMINATION HAVE BEEN THE NONPROLIFERATION ALTERNATIVE SYSTEMS ASSESSMENT PROGRAM (NASAP) AND THE INTERNATIONAL NUCLEAR FUEL CYCLE EVALUATION (INFCE).

THE INFCE STUDY HAS BEEN COMPLETED AND IS IN THE PROCESS OF BEING MADE AVAILABLE AT THIS TIME BY IAEA. INFCE HAS REAFFIRMED THE IMPORTANCE OF MAKING NUCLEAR ENERGY WIDELY AVAILABLE WHILE AVOIDING THE SPREAD OF NUCLEAR WEAPONS. THE U.S. LOOKS TO COOPERATING WITH OTHER NATIONS IN WORKING TOWARD THESE OBJECTIVES.

THE GOAL OF THE U. S. DOMESTIC NASAP STUDY WAS TO PROVIDE RECOMMENDATIONS FOR THE DEVELOPMENT AND DEPLOYMENT OF MORE PROLIFERATION-RESISTANT** CIVILIAN NUCLEAR POWER SYSTEMS AND INSTITUTIONS WITHOUT JEOPARDIZING THE DEVELOPMENT OF NUCLEAR ENERGY.

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*SYSTEMS OFFERING IMPROVED FUEL UTILIZATION EFFICIENCY AS COMPARED TO THE LWR ONCE-THROUGH SYSTEM

**"PROLIFERATION RESISTANCE" IS THE CAPABILITY OF A NUCLEAR POWER SYSTEM TO INHIBIT, IMPEDE OR PREVENT DIVERSION OF THE SYSTEM'S FUEL CYCLE MATERIALS OR FACILITIES FROM CIVILIAN TO MILITARY USE.

U. S. NUCLEAR REACTOR PROGRAM

As a result of the thrust of the President's nonproliferation policy statement, the INFCE and NASAP studies, and the crucial importance of reducing U.S. dependence on foreign oil, current energy policies encourage actions to help remove barriers to the increased application of light water reactors. Based on these policies, an LWR technology development program has been undertaken with the goals of: improving uranium utilization in LWRs to extend our limited uranium resource further into the future; assuring continued and increased reliance on LWRs to offset the national dependence on imported oil; and developing LWR safety technology which can reduce the probability and consequences of nuclear accidents, thereby improving the acceptability of nuclear power.

Consistent with these objectives a program to improve the utilization of uranium in LWRs is underway including both the development of near-term improvements which could be backfitted into existing LWRs and longer range non-backfittable improvements which would require significant design changes for their implementation. Demonstration of the technical feasibility of a 15% reduction in ore requirements for LWRs is targeted for 1988. Further improvements to achieve an additional 10-15% savings could be demonstrated after 1988 with the cooperation of the reactor manufacturers. An advanced reactor design effort is directed

TOWARD THE EXAMINATION OF THE FEASIBILITY OF NEW DESIGN CONCEPTS TO OBTAIN MAXIMUM URANIUM UTILIZATION IMPROVEMENTS FOR THE ONCE-THROUGH LWR FUEL CYCLE. THE PRINCIPAL EMPHASIS OF THIS STUDY IS ON VARIOUS SUGGESTED NON-BACKFITTABLE IMPROVEMENTS.

OTHER LWR TRECHNOLOGY PROGRAMS WHICH ADDRESS THE POLICIES AND GOALS REFERRED TO PREVIOUSLY INCLUDE EFFORTS AIMED AT INCREASING THE AVAILABILITY OF NUCLEAR POWER PLANTS AND AT REDUCING THE RADIATION EXPOSURE OF REACTOR PLANT OPERATING PERSONNEL. A LARGE LWR AT A 60-65% PLANT FACTOR DISPLACES ABOUT 25,000 BARRELS OF OIL EQUIVALENT PER DAY. THE OIL SAVINGS FROM A 10% INCREASE IN AVAILABILITY APPLIED TO CURRENTLY EXISTING PLANTS WOULD BE IN THE RANGE OF 130,000 BARRELS PER DAY OR NEARLY 50 MILLION BARRELS PER YEAR, AN OIL SAVING WELL WORTH CONSIDERABLE INVESTMENT. PROGRAMS AIMED AT IMPROVING SYSTEM AND COMPONENT RELIABILITY TO DECREASE UNSCHEDULED DOWNTIME AND IMPROVED DESIGN AND OPERATION TO DECREASE SCHEDULED DOWNTIME ARE BEING INITIATED AND THE DEPARTMENT OF ENERGY IS EMBARKING ON A SUBSTANTIAL INCREASE IN THESE PROGRAMS IN FISCAL YEAR 1981.

ANOTHER IMPORTANT EFFORT IS DIRECTED TOWARD REDUCING RADIATION DOSES TO PLANT OPERATING PERSONNEL. AS REACTORS GET OLDER, THEY REQUIRE MORE MAINTENANCE IN AN ENVIRONMENT WHICH CAN HAVE HIGH LEVELS OF RADIATION BECAUSE OF INCREASING LEVELS OF CONTAMINATION. TIGHTER REGULATIONS EXACERBATE THIS PROBLEM. IMPROVED RELIABILITY, REMOTE INSPECTION AND HANDLING TECHNOLOGY AND IMPROVED SYSTEM DECONTAMINATION TECHNIQUES CAN ALL BE USED TO REDUCE THE OPERATOR'S DOSE COMMITMENT. THESE APPROACHES ARE INCLUDED IN AN EXPANDING PROGRAM TO ASSURE THAT DOSES TO OPERATING PERSONNEL CAN BE AS LOW AS PRACTICAL.

IN THUS WIDENING THE SCOPE AND INCREASING THE FUNDING OF LIGHT WATER REACTOR RESEARCH, THE GOVERNMENT IS ALTERING A COURSE THAT PREVAILED DURING THE LAST DECADE. DURING THAT PERIOD THE ASSUMPTION HAS BEEN THAT LWR SYSTEMS, HAVING REACHED COMMERCIAL STATUS, DID NOT REQUIRE GOVERNMENT SUPPORT BEYOND SAFETY RESEARCH. THUS, THE FUNDING NOW BEING PROVIDED, MODEST THOUGH IT IS BY COMPARISON WITH THAT FOR ADVANCED REACTORS, IS YET EVIDENCE OF THE IMPORTANCE THAT WE ATTACH TO SUCCESS IN APPLYING LWR TECHNOLOGY AND AN ACKNOWLEDGEMENT THAT THERE ARE PROBLEMS OF A GENERIC CHARACTER TOWARD WHOSE SOLUTION THE GOVERNMENT CAN APPROPRIATELY CONTRIBUTE.

The National Uranium Resources Evaluation (NURE) program has been established to improved our estimates of the availability and accessibility of both uranium and thorium domestic supplies.

Another approach to extending uranium resources for use in LWRs is the development of advanced isotope separation (AIS) methods that could be applied to the existing large stockpile of tailings as well as future tailings from uranium enrichment plants. These tailings currently contain 0.2-0.3% fissile U-235, whose further extraction and utilization could increase the efficiency of total uranium resource use by about 20%. The program calls for developing three known AIS techniques through the preprototype phase. This will be followed by thorough evaluation of scaleability, economic potential, proliferation resistance and environmental effects, and a possible decision to proceed with engineering development of the best technique if the evaluation so warrants.

The National Energy Plan calls for the continued development of improved breeders as an option for possible future deployment if justified by market conditions and

NONPROLIFERATION POLICIES. THROUGHOUT THE PAST TWO DECADES BREEDER DEVELOPMENT HAS BEEN CENTERED UPON THE LIQUID METAL FAST BREEDER REACTOR (LMFBR), SUPPLEMENTED MORE RECENTLY BY INVESTIGATIONS OF A WATER COOLED BREEDER (WCB) AND A BACK-UP EFFORT ON A GAS COOLED FAST REACTOR (GCFR).

THE LIQUID METAL FAST BREEDER REACTOR PROGRAM IS CURRENTLY FOCUSED UPON COMPLETION OF THE FAST FLUX TEST FACILITY (FFTF), TO SERVE AS A TEST BED FOR ADVANCED BREEDER FUEL CONCEPTS AND TO PROVIDE OPERATING INFORMATION ON LMFBR PLANT COMPONENTS, AND UPON A CONCEPTUAL DESIGN STUDY (CDS) FOR A DEVELOPMENTAL PLANT THAT COULD SERVE AS THE NEXT LOGICAL STEP IN A LMFBR DEMONSTRATION AND DEPLOYMENT PROCESS. A PARALLEL BASE TECHNOLOGY PROGRAM HAS SUPPORTED THE FFTF PROJECT AND IS DEVELOPING THE INFORMATION THAT WILL BE REQUIRED FOR THE DETAILED DESIGN AND CONSTRUCTION OF THE DEVELOPMENTAL PLANT, SHOULD A DECISION BE MADE TO PROCEED.

THE FFTF IS A 400 MEGAWATT THERMAL SODIUM-COOLED, FAST-NEUTRON-FLUX REACTOR FACILITY SPECIFICALLY DESIGNED FOR IRRADIATION TESTING OF BREEDER REACTOR FUELS AND MATERIALS, LOCATED NEAR RICHLAND, WASHINGTON. MAJOR CONSTRUCTION OF THIS FACILITY WAS COMPLETED IN SEPTEMBER 1978, SODIUM FILL WAS COMPLETED IN DECEMBER 1978, AND CRITICALITY WAS ACHIEVED JUST LAST MONTH. AN EXTENSIVE ACCEPTANCE TESTING PROGRAM HAS BEEN UNDERWAY FOR MORE THAN TWO YEARS AND IS CONTINUING AS A PREREQUISITE FOR BRINGING THE FACILITY TO A FULLY OPERATIONAL STATUS.

In fulfilling its prime role of providing a test bed for demonstrating and evaluating the performance of future LMFBR plant fuel assemblies and core designs at reference conditions, the FFTF will be used to:

- Test fuel elements up to and including failure under dynamic sodium-flow conditions in order to establish ultimate capability and failure modes and thus help advance understanding of essential LMFBR core safety, reliability, and performance.
- Develop the advanced fuels and advanced cladding and duct materials essential to attaining operational breeding ratios in the 1.25 to 1.45 range with fuel doubling times of less than 15 years.
- Provide a prototype irradiation test bed for various fast fuel and blanket materials considered in the nonproliferation fuel cycle studies.

Although FFTF, as a test reactor, was not designed to breed or to produce electricity, it has provided and will continue to provide valuable information to follow-on plant development and base-technology programs in the areas of:

- Plant system and component design.
- Component fabrication.
- Prototype testing.
- Site construction.

Plant operation will generate useful operating experience on intermediate size components (pumps, heat exchangers, valves, and piping) and will confirm the design codes needed to extrapolate those results to larger size components. The design and construction phases of FFTF have already led to the successful development and application of sophisticated analysis and construction techniques associated with high temperature design, seismic qualification, and tornado protection.

The FFTF reactor with its high flux, high temperature environment, test flexibility, and extensive instrumentation is a unique resource, not duplicated anywhere in the world. It is the world's finest irradiation test facility, specifically devoted to the furtherance of improved reactor design.

In addition to the FFTF, operation of the Shippingport Atomic Power Station using a light water breeder reactor (LWBR) core will continue through the life of the core, after which core performance and breeding achieved will be assessed.

NUCLEAR WASTE MANAGEMENT

As we move forward to strengthen the nuclear option with research and development on advanced reactors we are also making major efforts directed toward resolving the radioactive waste management problem. In recent years problems associated with the management of radioactive waste materials and the public's perception of these problems, have been a major obstacle to nuclear power growth.

In April 1977, President Carter directed that a review of the entire waste management program be undertaken by an Interagency Review Group (IRG). The IRG completed this review with publication of the Report to the President on Nuclear Waste Management in March 1979.

The report summarizes what is known about each of the primary disposal options, identifies and analyzes alternative policies for guiding radioactive waste management, and makes important recommendations on the nature of the research and development plan underlying the waste management strategy. The IRG recommendations also suggest the next steps for further understanding and appreciation of radioactive waste management problems. The President's policy on waste management was enunciated in his statement of February 12, 1980.

The key elements of this policy are:

- The establishment of a State Planning Council to provide a framework for increasing state and local involvement in the waste management planning process.
- The characterization of a number of suitable sites in a variety of geologic media for mined repositories capable of accepting both reprocessed waste (e.g. from military activities) and unreprocessed commercial spent fuel. One or more sites will be selected on a regional basis from a set of four to five sites by about 1985.
- The cancellation of the Waste Isolation Pilot Plant (WIPP) project in Carlsbad, New Mexico as an unlicensed facility for the disposal of transuranic waste from the defense program. The site will be considered along with others for possible use as a licensed repository for both defense wastes and commercial high level wastes.

- Interim storage of commercial spent fuel from nuclear power reactors will continue to be the responsibility of the utilities operating these plants until a permanent geologic repository capability exists. However, the Administration is seeking to build or acquire limited spent fuel storage capacity at one or more Away-From Reactor (AFR) facilities for those domestic utilities unable to expand their storage capabilities and for limited amounts of foreign spent fuel when the objectives of the U.S. nonproliferation policy would be furthered.
- The establishment of regional disposal sites for commercial low level waste.

The President's radioactive waste disposal strategy provides for technical redundancy so that no single or small number of setbacks would undermine the entire program. It also assures that time will be available to put in place a good scientific program; to build procedures for licensing, public review and interaction; and to establish decisionmaking processes with state and local governments.

The statement also calls for the preparation of a National Plan for Nuclear Waste Management.

A draft Generic Environmental Impact Statement (GEIS) was issued in 1979 which evaluates and compares the environmental impacts of ten alternative terminal isolation disposal techniques. Deep geologic disposal is being pursued as the preferred technical approach.

Transuranic defense wastes, previously intended for disposal at WIPP, will be placed instead in the first commercial waste repository. Depending on the timing of site selection and the nature of regulatory commission requirements, it is anticipated that the first commercial repository could be operational in the mid-1990's.

The site investigation efforts include studies of salt formations, basalt, welded tuff, shales, granite and other potentially suitable rock formations. Program strategy is to proceed with a three-stage process of regional, area, and site specific investigations; each stage narrows the focus and increases the depth of information about each location to the point where specific sites can be chosen or rejected.

In the area of technology development, work continues on engineered barrier concepts, spent fuel packaging studies, radionuclide transport studies and risk assessment modeling in various media.

In-situ thermal tests using electrical heaters will continue in salt at Avery Island, Louisiana and in granite at Stripa, Sweden. Encapsulated spent fuel will be emplaced in basalt at the Near Surface Test Facility (NSTF) at Hanford and in the facility at NTS, and in a still to be sited Salt Test Facility.

Efforts will also continue in support of repository design and development. Work will emphasize design optimization studies for a repository in dome salt and conceptual design studies on alternative geologic media, such as basalt.

DOE has initiated a demonstration program for the solidification of high level wastes currently at the NFS site in West Valley, N.Y. Activities include preparation of an Environmental Impact Statement, a waste characterization program, preconceptual design of a solidification process, a program to remove the waste from the tanks, and a development program to support a selection of waste solidification process system.

Research and development will continue on safe and efficient operation of spent fuel storage facilities. Fuels of various types will be analyzed to identify their potential for fuel cladding failure. Fuel failure detection and fuel content and criticality monitors will be developed and techniques for disassembling and storing fuel will be developed and demonstrated. Dry storage in caissons or shielded containers will also be further developed and demonstrated at the Engine Maintenance and Disassembly Facility.

STRENGTHENING THE LWR ROLE

Essential as it is to resolve the problems of radioactive waste disposal, there are yet other measures that must be taken fully to establish nuclear power as a major contributor to the energy economy of the United States.

To understand this role it is helpful to view it in the perspective of over a quarter century of development. When in 1954 then President Eisenhower announced his "Atoms for Peace" program, nuclear energy was hailed as all but a panacea for meeting prospective needs for energy, both foreign and domestic. It was even described by a leading proponent as offering electric energy "as cheap as the unmetered air."

Despite such unrealistic predictions, and the favorable climate for nuclear energy which then prevailed, the U. S. program had trouble getting underway. For one example, the mid-1950's witnessed a major policy debate involving the Administration, the Congress, and the nuclear industry as to whether the commercialization of nuclear electric power would be carried out predominantly by the Federal government or by private industry. The decision was in favor of according the primary role to private industry.

Spurred on by this decision, the private utility industry, with modest government assistance, launched a number of nuclear plant projects in the late 1950's and early 1960's.

THE NAMES WILL BE FAMILIAR TO MOST IN THIS AUDIENCE: YANKEE ROWE, DRESDEN, SAN ONOFRE, CONNECTICUT YANKEE, TO MENTION BUT A FEW. BUT THEN, THIS EARLY ENTHUSIASM BEGAN TO WANE AND ORDERS FELL OFF FOR A FEW YEARS.

BY THE LATE 1960'S, HOWEVER, THE DRIVE FOR NUCLEAR ENERGY BEGAN TO ACQUIRE RENEWED MOMENTUM. ORDERS FOR NUCLEAR POWER PLANTS BEGAN TO MOUNT: AS YOU CAN SEE FROM FIGURE 2, SEVEN PLANTS WERE ORDERED IN 1965, 20 PLANTS IN 1966, 30 PLANTS IN 1967, 14 IN 1968, 7 IN 1969, AND 13 IN 1970. THE CYCLIC EFFECT BETWEEN 1965 AND 1974 WAS EXPLAINED AS A TYPICAL UTILITY ORDERING PATTERN. THIS EXPLANATION IS SUPPORTED BY THE PATTERN OF FOSSIL POWER PLANT ORDERS, WHICH EXHIBITS A SIMILAR CYCLIC BEHAVIOR.

ALL IN ALL, THE FUTURE LOOKED BRIGHT INDEED FOR NUCLEAR POWER IN THOSE EARLIER YEARS. THEN AROUND 1968 ITS BURGEONING GROWTH BEGAN TO BE CHALLENGED WITH INCREASING FORCE BY THOSE OPPOSED TO NUCLEAR POWER ON ENVIRONMENTAL AND SAFETY GROUNDS. THE SPECIFIC ISSUES VARIED AND OFTEN WERE NOT DEBATED RATIONALLY IN PUBLIC. INSTEAD OF INFORMED, THOUGHTFUL DISCUSSION AMONG GROUPS OF CONCERNED PEOPLE, THE CONTENDING FORCES BECAME POLARIZED. PUBLIC CONCERNS, INFLAMED IF NOT INFORMED BY THE CHARGE AND COUNTERCHARGE, CONTINUED TO MOUNT. THIS CONTRIBUTED IMPORTANTLY TO THE DIMINUTION IN GROWTH STARTING IN THE MID 1970'S.

There were yet other problems holding back the growth of nuclear power. As plants were built in increasing numbers, additional difficulties were encountered: shortages in numbers of trained engineers and technicians, lack of qualified technical and other top level mangement, low labor productivity, mounting construction costs, protracted regulatory processes, severe financial problems due to the high cost of money and the uncertainty of future power requirements, and poorly conceived and applied regulatory approaches.

It will be noted that these problems are not primarily technical in character; neither are they peculiar to nuclear technology. On the contrary they reflect a difficulty frequently encountered in bringing about widespread application of already demonstrated and proven technical processes. That is to say they were principally managerial, administrative and institutional in character. I shall return to this point later in my remarks.

Partially offsetting these unfavorable developments was the progressively imposing performance of the better managed plant projects. For example, the capacity factor of Connecticut Yankee in 1978 was 93.5%. In several regions nuclear power performed effectively both as regards reliability of operation and in holding down power costs. Yet notwithstanding these demonstrated capabilities, by 1975 the ordering of nuclear power plants had all but come to a halt and cancellation of existing orders had set in.

If there were any doubts as to the parlous state of the industry, they were terminated by the accident at Three Mile Island, now just one year ago. The period since then has been one of exhaustive examination of the accident itself, and beyond that, of the institutions in both industry and government which have roles in the application of nuclear energy.

The most important of these examinations and assessments was, of course, that carried out by "The President's Commission on the Accident at Three Mile Island," popularly known as the Kemeny Commission. I have no doubt that the major thrust of its findings and recommendations are well known to all like yourselves with a serious interest in the future of nuclear power. So I will not dwell on them here.

But it is important to discuss certain aspects of President Carter's response to the Commission's recommendations. While characterizing nuclear power as an energy source of last resort in the United States, he said:

> "Every domestic energy source, including nuclear power, is critical if we are to free our country from its overdependence on unstable sources of high-priced foreign oil," and
> "Nuclear power has a future in the United States -- it is an option that we must keep open."

THE PRESIDENT'S RESPONSE PROVIDED IMPORTANT SUPPORT BEARING ON THE FUTURE OF NUCLEAR POWER. BUT WE MUST REMIND OURSELVES THAT THE NATURE OF THAT FUTURE WILL BE DETERMINED BY THE EFFECTIVENESS OF INDUSTRY AND GOVERNMENT IN CARRYING OUT THE ACTIONS CALLED FOR BY THE PRESIDENT, SO AS TO IMPLEMENT THE SPIRIT AND INTENT OF THE COMMISSION'S RECOMMENDATIONS. YOU WILL RECALL THE EMPHASIS IMPLICIT IN THEM ON THE NEED FOR ACTIONS DIRECTED TOWARD STRENGTHENING THE INSTITUTIONAL, MANAGERIAL, AND REGULATORY ASPECTS OF THE COMMERCIAL APPLICATION OF NUCLEAR POWER, AND OF THE NEED FOR IMPROVED TRAINING OF OPERATING PERSONNEL. THE PRESIDENT'S RESPONSE REINFORCED THIS EMPHASIS. AMONG OTHER THINGS, HE SAID:

> "SAFETY OF NUCLEAR REACTORS CAN BE SIGNIFICANTLY IMPROVED THROUGH A PERVASIVE AND KNOWLEDGEABLE INVOLVEMENT BY UTILITY TOP MANAGEMENT IN SEEKING SAFE AND RELIABLE PLANT OPERATION. INDEED, THE PRIMARY REFORM MUST COME FROM WITHIN THE UTILITY INDUSTRY AND ITS SUPPLIERS."

THIS RECOGNITION THAT THE PRIMARY ROLE MUST BE ACCORDED TO INDUSTRY INITIATIVES AND ACTIONS IS CONSISTENT WITH PRINCIPLES WELL KNOWN TO ALL WHO HAVE EXPERIENCE IN CARRYING OUT TECHNICAL ENDEAVORS, NUCLEAR AND OTHERWISE. THAT IS, YOU CANNOT BUILD QUALITY INTO A PRODUCT "FROM THE OUTSIDE"; NEITHER CAN YOU REGULATE SAFETY AND RELIABILITY INTO A PLANT. SAFETY AND RELIABILITY COME FIRST AND FOREMOST FROM THE FORCEFUL AND INFORMED ACTIONS OF THOSE ORGANIZATIONS ACTUALLY CARRYING OUT THE JOB, UNDER ENLIGHTENED REGULATORY OVERSIGHT.

IF I SINGLE OUT THESE ASPECTS FOR EMPHASIS, IT IS BECAUSE I BELIEVE THEY ARE OF TRANSCENDING IMPORTANCE TO THE FUTURE OF NUCLEAR POWER. THE THREE MILE ISLAND ACCIDENT CAN BE VIEWED IN A NUMBER OF WAYS. UNFORTUNATE AS IT WAS, MANY OF US YET BELIEVE THAT IS HAS GIVEN THE NUCLEAR POWER INDUSTRY A UNIQUE OPPORTUNITY TO EFFECT STRENGTHENING MEASURES THAT HAVE BEEN RECOGNIZED AS NEEDED FOR SOME TIME.

THE REASONS THEY WERE NOT TAKEN WITH SUFFICIENT EFFECTIVENESS ARE COMPLEX. ONE WAS THE SHEER MAGNITUDE OF THE TASK. AS WE MOVED TOWARD CIVILIAN NUCLEAR POWER IN THE LATE 1950'S AND 1960'S THE UTILITY COMPANIES, REACTOR PLANT MANUFACTURERS, ARCHITECT ENGINEERS AND OTHER INDUSTRY PARTICIPANTS WERE CONFRONTED WITH MASSIVE TASKS OF ESTABLISHING WITHIN THEIR ORGANIZATIONS THE CAPABILITIES OF PERSONNEL, FACILITIES AND STANDARDS TO APPLY THIS NEW AND ADVANCED TECHNOLOGY. MOST OF THESE ORGANIZATIONS HAD HITHERTO BEEN INVOLVED IN THE PROCESSES OF BUILDING LESS TECHNICALLY ADVANCED PLANTS FUELED BY COAL, OIL OR GAS. NOW THEY WERE CONFRONTED WITH THE NEED TO COPE WITH A MORE DIFFICULT AND DEMANDING TECHNOLOLGY; A TECHNOLOGY WITH MORE RIGOROUS ENGINEERING REQUIREMENTS, MORE EXACTING SAFETY STANDARDS AND HIGHER STANDARDS OF WORKMANSHIP. THESE IN TURN BROUGHT GREATER NEEDS FOR EDUCATED AND TRAINED MANAGERS, ENGINEERS, TECHNICIANS, AND TRADES PERSONNEL. THE TRANSITION WAS A DIFFICULT ONE. THE RECORD OF THAT DIFFICULTY IS WRITTEN IN MANY OF THE PROBLEMS CITED EARLIER SUCH AS DELAYS IN BRINGING PLANTS ON LINE, IN EXTRA COSTS, AND IN LOWER THAN PROJECTED PLANT AVAILABILITY.

In the naval nuclear propulsion program a different and more effective course was pursued. In that program the principal laboratory and industrial participants were made to acquire and train the personnel and special facilities needed well in advance of starting work on a project. The successes achieved in that program are a reflection in large measure of the systematic and thorough manner in which the personnel and organizations were selected, trained, and integrated in pursuit of technical and managerial excellence in every aspect of the endeavor.

In citing differences between naval and civilian programs, it should be noted that the central customer role of the Naval Reactors organization provided opportunities for this systematic, comprehensive and orderly approach to the transition from fossil to nuclear power. By contrast, there existed no analogous organizational entity to play this role among the scores of utility companies throughout the Nation. But the difference is more realistically attributed to Admiral Rickover, who had the vision to see the need and, in the face of often formidable resistance, the will to effect the far reaching institutional and organizational changes needed.

The point to be emphasized is that a new technology called for the establishment of a new industrial and institutional environment for its effective application. In one instance the environment was well prepared in advance and always ahead of developing needs; in the other the preparation was not accomplished as well.

A FURTHER POINT IS THAT WE MUST TAKE FULL ADVANTAGE OF THE EXPERIENCE THUS ACQUIRED. AN OPPORTUNITY IS NOW PRESENTED TO EFFECT THE NEEDED STRENGTHENING MEASURES. EFFORTS HAVE BEEN UNDERTAKEN BY UTILITY ORGANIZATIONS AND COMPANIES TO PROVIDE TRAINING OF PERSONNEL AT ALL LEVELS: TOP MANAGERS, SUPERVISORS, OPERATORS AND TECHNICIANS. TO HELP IN THIS AND OTHER STRENGTHENING MEASURES THE INDUSTRY HAS ESTABLISHED AN INSTITUTE FOR NUCLEAR SAFETY ANALYSIS (INPO) AND THE NUCLEAR SAFETY ANALYSIS CENTER.

BUT WE MUST REMEMBER THAT THE TASK AHEAD REMAINS A FORMIDABLE ONE. ITS DIMENSIONS ARE ESTABLISHED BY THE FACT THAT SAFETY AND RELIABILITY REQUIRE HIGH STANDARDS OF SELECTION AND TRAINING, NOT OF OPERATORS ALONE, BUT OF THOSE CHARGED WITH ALL OTHER PHASES OF A PLANT PROJECT: DESIGN, CONSTRUCTION, COMPONENT FABRICATION, TESTING, AND MAINTENANCE IN SERVICE. THERE IS NO MAGIC SOLUTION; NO EASY WAY.

YEARS OF NUCLEAR POWER EXPERIENCE INDICATES, FOR EXAMPLE, THAT THERE IS NO EASY WAY TO GET ENGINEERS AND MANAGERS TO UNDERTAKE THE ARDUOUS WORK OF CODIFYING THE RESULTS OF THEIR EXPERIENCE IN ENGINEERING STANDARDS OF PROVEN EFFECTIVENESS. THERE IS NO EASY WAY OF GETTING MANAGERS TO STRUCTURE AND ORDER THEIR ACTIVITY BY INSISTING ON THE USE OF STANDARDS AND ON THE USE OF FORMAL PROCEDURES IN CONSTRUCTION, TESTING, AND MAINTENANCE PROCESSES. FINALLY, THERE IS NO EASY WAY TO GET TRADES PERSONNEL TO ADHERE TO THEM. BUT IMPROVING THE SAFETY AND RELIABILITY OF NUCLEAR POWER PLANTS, INDIVIDUALLY AND COLLECTIVELY DEPENDS ON

THE EFFECTIVENESS WITH WHICH WE ARE ABLE TO ENGENDER AN UNDERSTANDING OF THE IMPORTANCE OF STANDARDS AND FORMAL PROCEDURES. THESE NEEDED MEASURES CAN BE ACHIEVED ONLY BY COMMITMENT AND UNREMITTING EFFORT COMMENSURATE WITH THE VERY LARGE STAKES INVOLVED.

I'D LIKE TO CLOSE WITH THIS OBSERVATION. I THINK THAT WE IN THE NUCLEAR ENERGY FIELD REALIZE THAT WE HAVE THE OPPORTUNITY TO MAKE A CONSTRUCTIVE CONTRIBUTION TO THE WELL-BEING OF THE WORLD. MANY OF US ALSO FEEL THAT SINCE NUCLEAR POWER IS A SAFE, CLEAN, TECHNICALLY PROVEN SOURCE OF ENERGY, IT SHOULD ENJOY WIDESPREAD ACCEPTANCE. UNFORTUNATELY, THIS ACCEPTANCE HAS BEEN SLOW IN COMING. THEREFORE, OUR OPPORTUNITY CARRIES WITH IT A SPECIAL OBLIGATION. WE MUST REDOUBLE OUR EFFORTS TO ENSURE THAT WE COLLECTIVELY, COOPERATIVELY, AND EFFECTIVELY ADDRESS THE PROBLEMS THAT STAND IN THE WAY OF ACCEPTANCE. BY APPLYING THE HIGHEST STANDARDS OF PROFESSIONAL, TECHNICAL AND MANAGERIAL EXCELLENCE TO PROBLEMS LIKE PROLIFERATION, WASTE MANAGEMENT, RADIATION EXPOSURE, SAFETY AND SAFEGUARDS, WE CAN PROVIDE A MOST IMPORTANT ANSWER TO THE APPREHENSIONS OF THOSE OPPOSED TO THE EXTENSION OF NUCLEAR POWER -- THE ANSWER OF DEMONSTRATED PERFORMANCE. IN THIS REGARD THE SUCCESSES OF ONE NATION REDOUND TO THE BENEFIT OF ALL, THE LAPSES HAVE REVERBERATIONS EVERYWHERE. GIVEN THE IMMENSE POTENTIAL OF NUCLEAR ENERGY FOR CONTRIBUTING TO WORLDWIDE DEMANDS FOR ENERGY, WE HAVE AN IMMENSE CHALLENGE TO PERFORMANCE. IT IS A CHALLENGE TO WHICH WE WILL SURELY RISE -- BECAUSE WE MUST.

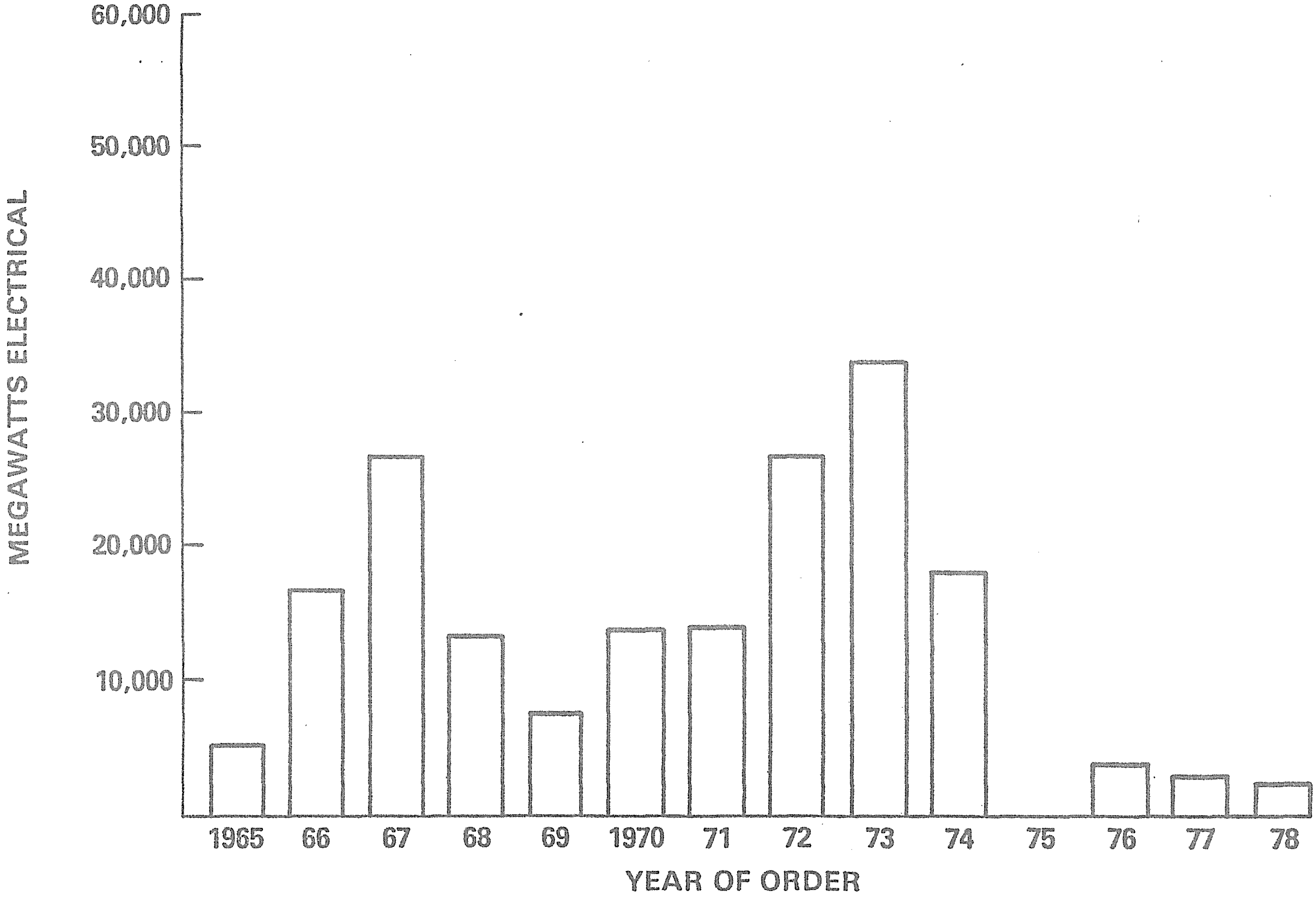
FIGURE 1

SOURCES OF PRIMARY ENERGY CONSUMPTION — 1979

	PERCENT
DOMESTIC	
OIL	25
GAS	24
COAL	19
NUCLEAR	4
RENEWABLES	6
TOTAL DOMESTIC	78
IMPORTED	
OIL	21
GAS	1
TOTAL IMPORTED	22

FIGURE 2

ANNUAL ORDERING OF NUCLEAR STEAM—ELECTRIC GENERATING CAPACITY BY U.S. ELECTRIC UTILITIES



Main Directions of Nuclear Power Development in the USSR

by Kulov Eu.V.

The USSR State Committee for the Utilization of Atomic Energy

1980

For the recent 30-40 years the structure of consumption of the world energy resources shifts to the side of oil and natural gas. Approximately 70% of power production of the globe is provided at the cost of these resources since they are the most convenient, universal. However, the exhaustion of the oil and the gas is inevitable. The basic way of solution of the energy problem is a fast development of the large-scale nuclear power together with the increase in the use of coal. Inspite of the fact that the USSR is the large industrial state, which bases its economic development on his own mineral fuel resources, the task of broad development of nuclear power is actual for our country, too. In the first place it is caused by the circumstance that about 80% of energy resources are concentrated in eastern regions of the country and at the same time about 75% of the population and power consumers falls within the European part of the USSR territory. The solution of the problem of fuel and energy transportation at long distances holds a prominent place in the development of fuel-power economy of the country. The development of nuclear power in the European part of the USSR provides the most effective way in the development of the fuel-power economy.

Due to high calorific value the volume of nuclear fuel transportations proves to be much less as compared with conventional fuels. Therefore, the nuclear power permits to locate power sources close to the place of consumption and facilitates the solution of the problem of power-supply for regions far remoted from fuel bases.

The influence of nuclear power upon environment is less than the effect of the conventional power based on burning of organic fuel.

At the present time the installed capacity of the USSR nuclear power plants amounts to 11 mln.kW. The development of nuclear power follows the path of the increase in the unit power of reactors and of the growth of power concentration at the chosen reactor sites. Power units with the WWER (PWR), and RBMK type (channel type) reactors form the basis for the present-day nuclear power of the country.

The first unit with the water-water (PWR) power reactor (WWER) with the power of 210 MW.el. was commissioned in 1964 at the Novo-Voronezh NPP (NVNPP). The basic factor which has determined the reactor power was the requirement of transportability of the reactor vessel by rail, which has also been valid for subsequent modifications of the WWER type reactors. The power of the second NVNPP unit amounted aready to 365 MW.el.

The next qualitative stage (the second generation) of the WWER development - the WWER - 440 reactor installation, the recator power of 440 MW - was used as the basis for a large series of NPP's, since satisfactory economical records had made these power plants quite competitive with the conventional fuel plants almost in all regions of the USSR European part. The III and IV NVNPP units have been built according to this design, whereupon the plant's power has attained 1455 MW. The cost of electrical power at NVNPP lies around 0.65 kop./kW.h. while the coal and gas-mazut power plants in this region provide electricity at the cost of 0.75-0.9 kop/kW.h. The load factor of the NVNPP equaling to 0.75-0.8 is also indicative of the effective operation of this power plant.

Besides the NVNPP several more power plants with WWER-440 reactors have been built in the USSR: two units of the Kol'skaya and two units of the Armyanskaya NPP. Four more units with WWER-440 reactors are under construction (2 units of Kolskaya NPP and 2 units of Rovenskaya NPP). In the future the construction in the USSR of NPP with WWER-440 reactors is not planned.

The next stage of the WWER-type reactor development (the third generation) is the WWER-1000 reactor with the power of 1000 MW.el. At present, the construction of NVNPP V unit with the reactor WWER-1000 is being completed. The commissioning of the plant - in 1980.

Based on the experience of coustruction of the NVNPP V unit the design of a serial reactor installation has been worked out. In the design of the serial WWER-1000 reactor technical solutions of the NVNPP V unit are maximally used but in contrast to it the fuel assemblies without shiths were used, seismic requirements were taken into account, some design changes were introduced. The first units with WWER-1000 reactor of the Kalininskaya, South-Ukrainian and West-Ukrainian NPP are now being constructed.

The development of channel water-graphite reactors has begun from the commissioning of the first nuclear power plant in Obninsk in June 27 1954. Then the Siberian 600 MW NPP has been put into operation, then - the first and the second units of the Beloyarskaya NPP with the capacity of 100 and 200 MW.

The next stage in the development of channel type reactors in the USSR was the boiling high-power reactor RBMK-1000.

The design of channel reactor of the RBMK-type provides the possibility of obtaining of high unit powers. On load any-channel refuelling ensures fuexibility of the fuel cycle and permits to increase availability of the power plant.

After putting into operation of the first two units of the Leningradskaya NPP with the RBMK-1000 reactor (I unit - in 1973, II unit - 1975) the construction of a series of these 1000 MW.el. reactors has been started. During 1976-1978 there have been constructed and put into operation 2 units of the Kurskaya NPP and 2 units of the Chernobylskaya NPP and in December 1 1979 the III unit of Leningradskaya NPP has been put under commercial load. Thus, the power of NPP's with RBMK-1000 reactors has attained 7000 MW. Several more analogous power-units are under different stages of construction.

The operation of the head plant the Leningradskaya NPP is characterized by high stability and high efficiency. The load factor reaches 0.82. The cost of the electrical energy generated by this NPP is somewhat lower than that of generated by power plant of this region of the country operating on organic fuel.

The Ignalinskaya NPP with RBMK-1500 reactors with the power of 1500 MW.el. each is being constructed in Lithnania.

The total power of this power plant will come up to 6000 MW. The increase in reactor power up to 1500 MW would further lower the specific capital cost of the NPP construction.

In the nearest perspective the intensive growth of the nuclear power capacity will be accomplished. If now the Soviet nuclear power has reached the rate of commissioning of approximately 2000

MW a year it can be assumed that by the end of the next decade the annual commissioning of nuclear power capacities will read 5000-8000 MW a year and by the end of century, probably, will exeed 10000 MW a year that is comparable with the rate of the present increase of all electric power capacity of the USSR. The construction of nuclear power plants, as it has been already said, will be accomplished mainly in the European part of the USSR.

To ensure high rates of the growth of the nuclear power the machine-building base is being extended and modernized. The first stage of the "Atommash" plant in Vogodonsk with the annual rate of production of reactor equipment of 3000 MW has been put into service and the Izhorsk machine-building plant is raising its capacities.

One of the principles in constructing nuclear power plants is the significant concentration of installed capacities on one site. The NPPs being constructed and planned include ususally several units with the total power of 2000-6000 MW. The study of optimum NPP (or NPP groups) power levels and the optimum territorial location of nuclear power plants is one of the actual problems of the large-scale nuclear power development. It should be solved together with the task of the development of the external fuel cycle enterprises and the reliable and economical storage of radioactive wastes.

Developing its own nuclear power the USSR accomplishes at the same time a broad international cooperation in this field, in the first place with the CMEA member countries. With the technical assistence of the USSR nuclear power plants in GDR, Bulgaria, Chzechoslovakia have been built. The construction of NPPs in

Hungary and Poland is under way. The construction of the "Lovisa" NPP in Finland with the participation of the USSR has been one more acknowledgement of achievement of the Soviet nuclear power engineering.

The cooperation of the CMEA member countries in the development of the nuclear power has far-reaching prospects. With the technical assistance of the Soviet Union it is expected to build in the CMEA member countries the nuclear power plants with the total installed capacity of about 37000 MW. The joint construction of two NPPs with the power of 4000 MW each is also being planned in the western regions of the USSR with the subsequent supply of electrical energy to neighbouring countries.

In recent years on the basis of bilateral agreements concluded between the USSR and the CMEA member countries - PRB, HPR, GDR, PPR, SRR, CSSR and also SFRY the cooperation in the production of equipment for nuclear power plants has been organized.

Thus, the nearest decades are to be the period of a wide introduction of atomic energy in the electric power energetics of the USSR and socialist countries.

The introduction into the USSR energy system of a large number of NPPs will require revision of their operating regimes. If until recently it was possible to operate the NPPs in the regime of base loads, then in the following-years they should be able to cover the variable part of load schedules. Already for some NPPs with the serial WWER reactors the load following regimes include weekly stut-downs and daily partial decreases of the power. The small range of changes in the operating temperature of the WWER primary coolant at the wide changes of loads creates good prerequisites for the long-term reliable operation of the reactor equipment under conditions of the variable power. The main technical obstacle of the use of nuclear plants in the electrical (and thermal) load following regimes is the possibility of fuel element claddings loss-of-tightness failures.

There exists a number of possibilities for introduction of nuclear power into the half-peak part of the electrical energy consumption schedule. In any of the considered cases, the economics is suffered, which, however, is typical for the conventional energy too. But for nuclear power things are redoubled by its high capital costs. Therefore, together with the analysis of the possibility of controlling the electric energy consumption schedule with the help of NPPs it is wirthwhile to consider also the solution of the "half-peak" problem by means of conventional plants.

Until now the nuclear power has found the wide application only in the field of electrical power production. It is well known that in the total consumption of energy resources the electrical power amounts to approximately 20%. At the same time more than 30% of power resources are consumed for heating and technological processes requiring the low potential heat with the temperature of the order of 150°C and yet about 30% are used in industry as a high-potential heat at the temperature of 500-1500°C. From this it follows that the solution of fuel problem is impossible without a broad introduction of the nuclear power in different branches of national economy consuming large quantities of organic fuel. For the last 15-20 years the heat-supply has been developed in the direction of the systematic growth of proportion oil and gas in the consumed for these purposes fuel. In this situation the replacement of organic fuel used for heat supply by the nuclear power seems to be even more important than the corresponding substitution in the field of electrical energy generation.

At the present time one can consider as proved the expediency of nuclear energy untilization for the central heat-supply. The places of the most probable location of nuclear heat sources - large cities, agglomerations, grouped systems of populated places with already formed local systems of the central heat-supply. Nuclear sources in such systems should be considered, as a rule, as the base ones, excluding the operating organic fuel heat sources from the base into the peak part of the thermal loads schedule.

Studies show that the heat-supply from nuclear energy sources can be provided either by means of atomic central heating and electrical power plants (AHEP) in which the heat generation is combined with the generation of electric energy, or using atomic power plants for heat supply only (AHSP), - nuclear boilers. The AHEPs are more efficient thermodynamically, but more complicated in construction and operation.

The USSR performs actively the work on the application of atomic energy for heat supply systems of cities.

In addition to designing the AHEPs with the use of proved type reactors the works are being carried out on the creation of nuclear boilers on the basis of the vessel type-water reactor. The design of a nuclear reactor and the degree of its safety is sensitive to the level of coolant parameters and to the value of the reactor core specific power. The decrease of pressure permits to simplify and to reduce the cost of construction with the increase of its safety.

For the purpose of heat supply with hot water the pressure in reactor is required to be not higher than 15-20 atm. The decrease in specific power of the reactor core enables to provide the reactor cooling under normal and emergency conditions with the help of natural circulation. As investigations show the power of AHSP unit should not exceed 500 MW. The relatively low power of the AHSP unit even at low specific powers of the reactor core and the lower (in comparison with the reactor of the NPP) pressure permit to accomplish an integral arrangement of the equipment. The AHSP compactness and the availability of the second protection vessel designed for the fuel pressure of the main reactor vessel, allow to protect it reliably against such external actions as explosions, a fall of a plane, etc. which convential NPPs and AHEPs are not designed for. The impossibility of radioactvity penetration to consumers of heat is reached due to the used an intermediate circuit.

The above-cited features of AHSP permit to consider them as a sufficiently powerful (300-500 G.cal./h) and safe source of heat-supply which can be located near large populated places. Under these conditions there is no need to build long-distance and expensive district heating pipelines. First units of heat supply nuclear plants with the power of 500 MW. thermal are being constructed in Gorky and Voronezh and in the future one should expect their broad propogation.

The construction of heat supply nuclear power plants costs more than that of boiler plants on an organic fuel but thanks to the low expenditures for the nuclear fuel cycle the unit cost of the produced heat would be approximately two times lower compared with the use of a traditional fuel. The calculations show that the amortization time of AHSP's is about 5-6 years. Such heat supply stations permit to save hundreds of millions tons of organic fuel and to relieve the transport of its freightages.

Much more complicated technical problem is the generation of the high-potential heat using nuclear energy. The studies in this field are at the stage of search of optimum technological solutions. The design of an industrial prototype of the nuclear power-technological plant on the base of a high-temperature reactor with the helium cooling (VG-400) with the thermal power of 1000 MW. is being worked out. Such a plant would permit the complex utilization of the HTHR's power - to generate electric energy and high-potential heat at the level of 950°C to produce ammonia and hydrogen. The use of high-temperature reactors with the helium coolant is being considered for application in ferrous metal industry, oil-chemical industry, synthetic fuel production, intensification of oil output.

The present-day nuclear power is based practically completely on thermal neutron reactors using only about 1% of the energy potentially available in the uranium fuel.

Its main economic advantage lies in low costs of an initial fuel, amounting now to no more than 10% in overall expenditures for nuclear energy. To keep this advantage it is necessary to work out and accomplish measures which would hinder the essential increase of expenditures for fuel under conditions of exhaustion of rich uranium ore resources. At the same time uranium resources in the most profitable deposits are comparable in their energy capacity with oil reserves available in the world. This is one of the central problems of a log-term program touching in one way or other all the components of the nuclear-power system. It is generally recognised that the solution of the problem of nuclear fuel supply lies in the development of fast neutron breeder-reactors in which the generation of the electric energy is coupled with prodution of the secondary fuel-plutonium. The operation of fast reactors increases the energy output from natural uranium by a factor of 20-30. A wide introduction of fast reactors in the nearest future will mark the second stage in the development of nuclear power.

In the USSR a great attention is being given to the problem of development of fast reactors. The first prototype fast power reactor with sodium coolant-BN-350 built in Shevtchenko on the shore of Caspian Sea has the twofold purpose - the generation of electric power and production of desalted water. The plant started its power operation in 1973. At the present time the reactor BN-350 supplies 120 MW. of the electrical and produces 80000 tons of desalted water a day. The operation of the reactor is characterized by the high operation factor which for the whole period of its operation amounted to 0.86.

From the beginning of the reactor operation there have been produced over 4 billions KWhr of electric energy and over 110 mln. tons of distillate that has become the invaluable contribution in the progress of the rich in mineral resources but remote and droughty region.

At the Beloyarskaya NPP near Sverdlovsk in the Urls the start up works at the 600 MW.el. fast reactor BN-600 are now under way. As opposed to BN-350 the reactor BN-600 has an integral arrangement of the primary circuit equipment and has advanced technological characteristics. The operating experience with the BN-600 reactor will be of great importance for selection of ways of the further development of fast reactors.

Studies carried out both in the USSR and abroad have shown that the optimum power of a commercial NPP with the fast reactor amounts to 1200-1800 MW. In this region quite acceptable economics is attained and at the same time the too comlicated problems in manufacturing the equipment do not yet appear. In the USSR the work is being carried out on designing such a plant with reactor of 1600 MW.el. with two turbines of 800 MW.

Speaking on the progress in the nuclear power field in the USSR one should of course mention the creation of atomic ice-breaker fleet. The exploration of northern seas is of great significance for our country. The construction of nuclear ice-breakers has marked a new stage in the exploration of the Arctic Sea route.

The first in the world nuclear ice-breaker "Lenin" has been constructed in 1959 and in December 1979 has celebrated the twentieth anniversary of its intense operation in the Arctic ice. In accordance with the program of construction of the series of nuclear ice-breakers in 1974 has been put into operation the ice-breaker "Arktika", and in 1977 the ice-breaker "Sibir" has come on stream. Both these ice-breakers are equipped with the unified nuclear power installation with the power of 75000 h.p. and in their technical parameters are superior to the ice-breaker "Lenin".

The operation experience of nuclear ice-breakers in the period of prolonged navigations, unexampled marches of the ice-breaker "Arktika" to the North Pole and the transarctic high lattitude voyage of the ice-brearker "Sibir" have demonstrated conclusively that nuclear ice-breakers are able to solve such tasks which are beyond the strength of the conventional ice-breakers.

Nuclear power installations have shown themselves as exclusively reliable, with the high radiation safety under all operational conditions. The valuable experience has been obtained, permitting to construct new promising installations. The nuclear ice-breakers have confirmed priority of the USSR in the atomic shipbuilding.

Summing up the above-mentioned, it should be noted that the promises of the progress of the nuclear power are sufficiently clear. First of all this is the further construction of NPP's with thermal neutron reactors, the use of atomic energy for generation of low-temperature heat for district heating and industrial needs, the provision of high-potential heat generation for power-consuming branches of industry.

The available and being worked-out reactors can be distributed among energetics branches as follows:

- thermal neutron reactors with the light-water cooling (WWER, RBMK) - NPPs, AHEPs, AHSPs,
- fast neutron reactors with the liquid metal and gas cooling-base load NPPs, in some cases - AHEPs,
- high-temperature graphite gas-cooled thermal neutron reactors - power and technological applications.

Besides, possibilities of other reactors are being studied.

It is most probable that the future large-scale nuclear power will be the system of different type reactors operationg each in the most reasonable for it field of energy production and linked to each other by the united fuel balance. Therefore, the nearest problems lie in the development of nuclear reactors for various fields of energy production as well as in the development of chemical reprocessing and refabrication needed both from the view-point of uranium resources economy and handling with radioactive wastes, securing their reliable and economical storage.

EMBARGO UNTIL 18:00 a.m. p.m. 3/5

入手

13th Annual Japan Atomic Industrial Forum Conference

Panel on the Nuclear Industry and Nuclear Non-Proliferation

5 March 1980

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International Atomic Energy Agency

1. Chairman Arisawa has suggested that the Agency should make a presentation on "Post INFCE and the Role of IAEA". On behalf of Dr. Eklund I have great pleasure in making a few observations about this matter.

Results of INFCE

2. Before doing so, let us look briefly at the results of INFCE. I would like to list 6 points:

(a) INFCE has confirmed once again that the nuclear industry took the right decision in the 1950's. This was to introduce uranium-fuelled thermal reactors for commercial power production and to proceed from these reactors, through commercial reprocessing, to the commercial use of the fast breeder reactor around the end of the century. This is the only technically proven way in which nuclear energy can make a lasting - one might almost say permanent - contribution to meeting the world's energy needs. INFCE has shown there is no going back.

(b) Secondly, INFCE has shown that this evolution of the fuel cycle - from thermal reactors to fast breeder rectors - does not bring with it significantly greater proliferation risks than the once-through or throw-away cycle or other more exotic fuel cycles which have been talked about for these last 30 years. It has also confirmed that "technical fixes" can do little to reduce the risks of proliferation.

(c) Thirdly, and perhaps this was its more important contribution, INFCE replaced the incipient confrontation of the mid 1970's by a process of consultation involving all interested states. This must continue.

(d) INFCE gave encouragement to work already proceeding in the Agency on an international plutonium storage shceme and on the study of spent fuel management.

(e) INFCE gave some useful pointers for the strenghtening of safeguards and for safe transport of nuclear fuel.

(f) INFCE began an important discussion on supply assurances and supply policies. It was not, however, INFCE's task to make recommendations on this subject. This therefore represents the main unfinished business which INFCE has left us.

3. While INFCE was proceeding, the world did not stand still. We received one further lesson, if not two, that the acquisition of nuclear explosive capacity is a deliberate political act. We were also reminded that this political act has a rapidly diminishing relationship to the use of nuclear power for peaceful purposes. We were shown once again that any country which has even a modest industrial base can acquire nuclear explosive capacity if it is determined to do so and does not count the cost in money or political consequences.

4. It is also clear that the technical barrier to proliferation no longer exists for some 20 countries and by the end of the century this list of countries will surely be much longer. This means that we shall have to depend more and more upon political and institutional restraints to put a brake on further proliferation as the technological restraints melt away and those of restrictive

supply policies loose their effectiveness. We were also shown that the spread of enrichment technology may in future present a bigger risk than reprocessing.

The role of the IAEA

5. There seems to be a consensus that the IAEA should again play the central international role in non-proliferation matters in the post-INFCE period. The IAEA is already making reasonable progress in formulating the IPS project and in the study of spent fuel management. IAEA mechanisms exist in the Secretariat and in SAGSI to take up the pointers which INFCE gave for the strengthening of safeguards and the IAEA is expanding its nuclear safety programmes and its work on safe transport. As you know, there will be a major IAEA conference in Stockholm in October on current problems of nuclear power reactor safety.

6. The IAEA can also provide the forum for the discussion of supply assurances in the framework of full-scope safeguards and other accepted non-proliferation policies. I shall return to this point later.

The NPT

7. While the IAEA is thus returning to its central role, we must never forget that the main barrier to proliferation is and remains the Non-Proliferation Treaty. The Treaty will face severe

tests in the next couple of years. In August this year, the second conference will be held "to review the operation of /the/ Treaty with a view to assuring that the purposes of the Preamble and the provision of the Treaty are being realized.

8. Membership of the Treaty has grown from 91 in 1975 when the first Review Conference was held, to about 112 or 113 this August. With the exception of Japan and Switzerland, almost all the new-comers are third-world countries. There is wide-spread dissatisfaction among them and among many industrial countries about the way in which Articles, IV, V and VI have been implemented. There is little progress to report on Article VI. In particular, the failure to reach agreement on a complete test-ban Treaty will be severely criticized. This is not only because of the value that such a treaty would have in putting a brake on the nuclear arms race. It is also because a comprehensive test ban treaty represents the third (and still missing) component of a fully effective world-wide non-proliferation regime - the other two components being the IAEA and the NPT. Article V of the Treaty is regarded by many as a dead letter. The discouraging record on these two Articles, together with the growth of third-world membership, may focus even greater attention than in 1975 on the question of access to nuclear supplies and technology. This is one of the reasons why the Director General has felt that it is so important to begin a serious examination of nuclear supply assurances as soon as possible.

9. A further test of the NPT lies ahead in the proposals endorsed in principle by the General Assembly last year, to hold an international conference on the political aspects of nuclear energy not later than 1983. Finally the two chief pillars of the Treaty are farther apart than they were in 1970 or 1975 and also less able to influence the outcome of the review conference and the course of nuclear events.

Supply Assurances

10. As I said, the main unfinished business of INFCE is in the field of supply policies, or as we have put it, irrevocable supply assurances in return for irrevocable safeguards.

11. If I may put forward some personal views, an examination of the framework for assuring international nuclear supplies might include the following points:

(a) Firstly, the need for governmentally underwritten supply assurances and the form that these assurances should take - for instance guidelines or a code of conduct or eventually perhaps a more formal arrangement.

(b) Secondly, the minimum internationally acceptable safeguards regime. Most of us would consider that NPT or other full-scope safeguards represent this minimum. However, it is a political reality that in certain cases nuclear supplies are being made with less than full-scope safeguards and will continue to be made for at least some time, even by those countries that are committed to full-scope safeguards. What should the policy be in such cases?

(c) Thirdly, the role that the international plutonium storage, and perhaps basic requirements for physical protection and minimum safety standards should play in a supply assurance scheme.

(d) Fourthly, it may be desirable to have machinery for amicable resolution and settlement of disputes which may arise out of future changes in nuclear export policy.

(e) Fifthly, it may also be desirable to look at proposals for an international fuel bank authority and at what is being called a supply safety net. Personally, I have some doubts about these mechanisms. The fuel bank proposals seem to represent a very complex mechanism which would provide supply assurances only to a rather small group of countries that permanently forego reprocessing, enrichment, etc. Safety nets, on the other hand, may be optically comforting but you tend to fall through the holes when they are put to the test. The IAEA's experience in this regard is not encouraging. When a major supplier changes its policy, there is relatively little that an international mechanism can do about it.

(f) Finally, one might consider declarations of intent to work towards multinational centres for sensitive fuel cycle activities. We must not underestimate, however, the serious practical difficulties involved in multigovernmental commercial operations. There are few examples of success.

This list of possible considerations is not intended to be comprehensive. It does indicate, however, that the task ahead is complex and lengthy and that there may be interconnections between its components - e.g. the nature of the IPS scheme and the time needed to set it up may have a bearing on progress in getting fuel and plant supply assurances.

12. Despite the progress that has been made during INFCE in narrowing the gap between supplying and receiving countries, we must also face the fact that there is still substantial disagreement on the crucial issue. This is whether or not and if so, to what extent the supplying State should exercise controls over the reprocessing of spent fuel which is derived from its supplies or which is produced by plant which it has supplied. This issue goes under the name of "prior consent".

13. The policy of one of the major suppliers was described recently. The Government concerned agrees "that the use of plutonium in fast breeder reactors might be a viable option for certain countries early in the next century". It maintains, however, "that the development, of the breeder reactor is likely to be so costly that only a few of the wealthier nations can afford them". Moreover, "in addition to having greater proliferation risks, the recycling of plutonium in current generation reactors is only marginally economic at best". In accordance with this policy, therefore, this major supplier and certain others seem likely to insist on maintaining the right of prior consent, and giving such consent only in cases where separated plutonium is put into a strict international

plutonium storage scheme and released only to these "wealthier nations" that are developing fast breeder reactors as a "viable energy option". It would be consistent with this approach to seek international agreement on stringent criteria which, if met, might permit the supplying State to waive the right of prior consent or, at least, to grant it automatically in advance.

14. Such an approach would, of course, be a considerable advance over earlier attitudes which tended to regard reprocessing as a wholly illegitimate activity. It also seems likely that countries like Japan would be able to meet such criteria.

15. Nevertheless, it seems to me that this approach would continue to give rise to many problems. Firstly, there is the difficulty of reconciling it with Article IV of the NPT. Secondly, it may be counter-productive. By burdening supplies with requirements that go beyond the obligations of the NPT, there is a great risk that we may lose the much more important objective of securing acceptance of full-scope safeguards. The would-be customer may turn to other, less demanding, suppliers.

16. There is also the risk of introducing another element of discrimination into the NPT between those NPT countries which meet certain minimum nuclear industrial requirements and those, chiefly third world NPT States, that do not. There is even the possibility of dividing the world into three (or more) nuclear clubs. The first would be the nuclear-weapon States, the second those countries that accept not only NPT but also all additional restraints, and the third those

countries that prefer to remain outside the temple and that might be tempted to form a mutual assistance club among themselves. Although I do not consider this likely, it would be a most deplorable development for the future of international security and the prosperity of the nuclear industry which we consider essential if the energy crisis of the 1980s is not to be prolonged and deepened in the 1990s.

17. I would suggest that a realistic policy should take account of the following three considerations:

(a) Firstly, as Dr. Eklund has said: a country that invests a billion or more dollars in a nuclear power plant, should at least be certain that the supply of fuel to that plant under accepted international safeguards will be assured for the lifetime of the plant. The domestic problems that the nuclear industry faces in most of the free-market countries are formidable enough without the added threat that supplies from abroad may be interrupted because of changes in export policies, or that major investments in peaceful fuel cycle plants may be jeopardized for the same reason.

(b) Secondly, as I said here three years ago, the reprocessing cat has been out of the bag since 1955, and all our efforts cannot put it back. In fact, it looks as if the enrichment cat is also crawling out of the bag rather quickly.

(c) Thirdly, the decision to acquire nuclear weapons or nuclear explosives is a political one. There have been numerous demonstrations that the countries that wish to maintain this position will, naturally enough, resist full-scope safeguards. Even if they accept certain supplies from certain countries under the "no reprocessing" condition, this will not prevent them from obtaining other supplies, indigenously or abroad. Nor will it prevent them from developing or acquiring reprocessing or enrichment technology, if they are determined to do so.

18. In other words, the main barrier to proliferation remains the political will and the top non-proliferation priority remains as it has been since 1970. It is to bring all the countries concerned into the international non-proliferation regime by accession to NPT, by full application of the Tlatelolco Treaty or by acceptance of full-scope safeguards. Concern about the inevitable spread of sensitive technologies must not blind us to this reality or deflect us from pursuing this cardinal objective.

19. May I conclude by recalling that when your Forum met three years ago, we had just learnt that it might not be possible to begin the operation of the Tokai-Mura reprocessing plant, and that there might be a major setback to Japan's careful plans and large investments aimed at acquiring a degree of energy independence through the use of plutonium in the fast breeder reactor. Since the question at issue could have affected Japan's future economic and well-being and industrial prosperity, such a setback could not have been confined to the nuclear energy field and could have placed serious strains on Japan's relations with its partners abroad.

20. Fortunately, reason and a spirit of compromise promptly prevailed, which made it possible for Tokai-Mura to start up, at least on a limited basis. In so far as INFCE has contributed to such compromises, it has served a valuable purpose. It is of great importance that the progress already made and the spirit of compromise already demonstrated should be maintained in the post-INFCE period when we search for a new consensus on the basis of Article III and IV of the Treaty, and when the time comes for re-opening important bilateral negotiations.

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Nuclear Industry and Nuclear Non-Proliferation:

Mr. Chairman, Ladies and Gentlemen,

thank you for giving me this opportunity to speak before the Japan Atomic Industrial Forum on this important topic at such an appropriate time. Appropriate time, because the most important international event in this respect during the last 2 years, namely the International Nuclear Fuel Cycle Evaluation, INFCE, has been officially terminated only last week. Although formally not binding, INFCE's findings might be the technical and economic factual basis of a new emerging consensus in this field. Practically all of its findings have been supported by more than 70 states and international organisations, a fact that cannot be disregarded for the future. Governments will now after receiving and "digesting" the INFCE findings draw the appropriate political conclusions.

Ladies and Gentlemen, before I will adress the question, what elements INFCE findings might offer for an international consensus in the area of making nuclear energy worldwide available while minimising the risks of proliferation, the INFCE mandate, and how this might have implications on nuclear industries worldwide, let me please outline before you some of the main conclusions of the INFCE study as an eye-witness to this event. From our point of view those are the following main findings which are not placed in an order to priority, but which I put in accordance with the already mentioned mandate of INFCE:

1. Nuclear energy is expected to increase its role in meeting the world's energy needs over the next 50 years.

2. Independently of reactor strategies chosen there is an urgent need for considerably stepping up efforts to increase uranium exploration and production and to overcome possible environmental, economic, political, social and other constraints which might hamper such development, in a jointly coordinated effort by uranium producing and consuming countries, their

...

designated entities or their industries.

3. A choice for a dedicated fuel cycle in a country depends on a variety of technical, economic, social, financial and institutional factors. A country's view on the practical availability of uranium for its purposes and needs is of paramount importance, for example in deciding whether and when to deploy the breeder system, whether to deploy an open fuel cycle with disposal of spent fuel elements without being reprocessed or to deploy a closed fuel cycle etc. These factors may differ in different states and lead to different appreciation and judgement. We regard the common development in INFCE of such a pluralistic and analytical framework for making fuel cycle decisions as one of the most important results. Hereby the reasons for decisions on any part of the fuel cycle is being placed on a rational economic and technical basis.

4. It has been recognised, that the energy value of plutonium cannot be disregarded. This is spelt out in the relevant parts on reprocessing, breeder deployment and LWR plutonium recycle even if this might in practise be only valid for certain states. With regard to breeders, an important consensus was achieved on the high amount of prospective capital costs of first FBR's, on development costs, prospective reductions in capital costs, on the economic and financial unattractiveness of premature deployment in developing countries and on a rational for cooperative arrangements.

5. The importance of assuring the supply of fuel, technologies and heavy water to make nuclear energy available worldwide was recognised as well. The need for improving assurance mechanisms, particularly to avoid the impact of supply interruptions, was acknowledged. Some institutional proposals to cope successfully with emergency cases were made.

6. Assurance of supply has an impact on minimising effectively the risks of proliferation. Maximising fuel supply assurances and minimising proliferation risks complement each other.

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7. The international consciousness of the proliferation risks inherent in some of the so called "sensitive points" of the fuel cycle has been sharpened.

8. It has been recognised once again that proliferation is primarily a political, not a technical matter. From a technical standpoint no absolutely proliferation resistent fuel cycle exists. There is no absolute "technical fix". The construction and planned use of fuel cycle facilities for nuclear power generation is not the easiest nor the most efficient route to nuclear weapons but might, under certain circumstances facilitate such a undertaking.

9. No single judgement about the risk of proliferation from the different fuel cycles can be made that is valid for now and for the future.

10. Other fuel cycles than the U-Pu-cycle can only be successfully deployed after the year 2000 and it will last some time before their commercial use will be achieved. Therefore their development will be disregarded in this context.

11. Nuclear energy can be made worldwide available while minimising the risk of proliferation.

In order to reconcile these two elements of INFCE, which are mentioned above, and here I find the most important INFCE finding, various measúres have been identified and discussed and suggested to be undertaken. Those measures include for example:

- to improve mechanisms for forecasting demands for nuclear power and nuclear fuel. In this context reference might be made to already ongoing activities in the IAEA, NEA and IEA;

- to step up efforts to increase uranium exploration and production and improve exploration techniques;

- to improve fuel supply assurance by establishing various

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mechanisms like a better information system on fuel availability, creation of a sound spot market, deployment of emergency mechanisms in case of supply interruptions (for example an international emergency network of national and regional pools, an international fuel bank;

- to rebuild confidence in the terms of nuclear trade by seeking common approaches against the background of the need to make nuclear power available to all nations which wish to use it for peaceful purposes and to achieve this in a way that avoids proliferation while respecting the sovereignty of nations and the national needs of technological development;

- to undertake R & D efforts for reducing enrichment levels in fuel elements for new research reactors, although exceptions for special types will probably have to be made and the potential back-fitting existing reactors may pose additional problems, not the least of them budgetary;

- to develop and demonstrate certain improved diversion resistant features of reprocessing technologies, also with respect to breeder fuel cycles, for example co-location and co-conversion;

- to improve the cost/benefit relation of existing safeguards measures and to develop and apply containment and surveillance measures complementary to material accountancy, in particular for large fuel cycle facility;

- to continue work on the establishment of a plutonium storage regime for excess plutonium, according to the IAEA statutes;

- to continue discussions on options for an international spent fuel management;

- to improve international cooperation in the utilization of fuel cycle facilities either by making available national facilities to render services to countries with smaller nuclear programs or by establishing multinational fuel cycle facilities, provided that various specific conditions are met, for

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example the assurance of supply of the participating states is guaranteed by appropriate arrangements;

- to continue consultations on bilateral and multilateral basis for smoothing adjustment of problems arising from diverging national interests and policies in connection with nuclear fuel cycles, possibly leading to common approaches, which might eventually result in more formal measures.

Ladies and Gentlemen,

INFCE has laid down a common factual basis on which now political actions might follow. This will be the decision of governments. The study itself might be characterised by the slogan "findings, but no bindings". I think INFCE, which now definitly is finished, might be followed by an appropriate action phase of "demonstration and negotiation". Technical developments like the development of fuel elements with a lower enrichment grade for research reactors, the application of further developed safeguards to large fuel cycle facilities must be technically demonstrated. The phase of expert talks, for example in the IAEA, on various topics like the storage of excess plutonium might lead to negotiations.

Ladies and Gentlemen,

what might be the main elements based on the outlined INFCE findings to be possibly used in building a worldwide consensus how to make use nuclear energy worldwide available while minimising the risks of proliferation? Let me tell you some of those elements:

1) The peacefeul use of nuclear energy will not be renounced of but will gain more importance in the future for covering world energy needs. For developing countries it can also play a significant role, but it will not be a panacea for the whole developing world.

2) Recognition that pluralism of pre-existing decision factors may lead nations to different judgements and appreciations

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on what dedicated fuel cycle might be best for each of them, and that it is each country's decision within international obligations, not anybody's else.

3) There is a need to minimise uncertanties in consumer countries in receiving assured supply which are caused by interventions of producer governments based on their national policies, in particular on non-proliferation policies. There is a possibility of working out certain principles and measures to improve such fuel assurances, for example by further development of international instruments, standards and practises towards a more certain and predictable regime of assurances of supply.

4) Nuclear energy can be made available while minimising the risks of proliferation by using a variety of technical, institutional and safeguards measures. Some of these measures do exist already, others have to be further developed.

5) Any further effort to reach a consensus can only be done in a concerted effort comprehending supplier and receiving states for nuclear fuel and nuclear technology, and is no more a privilege of one or another particular group.

Ladies and Gentlemen,

before I address the potential implications of INFCE on nuclear industries, let me address briefly the problem of prior consent rights. I have heard some people arguing recently, that INFCE has not been able to solve the political problems which arise in this contex. I am not happy about this statement because INFCE was not a diplomatic negotiation and had no mandate to solve political questions at all. What INFCE did, is making some remarkable statements on the problem of prior consent: The way how such rights have been dealt with in various working groups clearly show, that their existence and exercise does not belong to the bouquet of commonly recognised measures to maximise fuel and technology supply assurances and to minimise proliferation risks, which both complement each other. Whenever such rights were discussed in working

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group 1, 2, 3, or 6, they were critisized. Moreover, where they exist, their common, predictable application in the future was demanded. The part of the fuel cycle on which these rights primarily might be applied, that is mainly reprocessing, was, in addition, found to be an activity which was not at all to be condemned on proliferation grounds. On the contrary: the carrying through of those activities was found to have different justification on energy and economic grounds varying from one country to another. In addition, various other measures in the area of technique, safeguards and institutional, were commonly agreed in INFCE to offer good prospects to be effective non-proliferation undertakings.

I think that all these ideas and facts will be taken into account in the future discussions on this important topic. And the last point: the importance of consultations instead of unilateral actions were highlighted for any future action.

Ladies and Gentlemen,

let me now make some personal remarks on what the implications of INFCE might be on nuclear industries. This is a delicate task I have to fulfill here coming from government, but let me try it with your indulgence. I would like to name the following ideas:

- Industries might get a new fresh momentum from INFCE when carrying out their nuclear activities. They might use the INFCE finding as arguments in political debates, hearings, discussions, and publications particularly when the role of nuclear power for covering national and worldwide energy needs and the use of different fuel cycle concept is being discussed. Don't forget, that in INFCE you had the experts of more than 70 states and international organisations together in a hitherto unique assessment excercise of a new technology.

- Industries should focus on joint activities among uranium producing and consuming states to step up efforts in exploration and production of uranium by joint ventures, financial cross investments etc. They might try to create among themselves more efficient supply mechanism in cases of supply interruptions; they might try to create a spot market for fuel and a better information system on the availability of fuel among each other.

- Industries might pool their activities more than before in such cost-intensive and technically sensitive areas like the development of fast breeders, where Western Europe has led the way being liked through agreements also with Japan. The same might be applied to reprocessing.

- Industries might create sufficient interim storgage capacity until the end of this century also with a view of possibly assisting other states with small nuclear power programmes providing interim facilities for their spent fuel and here-by creating a positive climate for their national use of nuclear energy in their states.

- Industries might develop joint strategies for developing countries, also taking into account the pluralistic approach of decision factors in developing countries, particularly based on their specific, financial, resources and political structures.

- Industries should continue closest cooperation with state authorities in, let me call it, "Non-Prolieration Research Development and Demonstration", for example in the area of fuel elements with low enrichment grade for research reactors, in the area of applicability of safeguards on big fuel cycle facilities and in the area of new technical developments for reprocessing features as they are tried out presently at Tokai Mura.

- Industry should take an active part in consulting states in the political discussions which will come up for example with respect to an international excess plutonium storage regime or working out jointly common approaches of nuclear trade to enjoy a maximum freedom of intervention rights and other uncertainties.

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Ladies and Gentlemen,

the indispensable breathing spell that INFCE has provided has been used constructively, with significant progress in narrowing the gap and creating a common facual basis for the political negotiation that could follow now. Dr. Imai in "Nuclear Engeneering International" of December 79 suggested, that INFCE might be rearranged and utilized this time with a less formal and a less technical, but more flexibel and more political mandate. In response may I just point out that this would be the kind of work for which the IAEA was created and governments will now have to see what role IAEA should play in this respect.

Furthermore, the INFCE results will, among others, be formally taken into account in some important governmental discussions and negotiations in the near future. Those include:

- the negotiations and talks between the United States and Japan,

- the talks between EURATOM and the USA on the basis of the US-Non-Proliferation act of 1978, the NNPA, Sec. 304,

- the negotiations between EURATOM, Canada and Australia on nuclear transfers, the supply of natural uranium included,

- the renegotiations between the United States and many other states on bilateral cooperation-agreements, where the NNPA asks for some new rights of the USA to be incorporated.

Apart from these concrete examples where INFCE results will be an input, the United States will have to take into account INFCE findings when reconsidering the Nuclear Non-Proliferation-Act. In several parts of this law it is spelt out, that the present sections should not prejudge any INFCE results, for example Sec. 303a by which Sec. 131d of the Atomic Energy Act is reformulated, and Sec. 307.

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These parts of the law deal for example with such important items like prior consent rights on reprocessing of original US material, or on the question of transfer of reprocessing technology.
Last but not least I would find it logical, that the INFCE results will be taken into account during the preparatory phase of the second NPT Review-Conference and in the conference itself later in August of this year. These examples should do it to illustrate the general, practical political implications INFCE might have.

Unfortunately time is too limited to discuss the national implications INFCE might have in various states. One thing, however, I would like to stress: independently of how you regard INFCE to be useful or not useful, we have gained a tremendous capital of better understanding, of discussing less emotionally and more objectively in comprehending adequately technical and institutional aspects of this sophisticated topic, and I think that was worthwile. It would be a pity if we lose this momentum.
Ladies and Gentlemen, I am prepared to answer your questions later in the discussion. Thank you

Nuclear Energy and Non-Proliferation

Remarks at the 13th Annual Meeting of the
JAIF - March 4, 1980, Tokyo
by William C. Salmon
U. S. Department of State

The International Nuclear Fuel Cycle Evaluation was recently completed. Before I give you my own thoughts on its significant results and on next steps, I would like to make two observations.

First, societies work for a world at peace, a stable international political environment with no sudden significant disturbances to upset that stability. Reliable and adequate energy is a key factor today to world political stability. Nuclear energy for power production is necessary for adequate energy supply; but further expansion in nuclear explosive capability will significantly upset world stability. We must simultaneously work for both dependable, safe nuclear power as well as the absence of any increased potential for explosives. Each government responds to its public's preception of these two aspects. U. S. programs and policies are not exceptions.

Second, other concurrent energy activities are essential to our treatment of nuclear power. We must:

pursue all reasonable development of renewable energy sources, e.g.: solar, biomass; husband known non-renewable energy sources also permitting their long-term availability for non-energy uses; efficiently use the minimum energy we need; and keep our population growth under control We sometimes forget that while we look for technical solutions we are the source of our problems.

INFCE

INFCE brought together over 60 countries to study the realistic choices available in the further development of nuclear power - choices reflecting economics, safety and non-proliferation. President Carter welcomed the study, and appreciated the major efforts of so many people that went into the work of the evaluation. He said that the U. S. will take the results into account in U. S. domestic and international nuclear policies.

INFCE was not a victory for one side nor a defeat for another. It did not negotiate solutions to the future of the nuclear fuel cycle. I believe INFCE was successful in its assigned task of reflecting a wide range of prospectives, judgments and viewpoints on the several aspects of the fuel cycle. On most matters of substance a single view was agreed. On others differences were expressed in the report.

I should like to refer to a few INFCE matters that strike me as particularly useful and to mention a few areas where some caution is warranted.

First, INFCE has helped to remedy the tensions that were developing between suppliers and consumers. We now better understand each other's objectives, needs, and interests. We have a better appreciation of global nuclear energy needs and resources, worldwide concerns about nuclear proliferation, and the technical and institutional problems and possibilities that lie before us. There is broad agreement that there are proliferation risks associated with nuclear power and measures to make such risks more tolerable and manageable. Also, it is not appropriate to make broad generalizations about the comparative proliferation risks of different fuel cycles. However, we can all share the assessment that there are substantial risks associated with weapons-usable materials and the technologies that can produce them.

I believe that INFCE provides a good evaluation of the factors bearing on prospective availability of natural uranium. However, on the demand side, there will be a need for periodic revision of the estimates developed in INFCE. The data is over two years old and there have been large reductions in reactor orders and lengthy delays in construction schedules. For the United States projections for 1995 nuclear capacity have dropped about 30 percent. As construction of additional fuel cycle facilities and the introduction of new technologies depend on demand-supply relationships, it is important that estimates be kept up-to-date.

Reprocessing, recycling of plutonium in light water reactors, and the need and timing for breeders were key issues in INFCE. From my perspective, several important insights emerged.

While reprocessing has been preferred by some nations as the way to deal with spent fuel, the Evaluation makes it clear that other choices are feasible. Spent fuel can be stored safely on an interim or long-term basis, and terminal disposal without reprocessing appears to be a realistic option for either economic or nonproliferation reasons.

The great majority of participants shared the view that, for economic reasons, when reprocessing plants are built they, like enrichment plants, should be large in scale. And, apart from economics, scale is an important consideration for nonproliferation reasons.

It is worth noting that all agreed that the economic advantage of plutonium recycle in light water reactors will at best be small.

Effective international safeguards are essential, particularly for enrichment, reprocessing, and fabrication of plutonium or highly enriched uranium. Safeguards planning should be at the earliest stages of plant design. High priority should be given to the testing and optimization of new improved safeguards methods for these sensitive fuel cycle steps. While safeguards alone will not minimize proliferation risks from sensitve fuel cycle activities, I am convinced that compresensive safeguards coverage will be necessary if nuclear power is to play its proper role in meeting global energy needs.

Constraints that now apply to reprocessing and to separated plutonium need to be reinforced by other protective mechanisms. For separated plutonium, it was recommended that special attention should be given to placing excess plutonium under international oversight. The U. S.

is prepared to work cooperatively for an effective international plutonium storage regime.

The need and prospects for breeders are given considerable attention. There is no question that over the long term breeders could extend uranium resources in a dramatic way. This accounts for the heavy investments that the U. S. and other nations are making in developing the breeder and in assessing the feasibility, economics, and proliferation implications of its technolgy. But the breeder is not without its costs, risks, and uncertainties. The need and timing of breeder development will vary among countries depending on their technical infrastructure, electric grid size, confidence in access to uranium resources, and other factors. Especially important is the relationship between demand for power and the availability and price of uranium.

In the area of nuclear supply, INFCE recognized that a country pursuing a nuclear power program needs to plan ahead with confidence regarding reactor fuel supply and disposition of spent fuel. It will be crucial to preserve a high degree of confidence and stability in nuclear supply relations if nuclear power is to remain a viable energy option and if the premature spread of sensitive facilities is to be avoided. There is a need for greater predictability in nonproliferation conditions and the prejudicial results of abrupt or unilateral changes in conditions of supply. Also, suppliers cannot be expected to freeze their policies or to ignore situations that might seriously aggravate efforts to prevent the spread of nuclear weapons.

Implications for U. S. Policy

The results of INFCE will be taken into serious account as we review our policy; we hope others will do this also. I note that many aspects of current U.S. policy are reinforced by the results of INFCE. These include:

-- fuel cycle development must balance energy needs with non-proliferation requirements.

-- IAEA safeguards should be strengthened and improved

-- Research reactors should be converted to the use of low enriched uranium.

-- There should be international control of excess civil plutonium.

-- The use of plutonium in light water reactors has little if any economic benefit.

-- Reprocessing is not a prerequisite for managing nuclear waste, and international efforts to expand spent fuel storage capacity should be pursued.

-- Breeder reactors, while an important energy option for a number of states, are not likely to be attractive to states with modest nuclear programs.

There are then other aspects of INFCE conclusions which we will have to take into serious account in considering U.S. nuclear non-proliferation and export policy. Foremost among these is the concern voiced about reliability of supply and the exercise of bilateral rights in a manner that allows recipients to plan confidently the development of their nuclear fuel cycles.

Next Steps

One of the first orders of business is for key suppliers and recipient states to move toward agreement on the ground rules for the separation and handling of plutonium. Agreement on an effective IAEA International Plutonium Storage Regime (IPS) is a central element of this. In addition, agreement between suppliers and recipients on the exercise of prior consent rights with regard to plutonium separation and use will be needed. We are confident that we can reach agreement on arrangements and non-proliferation objectives.

A second important element is for greater reliability of supply of non-sensitive nuclear equipment and material for recipients who have accepted non-proliferation commitments such as the NPT or equivalent full-scope safeguards. Supplier states, including the U.S., can make greater efforts to improve the timeliness and reliability of their supply through such things as long-term licensing. A fuel bank and other back-up arrangements can also play a useful role in this regard.

There should also be increased political and financial support for improvement in IAEA safeguards, particularly advanced techniques for safeguarding sensitive facilities.

I also look toward increased attention to possible multinational arrangements for sensitive facilities to increase the barriers to misuse of such facilities. In addition, we should work toward agreement that development of new sensitive facilities should be in step with international requirements for enrichment and plutonium for economically justified programs and that such facilities should be designed to enhance the effectiveness of safeguards and to incorporate other barriers to proliferation.

INFCE produced a common factual background and a sound base for further development of peaceful nuclear power. That development will require the full and close cooperation of nations with signficant commitments to nuclear power. Each nation will bring to that cooperation the beliefs and commitments of its own people. The enduring strength of that future development will depend on the ability of that cooperation to meld the differing beliefs and needs of the nations involved. Patience and understanding will be essential to success.

shortened version

EMBARGO UNTIL 3/5 a.m. p.m. 18:00

INSTITUT "JOŽEF STEFAN"
L J U B L J A N A

Prof.dr. Milan Osredkar

Some notes on nuclear power in Yugoslavia
(JAIF, 13 ann. conf., 4-6 March 1980, Tokyo)

In order to understand yugoslav views and position in relation specifically to nuclear fuel cycle (NFC) one should know some/facts of which all people dealing with nuclear energy (NE) may not be aware.

Importance of nuclear energy including its disadvantages was realized in Yugoslavia soon. While allways stressing that it should be used for peaceful purpose only and not as a means of military, economic or political pressures, the peaceful uses of nuclear energy and its technologies for economic and social development are considered an inalienable right of every country. Even more so in the present world energy situation in which problems of all forms of energy have become a matter of international concern more than ever before. For such reasons, Yugoslavia, as one of the founders of the non-aligned movement, has endeavoured with other nonaligned countries to give peaceful uses of NE an appropriate place also within the nonaligned movement. At the Havana nonaligned summit in 1979, the question of NE, therefore, was discussed and conclusions accepted, supporting the mutual cooperation of non-aligned and developing countries. It was also agreed that, so far, no form of international cooperation had encompassed problems of NE in its full economic and political (and proliferation) implications. Therefore, the proposal for the UN conference on all aspects of NE (to be held by 1983) was supported.

In view of the risk of military uses of NE Yugoslavia has allways been a supporter of measures aggreed upon by the international community against any form of nuclear weapons use and horizontal or vertical proliferation. Accordingly Yugoslavia has cooperated with the IAEA in all fields of its activity including safeguards, and also has (among firsts) signed and ratified the Non-proliferation treaty (NPT). It also has repeatedly expressed its dissatisfaction with the discriminatory nature and with the poor implementation of mutual obligations assumed within the NPT.

To cover its growing needs for power Yugoslavia has, in the field of nuclear power, started the construction of its first nuclear power plant NPP at Krško (Westinghouse PWR, 630 MW), now nearing completion. Recently it also has started, within its general electrical energy planning, preparations for an expanded nuclear power programme. As it appears, the country will have to cover a good portion of its energy requirements with nuclear power stations since hydropower is not any more largely available and coal is also not sufficient and is located quite remotely from main consumption areas. In addition, in both hydro or coal case, problems of environment might arrise. Around the year 2000 the installed capacity of nuclear power stations under discussions is of the order of 10 000 MW.

In satisfying the need for nuclear power, some principles will be observed in arrangements related to programme implementation. Firstly, yugoslav industry and engineering will have to be involved in the largest possible extent in order to develop further its own ability and capacity, and improving, at the same time, the foreign trade balance. Yugoslav heavy equipment producing and engineering enterprises have built for instance large hydropower stations or supplied, within international cooperation, components for nuclear stations. In the Westinghouse turn-key contract,* however, the domestic contribution, due to various circumstances, has not achieved

* for our first nuclear plant of 632 MW in Krško

the desired level. Secondly, for the fuel cicle, arrangements will be sought which will give the country assurance of maximum realiability of supplies and least interference of any foreign interest. Our own uranium supplies will be developed and, since insufficient, complemented within international cooperation. Similary, our own fuel cycle abilities will be developed and complemented within international cooperation with adequate partners for supplies and services.

The situation in which Yugoslavia has to develop itself is very similar and quite typical for developing countries or countries in the initial stages of introducing nuclear power in general. Here it should also be stressed, that developing own industrial and engineering capabilities for nuclear power means an important contribution to industrialization in all other fields, i.e. creating basis for independent industrial development.

For us, there is, on one hand, no prejudice as to the extent of international cooperation against developing our own capabilities and facilities, while, on the otherhand, there is no intention to relinquish the right for acquiring and developing any nuclear technology related to nuclear fuel cycle or equipment for peaceful uses of nuclear energy if circumstances should dictate so.

There is also no prejudice as to the choice of the NFC to be used in the future nuclear power stations, whether light or heavy water fuel cycle. The main considerations will be reliability of supplies and independence of foreign interference while observing every [redacted] nonprofileration measures agreed upon by the world community, not accepting, however, the views that expanding the number of sensitive technicology facilities means, under all circumstances, increasing the threat to the world peace.

We believe that in parallel with the IAEA function of promoting nuclear energy and particularly in providing assistance to developing countries, also safeguards should be further maintained. However, no technical approach or fixes can solve the (horizontal or vertical) proliferation at the roots of the problem. The progress in this direction, which also means in implementing the NPT obligations, has been practically zero.

One additional consideration in deciding on the NFC and also on the type of reactor will be forms of cooperation with foreign partners and possibility of arrangements for more than one power station, for instance for a series of power stations to be built consecutively. Our industries hold the justified view that they should be able to plan for more than the first next power station and, generally, the view is accepted that the choice of the fuel cycle should be made once for a long time. Arrangements for cooperation with foreign partners in manufacturing equipment and components, of course, will strongly depend on arrangements for fuel and nuclear materials supply and services.

Financing will be obviously an important parameter in the implementation of the nuclear programme, since it is well known, that, in major projects, Yugoslav organisations had to rely on foreign loans in a significant extent.

And finally, economic considerations are important, particulary in relation to the NFC. It is very often mentioned in discussions that building fuel cycle facilities in smaller or developing countries is not economical and therefore existing or future facilities in industrial countries should be used by developing ones. This is obviously valid only under the assumption that it does not decrease the reliability of supplies and that it does not increase the threat of political pressures and dependence of the country. If this assumption is not valid than two facts enter the economical considerations: the most expensive (as H.Baba said) is the energy you don't have; and what price do you ascribe to national freedom.

Perhaps the matter should be turned around: conditions should be created for undisturbed exchange of nuclear materials, services, technology and equipment and a climate of mutual confidence has to be created which will stimulate international cooperation and remove the feelings on the side of less developed of their sovereignty and national interest being jeoparadized, while, at the same time, dispell suspicions on real intentions of either side.

Someone less informed might wonder why people in my country are so sensitive about reliability of supply of fuel and equipment, political pressures, sovereignty etc. In explaining that I will not go back to show how Yugoslavs even during the very recent history had to fight for their independence and freedom and what value they ascribe to that. It is sufficient to use only the illustration from the nuclear field.

Consistently with its views, principles, and practice Yugoslavia has, as mentioned before signed and ratified the NPT and accepted the IAEA full-scope safeguards, and has never given any ground for believing that it would not maintain these or any other international commitments. Yet, after the construction of our first power station was well underway, the supplier's government came unilaterally with additional requirements to be fulfilled if the export licences were to be issued. After this has been negotiated, later on, the supplying company came with changes in time table and price (resulting in our view mostly from internal problems of the company and difficulties they have in managing a turnkey contract), treatening with interruption of supplies and work. This could hardly be explained in a way favorable to the image of the supplier. In view of the experience of some other country in a similar position we should not be surprised to see some third organisation or agency from the supplier's country comming with some other requirements affecting the course of the project and the interest of the investor. Although the three actions are supposed to be fully independent from each other, they might on the side of investors be felt or understood as a concerted action. Altogether, it appears like blackmailing which seems to us a new phenomenon in international political and trade relations. It contributes significantly to further erosion of international confidence and causes more concern to countries dependent on imports. We believe that "Confidence in international nuclear supply cannot be based on thetoric alone. It can only be established by the consistent performance of suppliers, complemented rather that countermanded by their national legislation and reinforced, as necessary, by formal guarantees, but demonstrated, above all in practice". (ICGNE) The problem of international confidence is of crucial importance for the nuclear industrial development since one could not very well imagaine international cooperation without it. If is ~~a matter~~ of many discussions now and was in some ways also mentioned during the INFCE.

I believe, as many others do, that INFCE has resulted in a very good assessment of many problems existing in the use of nuclear energy. It has failed, while studying how to minimize the danger of proliferation, in finding any easily accessible proliferation - proof technical solutions for the NFC (if anyone should have expected them) or in convincing that the increasing risk of misuse of nuclear materials and technology alone is to prevail against other aspects when considering the introduction of a particular fuel cycle. The assessment has also covered a number of problems of particular relevance to developing countries, which in many instances are not of technical nature. Even if they are mentioned in reports INFCE, being a technical exercise, does not indicate solutions to them which mostly could be only political and financial.

It seems that the present needs require accelerated activity of the IAEA in arcas of international Pu storage nad spent fuel management which were started some time ago regardless of INFCE. In adition as announced by the D.G. in New Delhi, the work will start on problems of assured supply of fuel, materials, technology and equipement. The last item is of particular importance to all importers and to developing countries since (as known without INFCE) "lack of assurance of long-term supply has already in some cases motivated countries to adopt policies of fuel cycle self-sufficiency earlier than would be required by their optimum economic and technical development schedule". All three fields of activity are more or less already within the statutary scope of the Agency which should be strongly encouraged and supported also in this ~~relation~~ respect. In attempting to restore the international confidence in the present extremely difficult international situation the Agency has an important role. At the same time, the Agency will have to develop its activities much further, also in relation to developing countries. It will have to develop, for instance, the ideas of the so called technical asistance much beyond the present meaning of the term if the developing countries should become, also with the assistance of IAEA, able to participate in international undertakings leading to assured supplies, which, according to INFCE, can also contribute to non-proliferation objectives. Industrialized countries which undoubtedly have, as suppliers, significant interest in the market of developing countries will certainly find such activities of the IAEA useful and worthly of support in many ways.

In view of the forthcomming 2nd NPT Review conference one cannot avoid reflections on how does INFCE relate to it or what impact does it have on the balance of expectations versus implementation of NPT or how does it contribute to the promotion and general acceptance of the NPT spirit.

The balance is sadly poor and INFCE can in no way improve it. One could say that only Art. III has been implemented while at the same time one must realize that safeguards were being applied before and out of NPT since a number of non NPT countries accept them. Other articles are mostly not being implemented and are even being isolated. The big number of atomic bombs scattered around in many countries is horizontal proliferation de facto giving ground to many fears. Further development and manufacturing of atomic bombs is vertical proliferation and not cessation of the nuclear arms race. Transfer of technology is not being facilitated, one might say just the contrary.

The growing acceptance of safeguards regardless to NPT adherence reflects the desire of nations for peace and for mutual controls, and there is justified hope that gradually more countries will go this way. On the other hand, no one could offer sound reasons for subscribing to NPT today after the implementation has been so disappointing. No universality of NPT could be expected unless serious progress is done in the implementation of all articles of NPT.

I wonder what could be submitted to the RC NPT "in order to review the operation of this treaty with a view of assuming that the purposes of the Preamble nad the provisions of the Treaty are being realized" (Art. VIII/3). INFCE could contribute very little if at all.

To conclude, problems of NE today reach far beyond non-proliferation or technical aspects alone. They are very political and linked to main political issues of todays world and, therefore, have to be discussed as such at the UN conference. Even if this might look more difficult it offers hopes for more generally acceptable and more lasting solutions as compared to discussions limited to narrow problem-areas of NE.

EMBARGO UNTIL
12:30 a.m. / p.m. 3/6

RADIOACTIVE WASTE MANAGEMENT: THE REALITIES AS AGAINST THE MYTHS

Remarks prepared by Mr. I.G.K. Williams
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1. It is now almost a year since the accident at the Three Mile Island nuclear power station in the United States. This event was the No. 1 news item in most industrialised countries for several days and it continued to attract important news coverage during the following weeks and months. References to its relevance continue to be a constantly recurring theme in many countries in public and political discussions about the future contribution of nuclear power. It is no exaggeration to say that the accident at Three Mile Island has been widely represented as a major setback with far-reaching consequences for the continued development of nuclear programmes.

2. A visitor from another planet could therefore be forgiven for assuming that there had been a disaster of international proportions at Three Mile Island. Let us consider what really happened. It is certainly true that the plant itself suffered very serious material damage but, regrettable as this may be, it is neither the first nor certainly the last occasion when extensive damage to an industrial plant follows a malfunctioning or maloperation. It is also true that the plant is lost as a source of electricity for a period measured in years, that the accident revealed significant design weaknesses, that much blame has been attributed to the inadequate training of the plant operators and that the machinery for management and regulation

of the plant has been shown to have weaknesses. But it is equally important to recognise that no one was killed or injured by the accident, that the defences against catastrophe built into the reactor proved to be both resilient and effective and that there were no material consequences outside the perimeter fence of the plant. This last point may still come as a surprise to some people after all the excitement and anxiety which was generated.

3. In view of this, it is perhaps worth repeating that, although by the end of 1979 there were 232 power reactors with a total capacity of 119,000 Megawatts (electrical) operating throughout the world, there have not yet been any fatalities as a result of their operation. This compares with about 9,000 killed annually on the roads in Japan alone or over 100 in the coal mines of the United States. Moreover, by any objective standards, the inherent cleanliness of a nuclear power plant compares very favourably with the environmental impact of fossil fuels used for electricity generation. And then there are the economic considerations. Even if the flow of oil was assured against interruption – and with the turmoil in the Middle East this has manifestly not been the case for a long time now – diminishing world reserves and their value for alternative uses and as a feedstock for petrochemicals make it imperative to reduce the dependence of the industrialised economies on oil, whether imported or otherwise. In this situation, the indispensability of a major contribution from nuclear power is no less than a stark reality.

4. Mr. Chairman, you may wonder what is the relevance of all this to the problems of radioactive waste management, which are my theme today. My purpose is to illustrate the climate of opinion currently applying to all problems of nuclear energy. We even hear serious talk about foregoing the nuclear option or regarding it as a last resort, which are luxuries available only

to a few countries who have either small-scale needs or who are rich in indigenous energy resources. Substitution of large-scale imports of coal for imported oil could hardly provide a stable long term alternative. At best this would be a palliative and it would, in any case, have serious environmental implications. For many countries, the only alternative to the nuclear option is therefore a severe reduction of economic activity and a painful adjustment to lower living standards.

5. The vast majority of the opposition to nuclear energy, who are undoubtedly deeply sincere people, have not yet faced up to this harsh reality. Meanwhile, their willingness to espouse anti-nuclear campaigns may be because these provide a convenient vehicle, as suggested in the recent OECD publication entitled "Technology on Trial", for expressing anxiety about the effects on life styles of technological innovation. If this is true, there is an obvious obligation on public authorities to speak clearly and decisively on the true situation and the consequences of alternatives. On the other hand, it must also be said that a minority of nuclear critics, including many of those who have set out to lead public opinion on this matter, understand the position very well and see the inflammation of public concerns as a convenient vehicle for achieving changes in society.

6. It is all part of this scene that the problems of radioactive waste management are too often presented as unsolved or even as insoluble. Demands have been formulated for demonstrations of, and I quote, the "absolute safety" of waste management methods before any further commitment to nuclear power can be accepted. Superficially, these demands have the appeal of apparently giving overriding priority to the public welfare. In practice, they are formulated in unreasonable terms and reflect requirements not even considered in any other comparable context. "Absolute" safety is a myth in any field of human endeavour but it is a convenient catch-phrase to avoid responsibility for the terribly difficult political and social decisions involved in determining what is an acceptable level

of safety. Mr. Chairman, there is a justifiable confidence that radioactive waste management should not be an impediment to the adoption and development of nuclear power programmes. In the rest of the time available to me today, I should like to explain why I firmly share this confidence.

The meaning of waste "management"

7. Perhaps first I should define the meaning of some of the terms I shall use. The concept of waste "management" embraces all of the stages from the identification of material as waste to its final disposal. In other words, waste management includes all the necessary techniques for handling and treatment of wastes, for their storage and transportation and finally for their disposal. Most of these phases are generally recognised but some definition of the distinction between storage and disposal is important. This is because the terms are sometimes used as synonyms, a practice which is confusing, sometimes I fear deliberately. There seems, for example, to be some reluctance to talk about disposal, which has an air of finality, and instead to use such euphemisms as "final storage" or even "ultimate storage", which reflect a defensive frame of mind and perhaps unwittingly help to maintain public anxiety.

8. I think this is regrettable for two main reasons. First, technologies of radioactive waste management, particularly those concerning spent fuel or high level liquid wastes, include lengthy cooling periods or other stages which make storage, in the sense of having the intention to retrieve, perfectly appropriate. Secondly, greater assurance would surely be given by the bold adoption of practices to assure isolation from man and the use of terms making this intention clear. An impression that there remains an intention to retrieve after disposal has been implemented must imply that the intended isolation from man could be easily breached. This would hardly inspire confidence in its long term effectiveness.

9. *Thus, the term "storage" should be used only to mean the emplacement of waste materials with the intention of retrieving them later. This is, in principle, a temporary arrangement though possibly of extended duration, and normally, it implies continuing surveillance. "Disposal", on the other hand, should mean the emplacement or release of waste material without the intention of retrieval. A disposal practice may be irreversible or retrieval may remain possible, as is sometimes shown by recovery of useful materials from municipal garbage dumps. However, it is the absence of any intention to retrieve which defines disposal and implies that surveillance should be required only for limited periods, if at all. The importance of these definitions is that exactly the same procedure may constitute either storage or disposal according to the intention at the time it is undertaken; and this is why the use of the terms with their precise meaning is so important. A more confident presentation of the respective places of storage and disposal, in the true meaning of these terms, would in my view contribute to an improved climate of opinion.*

Basic strategies

10. *The fundamental purpose of radioactive waste management is to assure protection against radiation risks of both current and future generations. This means that the procedures applied must ensure that the quantities of radioactive materials finding their way into the atmosphere or the food chain will not constitute an unacceptable risk either now or in the future. Acceptability of risk can only rationally be based on a comparison between the advantages expected from nuclear energy and the possible detrimental effects on public health and the environment, taken as a whole. Ultimately, of course, this involves a political judgement and it is not one which can be rendered in absolute terms. It therefore needs an accurate political and public understanding of the factors involved, particularly when presentation of the possible detrimental effects is made in statistical terms.*

11. Misuse of statistics is, unfortunately, only too common in public life. It is frequently said, for example, that for the population of a particular city or region or country, the expected number of deaths from cancer over the next (say) 30 years will be a certain number. This number is derived from past mortality statistics, the age distribution and other characteristics of the relevant population and so on. It can, however, be no more than an intelligent projection which includes a significant margin for error. The statisticians have well-tried techniques for determining whether a variation from a figure foreseen is statistically significant or whether it is within the random deviations which are inseparable from any outcome subject to such an infinite variety of loosely connected influences. It is only when a variation is shown to be statistically significant that there is any purpose in seeking to identify the particular influence or influences leading to this change.

12. This point may be clearer on the basis of an example. The report of the Kemeny Commission into the Three Mile Island accident mentioned that the expected deaths from cancer within 50 miles of the plant would eventually total 325,000 from among the 2 million living in this area. The statisticians indicated that a variation in the actual figure by 1000 either way would not be statistically significant. The Kemeny Commission pointed out that there is no conceivable statistical method by which, in such circumstances, a particular release of radioactivity could lead to one or even 10 additional cancer deaths being detected during the relevant period. Unfortunately, however, there has been a growing practice in recent years to convert the possible consequences of even quite small releases of radioactivity into estimates of additional cancer deaths. Quite apart from the fact that the bases of such estimates are usually open to considerable professional challenge, the very character of the underlying radiobiological assumptions also means that any additional cancer deaths could not be distinguished from the much *larger number which would occur anyway. The use of such estimates is therefore essentially an appeal to public emotion and also nearly always involves a misuse of statistics. I therefore urge everyone to treat such comparisons with the utmost caution.*

13. A necessary condition for making a rational judgement on acceptability of risk is to ensure that population exposure as a result of radioactive waste disposal meets radiological protection standards derived from a meticulous evaluation of all available knowledge and experience of the biological effects of radiation and thus from a broader basis than that relating to any particular situation. In practice, this means that population exposure from radioactive waste does not amount to more than a very small proportion of that experienced since time immemorial from natural sources and more recently from medical applications of radiation.

14. This approach is made possible by the work of the International Commission on Radiological Protection, or ICRP as it is known, which has existed as a completely independent professional body for over 50 years. I mention this point because its earliest recommendations were formulated before nuclear energy had emerged as the major factor it represents today and those it now makes reflect the cumulative application of the best available professional knowledge and experience over a very long period. The ICRP has established and keeps under continuous review a comprehensive set of guidelines to limit the risks to man resulting from exposure to ionising radiation and these guidelines take account, of course, of the continuing exposure from natural and medical sources. They include recommended dose limits and are recognised throughout the world as the basis upon which independent national regulatory authorities are able to define the occupational and public health requirements to be met by the management of radioactive wastes. The guidelines are not static: as I have mentioned, they are kept under *continuing review as knowledge and further experience is accumulated. Similarly, their interpretation in relation to the various aspects of radioactive waste management is kept under continuing consideration by national authorities and by international organisations such as the OECD Nuclear Energy Agency.*

15. While compliance with radiological protection standards derived from ICRP Recommendations, both for present and for future generations, is a fundamental requirement, there are also other important safety and environmental objectives of radioactive waste management. It is important, for example, to avoid unnecessary interference with present or future exploitation of natural resources, to avoid bequeathing unsolved problems to future generations and to take care not to spoil the quality of the natural environment. In practice, these objectives are met in most cases by providing sufficient isolation of radioactive wastes from the biosphere to achieve the required standards of protection, including through time. The means by which this is achieved are the essence of the practice of radioactive waste management. They depend fundamentally on the physical and chemical properties of the particular waste forms.

The variety of radioactive wastes

16. This is, in fact, one of the factors impeding informed public discussion on this subject: radioactive wastes are too often spoken of as though they are a single homogeneous commodity. On the contrary, they may take many different physical and chemical forms, their only common feature being their radioactivity which may, in turn, vary from very high to barely detectable. Some of the radiation is highly penetrating and must therefore at all times be shielded by protective containment, while in other cases the radiation may have no penetrating powers at all but becomes hazardous if inhaled or *ingested through the food chain. One common characteristic of all radioactive materials is that the intensity of the radiation decreases progressively, or decays, at a rate which is characteristic of the particular radioactive isotope concerned. This decay rate may vary from micro-seconds to millions of years.*

17. Waste management techniques must take account of all these physical and chemical factors and must therefore be tailored to the particular circumstances in which the waste is found. Thus, another cause of public disquiet is generalised references to radioactive wastes without specifying the particular characteristics which determine their potential hazards and which are therefore decisive in determining the waste management practices and procedures which have to be applied.

18. Clearly, the natural phenomenon of decay of radioactivity is one very important consideration in developing radioactive waste management procedures. In general, the shorter the lifetime of particular radioactive wastes, the simpler are the problems of disposal. Consequently, the preparatory stages of the complete waste management sequence are also simplified. At the other extreme, the rate of decay may be so slow that, for most practical purposes, the hazards must be regarded as comparable in persistence with those of stable toxic chemicals, such as dioxin or certain cyanide compounds. In approaching this wide variety of possibilities, it is reasonable to seek a standard of isolation from man and his environment which will provide that, at any point in time, any consequential exposure to radiation will be acceptably small compared with that already arising from naturally-occurring sources. As I have already mentioned, this is generally achieved by ensuring containment or isolation for suitable periods of time which may, in some cases, extend to tens of thousands of years. On the other hand, it does not exclude dilution and dispersion into the environment under strictly controlled conditions where such a practice is compatible with the objectives I have already defined. There are, for example, cases where it can be demonstrated that the risks from exposure of workers during processes for the retention, treatment and alternative disposal of certain liquid and gaseous effluents of low radioactivity would be greater in radiological protection terms than would result for the population as a whole by their controlled discharge into the environment.

19. It may not be superfluous, at this stage, to make the point that there is nothing inherently reprehensible in the creation of waste materials. It is a normal consequence of virtually all industrial processes that wastes are generated and economic considerations alone dictate that these should always be reviewed to identify those which can be put to alternative uses. In the nuclear field, a particular example is, of course, the plutonium produced by the irradiation of fuel in thermal reactors. Its recovery together with the unspent uranium by reprocessing is an example of conversion of a by-product from a waste form into a useful material. Of course, reprocessing itself still leaves highly active wastes, which include both fission products and residual uranium, plutonium and other by-products of nuclear fission. Unfortunately, in addition to being highly radioactive, these materials also include constituents which possess varying lifetimes some of which are very long indeed. The radioactive waste management practices required must take account of these complex and variable characteristics.

20. At the other extreme, the working areas in nuclear installations, research and development laboratories, radiochemical production facilities and other places where radioactive materials are handled or used must be maintained in a clean and uncontaminated condition. This requires the application of meticulous housekeeping practices which, in turn, lead to the accumulation of mixed trash which may be only mildly contaminated or merely be suspected of being contaminated. A proper concern for public health and safety requires that these wastes, which may become large in volume, should be treated as radioactive and appropriate management techniques developed in accordance with the general criteria

I have already mentioned. The problems of disposal are, of course, quite different from those associated with the highly active wastes arising from reprocessing of spent fuel.

The present situation

21. These are but two examples, taken at random, of very differing forms of radioactive wastes which arise from the production and uses of nuclear energy. Categorisation of radioactive wastes tends to involve considerable over-simplification. It is, nevertheless, possible to reach a number of broad conclusions about the present situation and to derive from these an assessment of the remaining problems and the correct perspective in which these should be viewed.

22. The first point to make is that the total range of radioactive wastes from the nuclear industry exists already and the basic requirements for their management can be suitably defined on the basis of existing knowledge and established radiation protection criteria. This alone is a very important consideration: it means that all the problems exist already and it is only their scale which will develop with the progressive extension of nuclear programmes. Another important point to establish is that acceptable disposal methods, which have been demonstrated in practice to be sound, already exist for most types of radioactive waste. For the high level long-lived wastes which constitute the remainder, safe interim arrangements have been devised, as I shall explain more fully in a moment, and have been applied whenever necessary.

23. For example, liquid and gaseous wastes may be converted into solid form for disposal. Alternatively, as I mentioned just now, it may be better for such materials to be dispersed in limited and controlled quantities into the environment. In this sense the disposal of low level short-lived materials presents no serious technical difficulty. Shallow land burial *is a safe option for solid or solidified wastes of this nature provided that steps are taken to limit their dispersion in the air or by ground water. The conditions to be satisfied can take account of the short duration of the hazard for such materials but must include careful selection of disposal sites according to their local geology and proximity to land frequented by man or, for example, by farm animals. For the relatively short period until the wastes become harmless, natural or man-made containment is normally accompanied by surveillance until the land can again be made available for unrestricted use.*

24. A special consideration applies in uranium producing countries, where quantities of uranium mill tailings which may run to millions of tons present special problems. This is because the milling processes expose low level but long-lived radioactive materials which may originally have been well contained by nature. Extraction and treatment of the ore can thus release radioactive materials into the atmosphere or surface water and the long term implications require measures to ensure stabilisation of the mill tailings. This is a matter which continues to be the subject of intensive study and a very active programme of co-operation has been developed between the principally interested countries.

25. Another solution to the problem of solid or solidified low level wastes is to dump them in specially designed containers into the deep ocean at carefully selected sites. The containers used are designed to keep their integrity during descent to and impact on the ocean floor and to minimise to the extent reasonably achievable subsequent release of radioactivity into the sea. When this eventually takes place, the radioactivity is, of course, dispersed by the very great dilution of the ocean. Here as elsewhere, the safety assessments made prior to disposal are based on very conservative assumptions. One such assumption is that the radioactivity is immediately released when the containers reach the ocean floor.

26. Disposal by this method is subject to the provisions of the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (the so-called London Convention, to which there are now 42 Contracting Parties). It is also subject, in particular, to the Recommendations established by the International Atomic Energy Agency concerning the application of the Convention to radioactive wastes. This regulatory framework prohibits the dumping of defined high level wastes. In addition, the OECD has established a Mechanism to further the objectives of the London Convention by providing, between the 20 countries which participate in this Mechanism, a system of consultation and surveillance on the sea dumping of radioactive wastes.

27. For all the problems I have mentioned so far, satisfactory waste management procedures have been developed and are in operation. In the case of high level wastes, however, which are essentially those associated with spent fuel from nuclear reactors whether or not reprocessing takes place, a complete management strategy can be defined but further work is needed to prove the final stages. Meanwhile, interim arrangements, which are perfectly satisfactory for a period measured in decades, have been adopted and can be progressively superseded as it becomes possible to implement on a routine basis the final stages of the chosen management strategy.

28. If reprocessing takes place, these high level wastes arise initially in a highly concentrated liquid form. It has been shown that this can be stored safely for many decades in double-walled stainless steel tanks but these require continuous surveillance. An interim period of storage in liquid form facilitates dispersion of the intense heat emitted during an initial phase of decay of shorter-lived constituents. The liquid form also facilitates subsequent processing (such as for the chemical recovery of useful constituents), but it is undesirable for long term storage and is unsuitable for transport or disposal. There is therefore general agreement that conversion to solid forms should proceed expeditiously and the relative merits of various feasible solidified forms are being evaluated. Plants for their production are being designed in several countries and are already in operation in some.

29. Some figures may help to put the scale of this problem into perspective. Reprocessing of the spent fuel from generation of 1000 MW of electricity for one year in a typical light water reactor would lead to the production of about 3 cubic metres of high level solidified waste. With the present nuclear generating capacity in Japan (and assuming a 70% load factor) this would mean about 32 cubic metres a year of high level solidified waste. By the year 2000 this amount may rise to between 200 and 300 cubic metres annually, according to the assumptions made about the level of installed nuclear capacity achieved by then. The cumulative total of high level solifidied waste until the year 2000 would cover an area the size of a tennis court to a height of between 7 and 10 metres according to the same assumptions. This is a simple indication of the physical size of the disposal problem for high level wastes from the Japanese nuclear programme.

30. The technical feasibility of suitable containment in natural geological formations of these highly radioactive solidified wastes is viewed with growing confidence. Care will be taken, in their solidification, to ensure that the final waste form will be compatible with the geological and geochemical environment intended as its final resting place. Waste repositories in suitable geological formations will not present any special risks for those living in their immediate vicinity either at the time of emplacement of the waste materials or subsequently.

31. It is important to recognise that this is because the concept of geological disposal involves the creation of successive barriers to the return of hazardous materials to the human environment. First, there is the nature of the waste itself; in most cases this will probably take the form of a virtually insoluble glass. Secondly, encapsulation in suitable containers will provide stability in the chosen geochemical environment of the waste repository. Thirdly, disposal sites will be chosen for their known containment characteristics and stability through geological time. If, nevertheless, all these protective barriers fail, there are a number of natural mechanisms such as ion exchange, filtration and surface adsorption which would retard the migration of most radioactive materials. The notion of catastrophic failure of a geological waste repository is therefore not credible.

32. In collaboration with the IAEA, we organised last Summer an International Symposium to provide an authoritative overview of the status of geological disposal programmes throughout the world. The Symposium was attended by nearly 400 people from 32 countries and 4 International Organisations. During 10 sessions 68 papers were presented. This is a measure of the effort being devoted to this matter. For the purpose of radioactive waste management, a most important result emerged from the Symposium. This was a clear consensus that many geological environments exist with the capability of providing safe isolation for all types of radioactive waste.

The real problems

33. What then are the real problems ? The natural reaction of most people is that, with so much discussion focussed on the question of radioactive waste management, there must be a real problem somewhere. Of course, there is a big difference between a problem having been solved in principle and the solution

being applied in practice. There is also a big difference between a solution being available and a solution being implemented; and you will recognise from my analysis that it is in these senses that much work remains to be done. There is no question, on the other hand, of the radioactive waste management problem having been solved only in principle: fully adequate solutions are clearly available. Nevertheless, in any evolving situation, confidence in ultimate success has to be justified. The big difficulty in the field of radioactive waste management is to provide convincing evidence for this purpose, not least because the essential requirement in relation to high level long-lived wastes is isolation for extremely long periods of time.

34. Obviously, there is no way that safe isolation for tens of thousands of years can be "demonstrated", at least in the sense in which this is usually understood. It is therefore necessary to provide convincing evidence of an acceptable level of safety by accumulating detailed data on the geological and geochemical characteristics of potentially suitable repositories. An unqualified guarantee of safety cannot be given if only for the reason I have already mentioned that "absolute" safety is a myth. This is perhaps only another way of acknowledging that no human activity can be completely risk free. It is also a recognition that we should not be searching for some idealised solution but for a practical one which provides an acceptable neutralisation of risk in exchange for the benefits available from the application of nuclear power.

35. In this sense, one of the more disquieting features of the public controversies relating to radioactive waste management has been the inflammation of public opinion against programmes of investigation relating to geological disposal. This clearly is an obstacle to the introduction of final solutions. Since the interim arrangements are, by definition, less satisfactory than the final solutions being prepared, it can *be argued that obstruction of this work is against the public interest. One common reason for this situation is that people are in favour of a final solution to the problems of radioactive waste management provided that this solution is adopted somewhere else. In other words, public confidence does not depend on widening the range of alternatives available. What is needed is confident leadership by decision makers and a refusal on their part to allow irrational fear to determine political decision or to delay the solutions everyone claims to want.*

36. There have also been some suggestions from the critics that the adoption of interim management practices is an irresponsible reflection of unsolved problems, which are being bequeathed to future generations. I hope I have been able to show that such a belief is entirely without foundation. The approach being adopted permits systematic further study of available options and the development of improved disposal concepts and methods based on well established scientific and engineering data. As soon as technical and social acceptability have been established, large scale disposal of high level wastes should be implemented without delay, if only because this will lead to a significant improvement in the level of safety and will reduce or eliminate the need for continuing human surveillance.

Conclusion

37. In the time available today, I have been able only to highlight some of the essential considerations applying to the very complex problems of radioactive waste management. The technical aspects are dealt with much more fully in a Report published by OECD in September 1977 entitled "Objectives, Concepts and Strategies for the Management of Radioactive Waste arising from Nuclear Power Programmes.". This has been translated into Japanese and is available from the Japan Atomic Industrial Forum. It is also available, of course, in English from the OECD Publications and Information Center here in Tokyo. This Report remains an authoritative source of reference on the subject and is a convincing justification for confidence in the measures which have been taken or are planned.

38. I make this point because, in my opening remarks, I felt obliged to draw attention to the extremely hostile climate of opinion which militates against any unemotional consideration of this very complex subject. However, while emphasising the need for greater objectivity in public discussion on this matter, I would certainly not wish to convey any impression either of complacency or of indifference to the high standards required. It is clear that the utmost care must continue to be required to protect present and future generations. I am glad to testify that this consideration dominates the thinking of all those I have met with responsibility in this field.

39. It can therefore be said with confidence that, for all categories of radioactive waste, acceptable solutions have already been proved or safe interim management arrangements exist. Enough is known to be sure that the remaining technical problems, notably those concerning the disposal of highly radioactive and/or long-lived materials will be solved. To achieve this the research and development programmes to resolve these outstanding problems must continue to enjoy high priority and must be seen by public opinion as deserving support rather than hostility. It goes without saying that the intensive international co-operation which already exists in this field must and will be maintained.

EMBARGO UNTIL
3/6 ~~a.m.~~ p.m. 18:00

GERMAN CONCEPTS ON NUCLEAR SAFETY

Ladies and Gentleman,

first I would like to thank you for your invitation to speak to you about German concepts on nuclear safety.
It is not an easy task to treat this wide subject completely within thirty minutes, and therefore I want to concentrate on three focal points:

1. In the first Chapter I will give a short description of the German safety concept, in particular with respect to differences to the international standard.

2. The second Chapter will deal with risk analyses generally, and with the results of the German Risk Study in particular.

3. In the third Chapter I will try to describe how the events which led to the TMI-2 accident sequence would have affected German nuclear power plants, and what the consequences are in the Federal Republic of Germany with respect to the safety concept.

By Prof. Dr. A. Birkhofer; 13th JAIF Annual Conference, 1980

1. The safety concept for nuclear power stations in the Federal Republic of Germany

Like in other countries, the safety concept in the Federal Republic of Germany is based on the "Defense in Depth". Despite of basic agreement in the objectives and in the methods of reactor safety, considerable differences in detail have developed in various countries.
In the following I will mention some aspects which are typical for German nuclear power stations, even if they are not extraordinary in international comparison.

To assure basic safety, the supplier of a nuclear power station works out a quality assurance system.
Independent experts, upon orders of the licensing authority, review this QA system.
Material testing plans and fabrication and examination sequence plans are part of the system.
In these plans the individual requirements for tests at materials and semi-finished products are laid down, and the in-process inspection steps are described.
For example, the welds of the reactor pressure vessel are subjected to ultrasonic inspections each time after the end of welding, after heat treatment and after the factory pressure test.
Each of these inspections is made three times:
By the manufacturer, by the plant supplier, and by the independent expert organization.
After installation in the plant and the subsequent system pressure test, another ultrasonic examination is performed, serving at the same time as pre-service inspection ("fingerprint") for the recurrent examinations.
In this way the welds of the reactor pressure vessel are examined up to 10 times.

This is also the case for all other components of the reactor coolant system.
For other systems in the nuclear power station the extent of examination is adapted to their safety-related significance.

As for the operation of the nuclear power station, a high degree of automation of controls and interlocks is aimed at.

The resulting relief of the operating personnel is thus decreasing the probability for erroneous actions and limiting the possible consequences of such actions.

On the second level of "Defense in Depth" the reactor protection system is one of the most important protection devices.
It keeps under surveillance those process variables which are essential for the safety of the reactor and of the environment, and actuates, if necessary, protective actions trip.
The initiation of all safety-related devices is automatic and has priority over manual actions and operational interlocks and automatic controls.
All important components receive control commands which take them into those positions or operating modes which are necessary to bring the respective incident under control.

The analog part of the reactor protection system serves to take analog measurements of those physical parameters which represent the state of plant operation.
The measurements are redundant, so that comparisons of measured variables are possible.
In addition divers initiation criteria are used, so that the state of the plant is known through measured variables which are physically not interdependent.

In the logic part the measured values are compared with limit values.
If limit values are exceeded the necessary actuation signals are formed reliably in 2-of-3 or 2-of-4 logic gating.

A special feature of the reactor protection system is its so-called dynamic self-examination.
For this purpose the four channels of the logic part receive sequenced pulses which successively pass all parts of a channel.
All disturbances within the reactor protection system are recognised by an interruption of the pulse sequence, and, in addition to the self-annunciation in the control room, the safety function of the disturbed channel will be released, according to the fail-safe principle.

Finally, the third level of "Defense-in-Depth" are the safety systems, whose main task is to prevent consequential damages to the activity barriers in case of accidents.

The firstpicture shows, as an example, the emergency core cooling system. BILD 1
The four subsystems which are independent from each other, (there are no interconnections), can easily be recognised.
Two of the four subsystems are sufficient to accomplish the required safety function.
A further subsystem takes account of the single failure criterion, which is also applied to passive components.
The functioning of components and systems of safety-related significance is tested in regular intervals.
A fourth subsystem is added so that the availability of the complete system is not unduely reduced during test and examination or during repair of one of the subsystems. ~~BILD 1~~

The next picture shows the principles which are applied to the design of safety systems. BILD 2
First there is the redundancy principle which, as I have mentioned, leads to 4 x 50 percent systems.
It is quite natural that this principle is also applied to the supporting systems like automatic control and power supply, so that the individual subsystems are self-sufficient.

Then, there is the principle of diversity which is applied to avoid common mode failures. BILD 2

The separation of redundant safety subsystems is consistent throughout: no interconnections, no connecting common pipes, no common components, separate location in the plant and mutual constructional protection.
All this assures that failures caused by pipe ruptures, flying fragments, etc. are restricted to not more than one train of a safety system, and can never jeopardize its overall safety function.

In addition the reactor protection system uses extensively the fail-safe principle, in particular for reactor trip initiation.

To prevent erroneous operator actions, all functions of safety-related importance which are needed during the first 30 minutes after an accident, are automatically controlled by the reactor protection system.

Pressurized water reactors are equipped with a spherical full-pressure containment which withstands the pressure build-up after loss-of-coolant accidents without need for pressure suppression. BILD 3
Also characteristic for German PWRs is the spent fuel pool inside the containment.

The containment is surrounded by a solid concrete shell, with an average wall thickness of 2 meters.
Leakages from the containment into the annulus between the steel and the concrete shell can be extracted and filtered for controlled emission through the stack.
The concrete shell protects the containment against external events.
Design basis is the crash of a fast flying military airplane.

The design against accidents caused by "external events" not only considers natural causes like earthquakes, but in addition to the airplane crash also other man-made causes, like explosion shock waves and sabotage.
It is the consideration of external events which has led to a far-reaching decoupling of safety systems from operating systems, which - in addition to the structural measures against external events - is characteristic for the safety design. BILD 3

So, in addition to the main feedwater system and to the startup and shutdown pumps which can operate on emergency power, there is a completely independent emergency feedwater system, separated into four redundant trains. BILD 4
Each of the emergency feedwater pumps is directly driven by its own diesel engine, to supply water to its respective steam generator; the steam is blown into the atmosphere through the controlled relief valve, which itself is protected against external events.

It was not only the TMI accident which has shown the importance of reliable heat removal via the steam generators.
It is known from the emergency cooling analysis for small leaks that the reactor has to be cooled by the secondary system.
Therefore a heat sink on the secondary side of the steam generators must be secured.
This requires not only steam generator feeding, but also the automatic control of the relief valves.
With these measures it is possible to cooldown the plant through controlled secondary side pressure reduction, until the long-range removal of decay heat by the low-pressure residual heat removal system is possible. BILD 4

All systems necessary for securing residual heat removal, shutdown, and long-range subcriticality, are located in the "emergency feedwater building" which offers protection against external events. BILD 5

This includes the storage of coolant and the energy supply, so that the plant can be kept in a safe state for 10 hours, without need for manual interference during that time. BILD 5

Operating Experience

The limited time does not allow me to discuss in detail the experience gained from plant commissioning and operation.

There is an immediate feedback from experiences during construction and commissioning of the plants in the planning stage.
The cause for this is not only the good exchange of information between licensing authorities and independent experts in our country, but also the fact might contribute that planning and construction of nuclear power stations is in the hand of one singly responsible enterprise.

Summarizing, it can be said that the safety concept laid down in the "Nuclear Power Plant Safety Criteria", issued by the Federal Minister of the Interior, and the "RSK Guidelines for Pressurized Water Reactors" have in principle proven their worth.
The safety concept is periodically updated, taking into consideration operating experience and results of safety-related research programs.

2. Risk Analyses

Now let me turn to the second chapter which deals with risk analysis.

Looking at the experience of more than 25 years of reactor operation nuclear industry has an excellent safety record.

On the other side it is evident that absolute safety cannot be achieved and the question remains, whether nuclear plants are "safe enough".

As an objective measure of safety, one can consider the risk which remains in spite of all precautions taken.

Although risks from nuclear plants cannot directly be quantified from experience, they can be assessed by means of analytical methods.

The first comprehensive risk study has been performed some years ago in the U.S. under the direction of Rasmussen.

Applying essentially the same methods a "German Risk Study" for nuclear power plants with pressurised water reactor has been performed and published last year.

It may be of interest to show here the main results of this study and to discuss some insights gained during the study with regard to merits and limitations of the methods.

As reference plant for the study Biblis B has been adopted. This 1300 MW plant, a KWU-designed pressurized water reactor started commercial operation in early '76.

For the estimation of accidents consequences actual sites have been accounted for. All German reactor sites have been considered at which plants with more than 600 MW electric power have been operating, under construction or during licensing process.

This let to 19 different sites with a total of 25 plants.

Up to 80 km actual population distribution have been applied for the calculation of consequences.

For greater distances, consequences are practically independent of actual population distribution, since only late effects can occur.

Therefore, from 80 to 540 km distance a constant population density of 250 inhabitants per km^2 has been used, outside 540 km up to 2.500 km 25 inhabitants per km^2 were assumed.

The safety concepts applied in nuclear power plants ensure that accidents do not cause dangerous release of radioactive material into the environment as long as the engineered safeguards are properly operating.

Therefore, only those events contribute significantly to the risk which result from failure of systems required to cope with an accident.

The sequence of events, starting from an "initiating failure" is dependent on the functioning or failure of actuated engineered safeguards.

Since a number of different systems are actuated, a multitude of different courses of events is conceivable, depending on the possible combinations of system success and system failure.

The frequency of a specific sequence of events is determined by the frequency of the initiating failure and by the probabilities of success or failure of the different systems required.

For highly reliable systems these probabilities are frequently not known from direct experience.

Therefore, they have to be calculated analytically.

This is done mostly by means of fault tree analyses.

A fault tree represents the logical structure of the functional interaction between different systems components.

On the basis of this structure the probability of system failure is calculated as a function of probabilities of component failures.
In doing so, also the influence of human behaviour and of external events on system reliability may be considered.

To analyze the risk from a nuclear power plant mainly events leading to the meltdown of the reactor core have to be traced.

Only in this case large amount activity releases could happen.

To calculate core melt frequency which is an important milestone for the estimation of risk, about 70 accidents sequences have been considered to some detail, using event tree and fault tree methods.

The contributions of loss-of-coolant accidents and transients to core melt frequency have been analyzed. In addition, the study estimated the influence of external impacts, like earth-quake, air plane crash, chemical explosion, and floods.

Summing up all relevant contributions an overall melt frequency of about 10^{-4} per year has been calculated.

Contributions of the different initiating events to the core melt frequency are shown in the next figure. The dominant contribution results from a small leak, mainly for the following reasons: BILD 6

- Small leaks may occur more frequently than medium or large breaks.

- In order to remove the decay heat, the reactor has to be cooled-down by secondary system. For this task operator action is necessary to initiate and control its function. In this case the influence of manual actions reduces the system availability significantly.

The second contribution results from transients.

There is a coupling between transients and small leaks, if a pressurizer relief or safety valve would fail to close after it had opened due to loss of the heat sink.

This sequence played a dominant role when first results of the study have been published in November 77. Plant improvement reduced its probability considerably.

We may recall that a stuck open relief valve played an important role in the TMI accident.

This insight from the study which is essentially in accordance with WASH-1400, is stringently suggesting to look more intensively also into small leaks and transients. Safety assessment as well as safety research have taken note of this situation. ~~BILD 6~~

In the next figure the influence of different failure modes of safety systems on core-melt frequency is shown. BILD 7

About two thirds of core-melt frequency is caused by human errors leading to safety systems failure.

For newer plants improved automatisation may result in a reduction of this influence. ~~BILD 7~~

After fission products have been released into the containment, the release into the atmosphere is determined by the containment failure mode.

In the next step of the study, therefore, containment failure modes have been analyzed.

By combining results of core melt analysis with the analysis of containment failure modes, amount and frequency of fission product releases from the plant are obtained. Accident sequences resulting in the same containment failure mode are grouped together into one of eight release categories.

Typical data of these categories are shown in the next figure. The release categories 1 through 6 comprise core melt accidents. The most frequent containment failure is by overpressurization about one day after the accident. Categories 5 and 6 comprise these "late overpressure failure" events. BILD 8

In category 5 additionally a failure of filter systems prior to containment failure is assumed.

Categories 2 through 4 comprise core melt accidents with failure of containmemt isolation assuming various openings.

Category 1 contains the most severe releases. It is assumed that reactor pressure vessel and containment are seriously damaged by a steam explosion after core melt-down.

The state of present analysis shows that such an event is extremely unlikely and may be even impossible,

However, as a very cautious assumption, in accordance with WASH-1400 a one percent probability of a steam explosion destroying in the containment integrity is postulated.

Supplementary, the study has analyzed loss-of-coolant accidents, properly coped with by the emergency core cooling systems.

These events are grouped into categories 7 and 8.

Core integrity is essentially maintained and activity release from the core is only caused by cladding failure and therefore relatively small.

In category 7 failure of containment isolation is postulated. ~~BILD 8~~

For the calculation of accident consequences emergency procedures, like evacuation of contaminated areas, have been taken into account based of government recommendations existing in Germany.

The next figure shows the correlation between number and frequency of acute fatalities which could be caused by radiation exposure to the public after a nuclear accident. BILD 9

With 25 plants in operation a frequency of about 10^{-5} has been estimated that acute fatalities are caused.

The study has made an attempt to quantify confidence intervalls of the results.

These are shown at selected points.

From this figure it can be concluded that large consequence events are extremely unlikely. ~~BILD 9~~

The next slide shows that these low frequencies result as a product of several factors. BILD 10

Considering 25 plants, calculations show a core melt frequency of 1 to 400 per year.

Given a core melt-down, fission product release is limited by the containment in most cases very effectively.

There is only a chance of 1 to 16 that potentially lethal doses would appear after severe containment failure.

In this case, consequences depend on weather conditions and population distribution. The chance for this situation is 1 to 10 that acute fatalities are caused.

Given a core melt accident the probability is higher than 99 %. that no acute fatality will occur.

A great number of fatalities could only occur after the most severe accident, if unfavourable weather conditions coincide with specific site conditions.

Given a potentially lethal activity release, the probability is again less than 1 % that 2000 or more acute fatalities are caused. BILD ~~10~~

Besides acute fatalities, similar to WASH-1400, late health effects were calculated.

Late health effects reflect the possibility of an increased risk of cancer or leukemia due to radiation.

These effects may show up after a latent period of some decades.

They have therefore been traced over several generations.

From the next slide it can be concluded that late effects are estimated also for less severe accidents. BILD 11

With a frequency of about 1 to 200 per year for 25 plants a considerable number of late fatalities has been calculated.

It has to be born in mind that a linear dose-risk relationship has been used by the study.

That means that even the smallest radiation exposure is assumed to cause an increase of risk of cancer.

Late health effects which have been calculated would appear over large areas.

As an average about half of these effects may occur outside the Federal Republic of Germany.

This emphasizes the international importance of reactor safety.

Applying the assumptions of the study - the linear dose-risk relationship - it can be calculated that about half a percent of all cancer fatalities are caused by natural radiation.

Although this influence is rather small, the absolute figures amount to more than 50.000 for Germany and about 600.000 for Europe, if the whole period of life is considered. BILD ~~11~~

The study also estimated the number of people and the extension of areas affected by evacuation or relocation.

However, the models are very crude in this respect so that the results can only be considered as rough estimates and are not presented here.

Which use can be made of methods and results of risk studies ?

From the engineers' point of view it is obvious that a systematic and comprehensive reliability of all important systems allows a quite objective assessment of the plant design.

Particularly, it is possible to study also the interrelation of different systems and to identify problems which could arise from the cooperation between different technical disciplines like electronics and chemical engineering.

Considering the relatively large uncertainties of the results, however, conclusions should be drawn only cautiously.

But there are many ways how the results of risk analyses could be used.

An obvious task is to reflect to which extent the safety concept is well-balanced.

By identifying the most important contributors to the overall risk one can judge if too much effort is put in some areas and too less in others.

As an example the contribution to the overall risk from airplane crashes is negligable according to the result of this study, nevertheless, German power plants have quite an extensive protection against airplane crashes.

Another lesson - as mentioned earlier - would be to put more effort on the analyses of transient and small leaks.

Another question is if consequences of major accidents could be further limited.

Examples would be the improvement of the containment design and a systematic analysis about the possibility of steam explosion.

Risk analyses may also help to improve emergency procedure and to get a better understanding about possible concequences and actions to be taken after a major release of radioactivity.

In my opinion in this area further work has to be devoted.

During the work on the German Risk Study we found that in principle the methods required for theoretical risk assessment are available. In numerous areas, however, further developments which improve the quality of the analysis would be desirable and also possible.

In phase B of the risk study the following areas should be dealt with in depth:

- Evaluation of operating experiences
- Detailed examination of further accidents
- Improved differentiation of sequence of events
- Assessment of reliability of results in the accident simulation
- Improvement of the accident consequence model.

3. Effects of the TMI Accident on the Safety Concept of German Nuclear Power Plants.

In the last chapter of my lecture I would like to discuss the conclusions which are to be drawn from the TMI accident, as far as German nuclear power plants are concerned.

I can assume that you are familiar with the sequence of events from the various reports which have been written about it.

Therefore, I shall limit myself to some remarks about the course which a similar event would have had in a German plant, and about the conclusion which we draw for the safety concept in the Federal Republic of Germany.

As the investigations show - in particular the report of the Kemeny Commission - aside from shortcomings in training and qualification of the operating team, there are peculiarities and imperfections in system technology which are to blame for the Harrisburg accident.

These weaknesses have been avoided already in the design stage of German nuclear power plants.

For example, the problem of interfaces between parts of the plant which have different suppliers is not so severe because planning and realization of the project is under the responsibility of one single supplier. Beyond that there is an intensive dialogue during the licensing procedure between supplier, the future plant owner, the licensing authority, the independent experts, and the Reactor Safety Commission.

This helped to avoid communication problems, which have been particularly critizised by the Kemeny Commission, from the beginning.

Also, in the Federal Republic of Germany it is guaranteed that results of the running research programs in safety technology are taken into account to the extent nece-sary during the erection of new nuclear power stations.

Aside from this somewhat more favourable constellation the safety design of German reactors allows to take a number of further advantageous measures:

- Avoidance of interface problems; consideration also of the seoondary side and of the peripheral equipment of the reactor protection system;
- Independence of the safety system from operational systems;
- Avoidance of common components, for example interconnecting pipes;
- High degree of redundancy and complete separation of trains in safety systems;
- Actuation from the reactor protection system of all functions which are essential for safety;
- Automation and interlocks for the support of the operating crew;
- Consideration of small accidents with increased probability in the safety concept.

  This means that apart from design basis accidents like the double-ended rupture of a main coolant pipe, also the more probable "small" and "medium" leaks (breaking of a cennecting pipe) are analyzed and the necessary countermeasures are provided.

Which consequences can be drawn from this accident ?

Could it have a similar course in a German plant ?

Four-loop plants would, due to differences in design, react less sensitive upon the initiating event, which has been the failure of main feedwater supply.

As has been shown earlier,
completely independent from the operational main feedwater supply and the startup and shutdown system, there is a redundant emergency feedwater system with separated trains. BILD 12

The primary pressure surge is such that the pressurizer relief valve would not have to open in this case.

If it opens, and if it should remain stuck open, an isolation valve would close the line automatically a few seconds later.

The operating personnel would have no cause to switch off high-pressure injection in a similar case.

In contrast to the U.S. plant the high-pressure charging head is below the relief valve response pressure.

The secondary side cool-down, which is automated in the new plants, would have achieved reliable core cooling by the low-pressure residual heat removal system long before the first damages to the core.

The disturbance which began on the secondary side would have caused immediate reactor trip.

The general automation would also have absorbed human failures to a wide extent.

From these explanations it becomes clear that the initiating event which had occured in an operational system would have led to no more than operational measures in a plant according to the German safety concept.

The Three Mile Island experience brings up the one question whether fundamental corrections to the safety concept are necessary.

Some say that it is necessary to design plants so that the effects of core melting can be controlled.

This has been discussed before.

It has been abandoned in favour of the solution to prevent core melting with all possible means, in my opinion for good reason.

I believe, therefore, that the basic concept is correct of re-establishment and maintanance of decay heat removal by the emergency and residual heat removal system and by the emergency feedwater system with not-interconnected 4 x 50 percent rerundancy systems.

Automation eliminates the necessity for quick human interference.

The consequences from Three Mile Island should therefore be the renewed examination of the safety concept with respect to deficiencies, for example the question whether human influence has been sufficiently taken into account.

It is decisive that the safety technology not only controls those disturbances which seem to be particularly critical, but that extensive precautions are taken also against seemingly insignificant events.

This is already the case to a far-reaching extent in our plants.

The German risk study, too, in accordance with the Rasmussen report, shows not that "large" design basis accidents determine the risk, but rather the "small" leaks and manual interferences.

With the aim of a still more reliable prevention of core melting, investigations are currently carried out in our country in close cooperation between suppliers, utilities, independent experts, licensing authorities, and the Reactor Safety Commission.

The investigations include:

- Introduction of redundant and divers signals for the state of the primary curcuit and for the temperature surveillance in the reactor core;
- Measures for improvement of the containment isolation functions;
- Improvement of primary system injection and of the automated secondary-side rundown for the case of small leaks;
- Improvement of the emergency power supply for better command of accidents with simultaneous loss of offsite power;
- Improvement of operating personnel training, and of the information display inside and outside of the control room; furthermore continued development of the programs for simulator training.

These considerations include the recommendations of the "Lessons-Learned-Task-Force" (NUREG 0578 and 0585), of which many have been realized in recent years.

In our considerations we do not only look at measures for accident prevention, but we also examine measures for damage mitigation after a core melt-down did happen, so that consequences are limited and dangerous releases of radioactivity into the environment are prevented.

Already the risk studies showed the superior importance of the containment.

The possibility for a further increase of the reliability of containment isolation is currently under examination.

Other measures under examination include the prevention of containment failure by a slowed-down pressure buildup, or methods which at least can delay the point in time of containment failure.

There are no final results of these examinations available yet.

Altogether it can be said about these damage-mitigating measures that final decisions are only possible after a comprehensive process of deliberation. The gain in reactor safety on the one hand must be weighed against possible safety-related disadvantages on the other hand.

Therefore, it cannot be foreseen today if and which of these measures will be introduced into the safety concept of German nuclear power plants.

Concluding Remark

Finally I would like to state that operating experiences as well as the risk analysis confirm the reactor safety concept.

This does certainly not exclude the continual examination of safety questions, as is also usual and necessary in other fields of technology.

Improvements must be introduced whenever this seems required on the basis of experience or research.

Such improvements, however, would primarily have to orient themselves towards better methods of operation, and not towards spectacular methods whose advantages and disadvantages can only be determined after comprehensive discussions.

Thank you.

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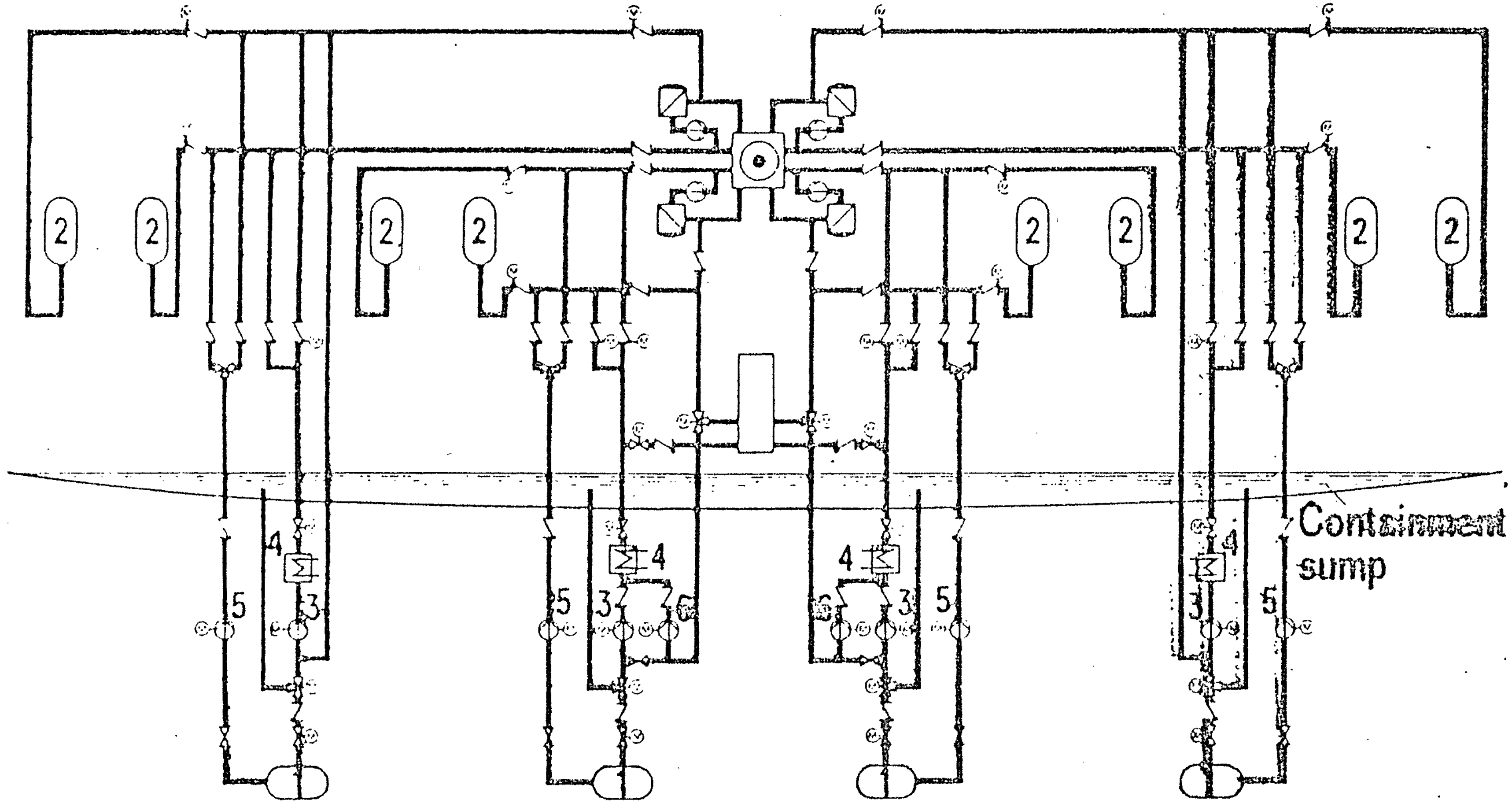
4-Loop Primary System



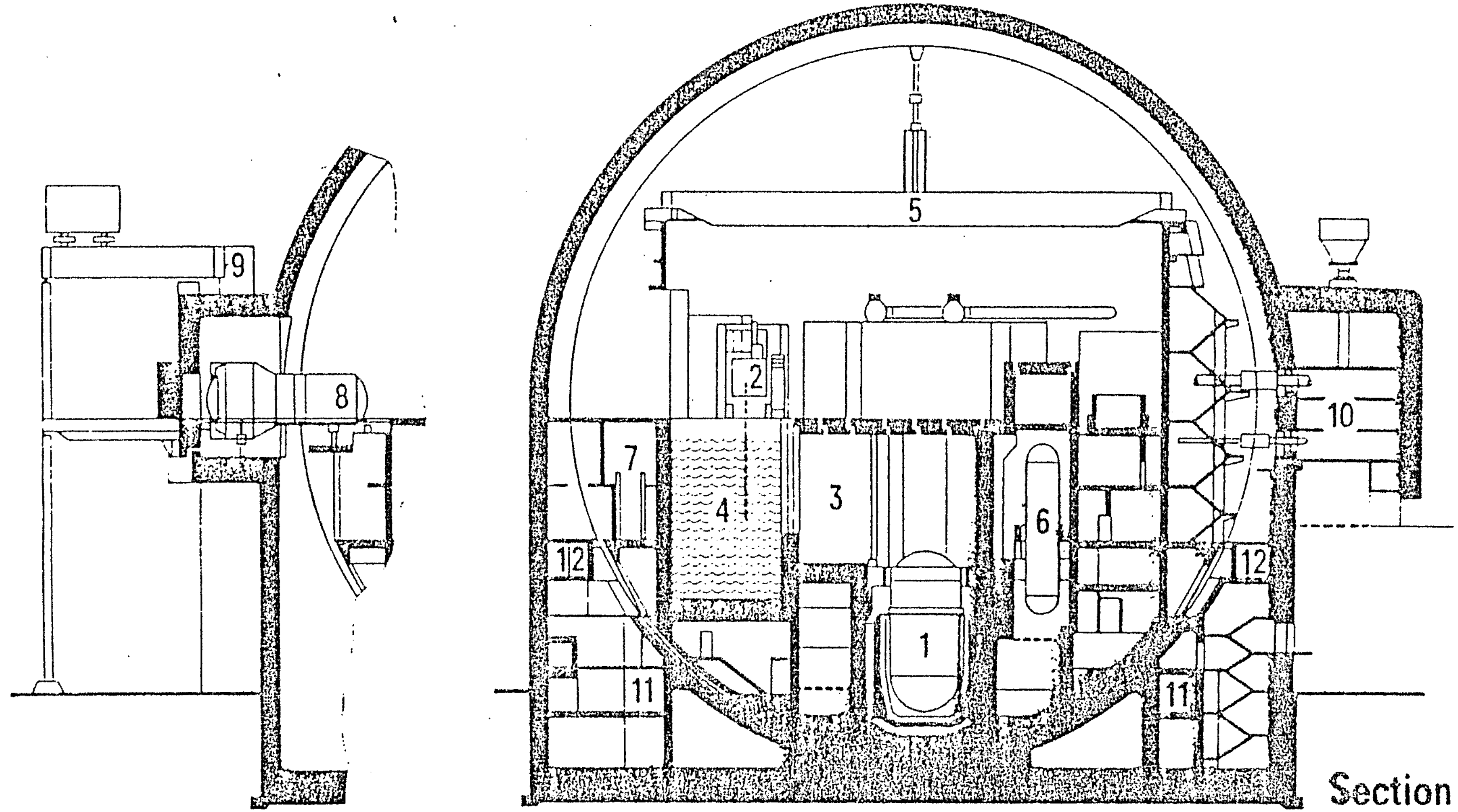
1 Storage Tank
2 Accumulator
3 Decay Heat Removal Pump
4 Decay Heat Removal Exchanger
5 Hp-Injection Pump
6 Spent Fuel Pit Water Pump

Emergency Core Cooling and Decay Heat Removal System

Auslegung gegen	Prinzip	Bedeutung / Beispiel
Einzelfehler (A)	Redundanz	Installation von Reservesystemen (Kernnot- und Nachkühlsystem: 4×50%)
Fehler mit gemeinsamer Ursache (B)	Diversität	Anwendung unterschiedlicher Wirkungsmechanismen bzw. Gerätekonstruktionen (Anregekriterien Reaktorschnellabschaltung)
Übergreifender Fehler (C)	räumliche Trennung	getrennte Aufstellung redundanter Teilsysteme
	baulicher Schutz	Reaktorgebäude, Auslegung gegen Flugzeugabsturz
A, B, C und Ausfall Hilfsenergie	Fail-Safe	Systemfehler wirken eindeutig sicherheitsgerichtet (Schnellabschaltsystem)
menschliches Versagen	Automatisierung	Reaktorschutzsystem

Auslegungsgrundsätze für Sicherheitssysteme

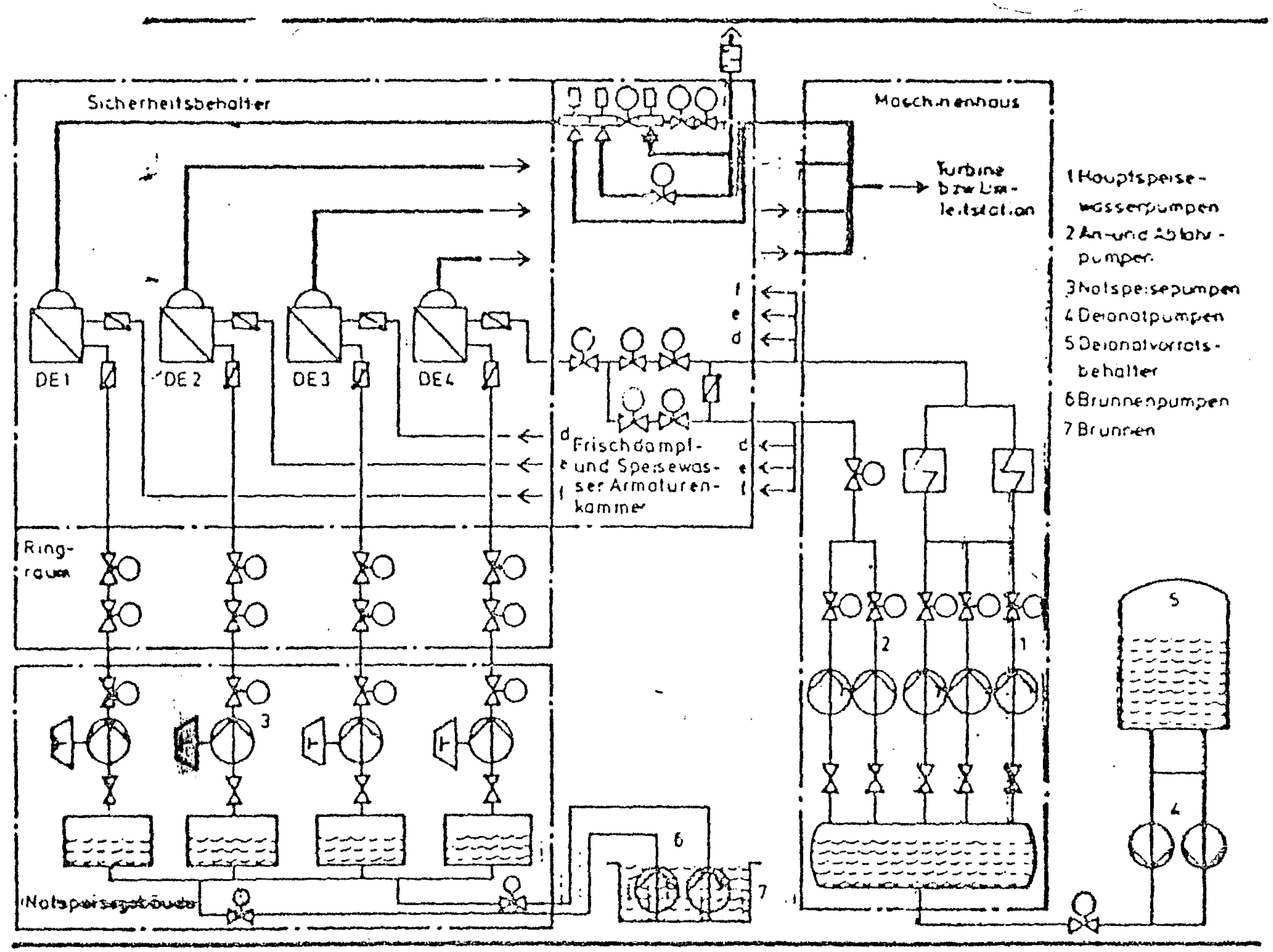
Abb.



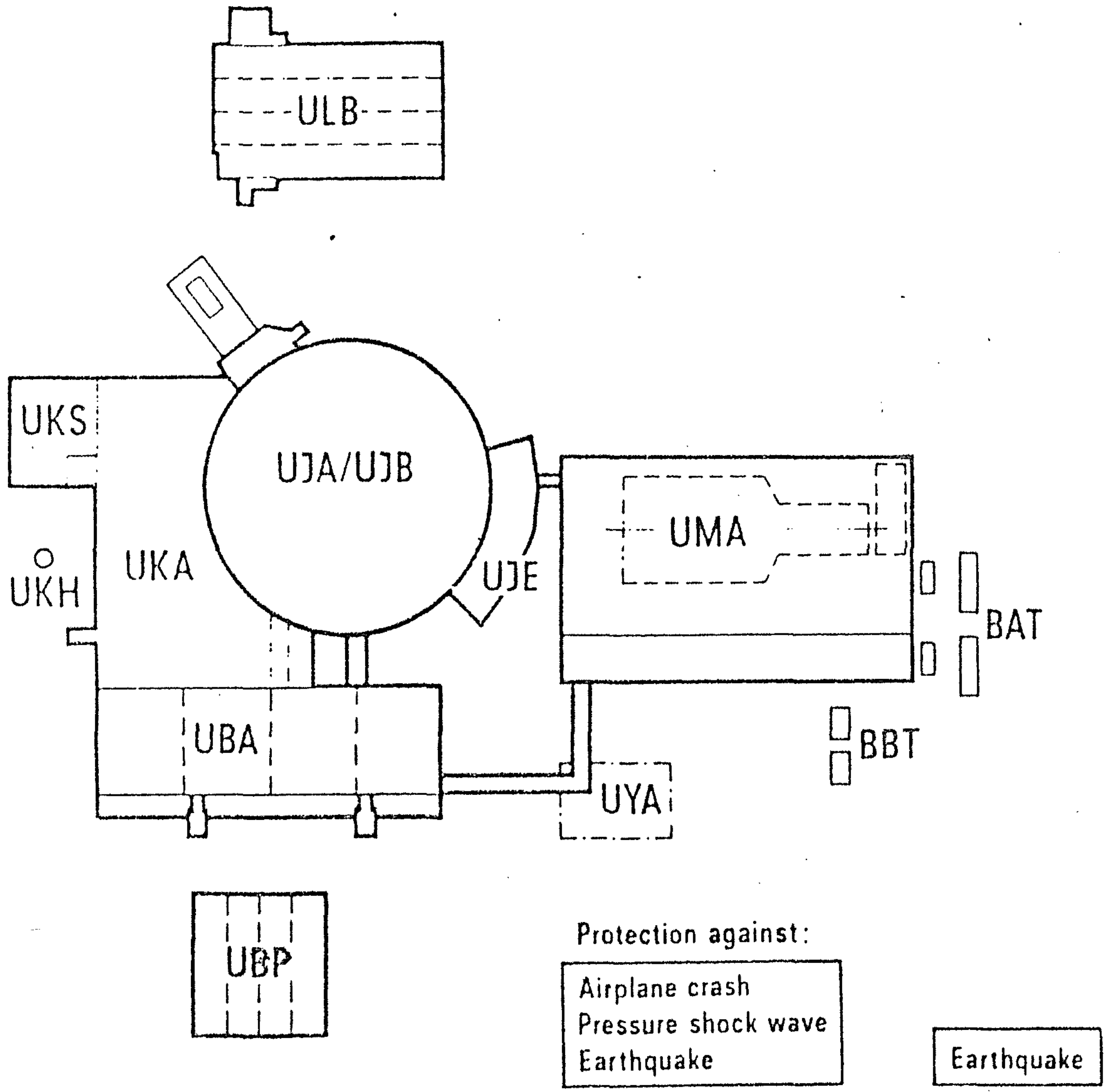
1 Reactor pressure vessel
2 Refuelling machine
3 Lay down position for core internals
4 Fuel pool
5 Reactor building crane
6 Pressurizer
7 New fuel store
8 Equipment lock
9 Gantry
10 Main steam and feedwater valve room
11 Pipe duct
12 Cable duct

PWR 1300 MW

Reactor Building



Frischdampfsystem und Dampferzeuger-Bespeisung



BAT Generator transformers
BBT High-voltage auxiliary supply transformers
UBA Switchgear building
UBP Emergency power and chilled water supply building
UJA Reactor building, containment interior structure
UJB Reactor building annulus
UJE Main steam and feedwater valve compartment
UKA Reactor auxiliary building
UKH Vent stack
UKS Radwaste building
ULB Emergency feed water building
UMA Turbine building
UYA Personnel facilitics and office building

Fuel fire after airplane crash

from KWG on

PWR 1300 MW
Site plan

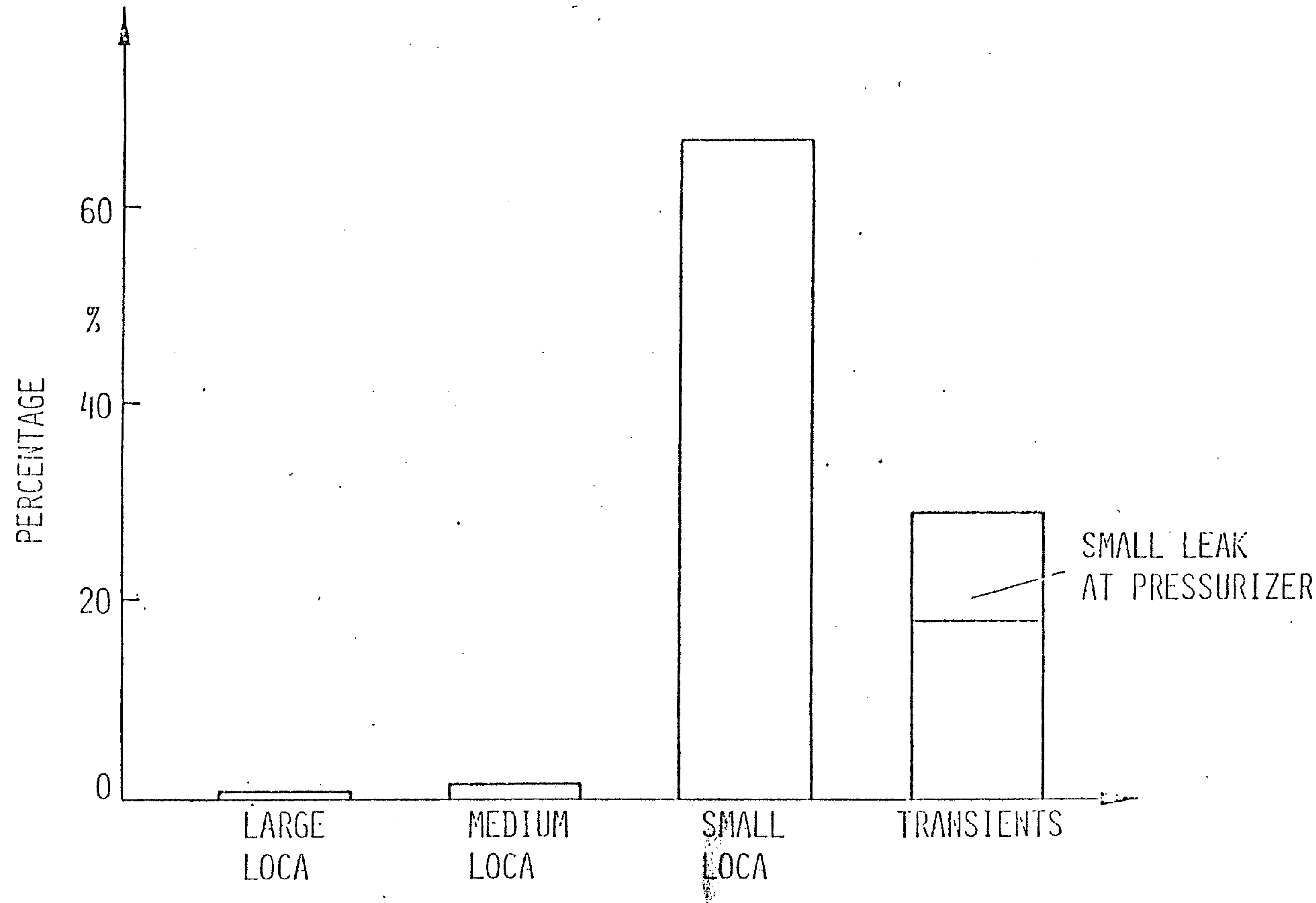


Fig. 1 RELATIVE CONTRIBUTION OF VARIOUS ACCIDENT INITIATING EVENTS TO THE PROBABILITY OF CORE MELT

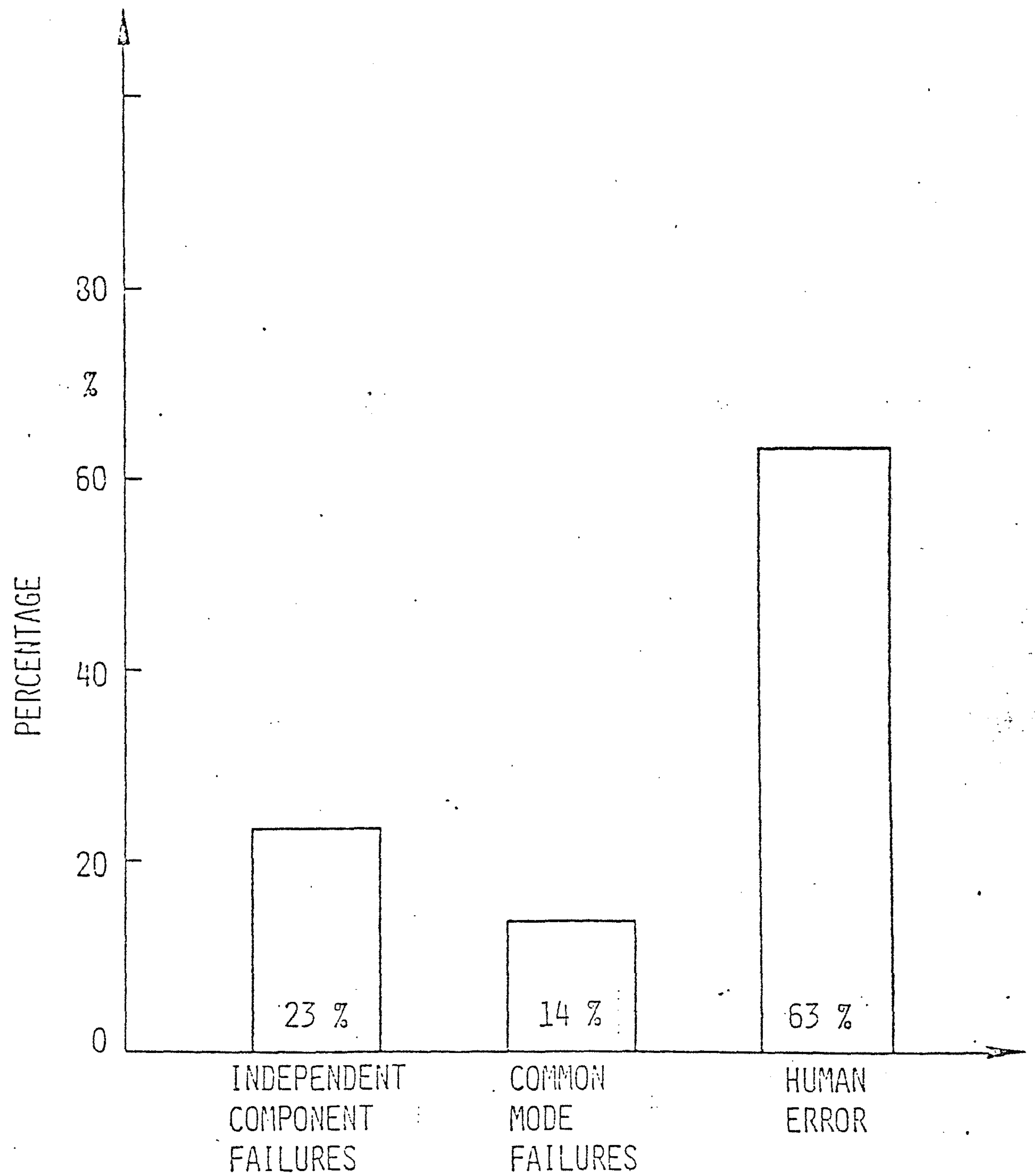


Fig. 2 RELATIVE CONTRIBUTION OF DIFFERENT FAILURE MODES TO THE PROBABILITY OF CORE MELT

REL.C. NO.	DESCRIPTION	TIME OF RELEASE H	PROBABILITY *) PER REACTOR YEAR (MEAN)
1	CORE MELT, STEAM EXPLOSION	1	2×10^{-6}
2	CORE MELT, LARGE CONTAINMENT LEAK (300 MM Ø)	1	6×10^{-7}
3	CORE MELT, MEDIUM CONTAINMENT LEAK (80 MM Ø)	2	6×10^{-7}
4	CORE MELT, SMALL CONTAINMENT LEAK (25 MM Ø), LATE CONTAINMENT OVERPRESSURE FAILURE	2	3×10^{-6}
5	CORE MELT, LATE CONTAINMENT OVERPRESSURE FAILURE, FAILURE OF FILTER SYSTEMS	25	2×10^{-5}
6	CORE MELT, LATE CONTAINMENT OVERPRESSURE FAILURE	25	7×10^{-5}
7	DESIGN BASIS ACCIDENT, LARGE CONTAINMENT LEAK (300 MM Ø)	0	1×10^{-4}
8	DESIGN BASIS ACCIDENT	0	1×10^{-3}

REL. C. 7 AND 8 ARE NO CORE MELTDOWN ACCIDENTS

*) PROBABILITIES ARE CALCULATED INCLUDING 10 % CONTRIBUTIONS FROM ADJACENT RELEASE CATEGORIES

Fig.3 TIMES OF RELEASE AND PROBABILITIES OF THE RELEASE CATEGORIES

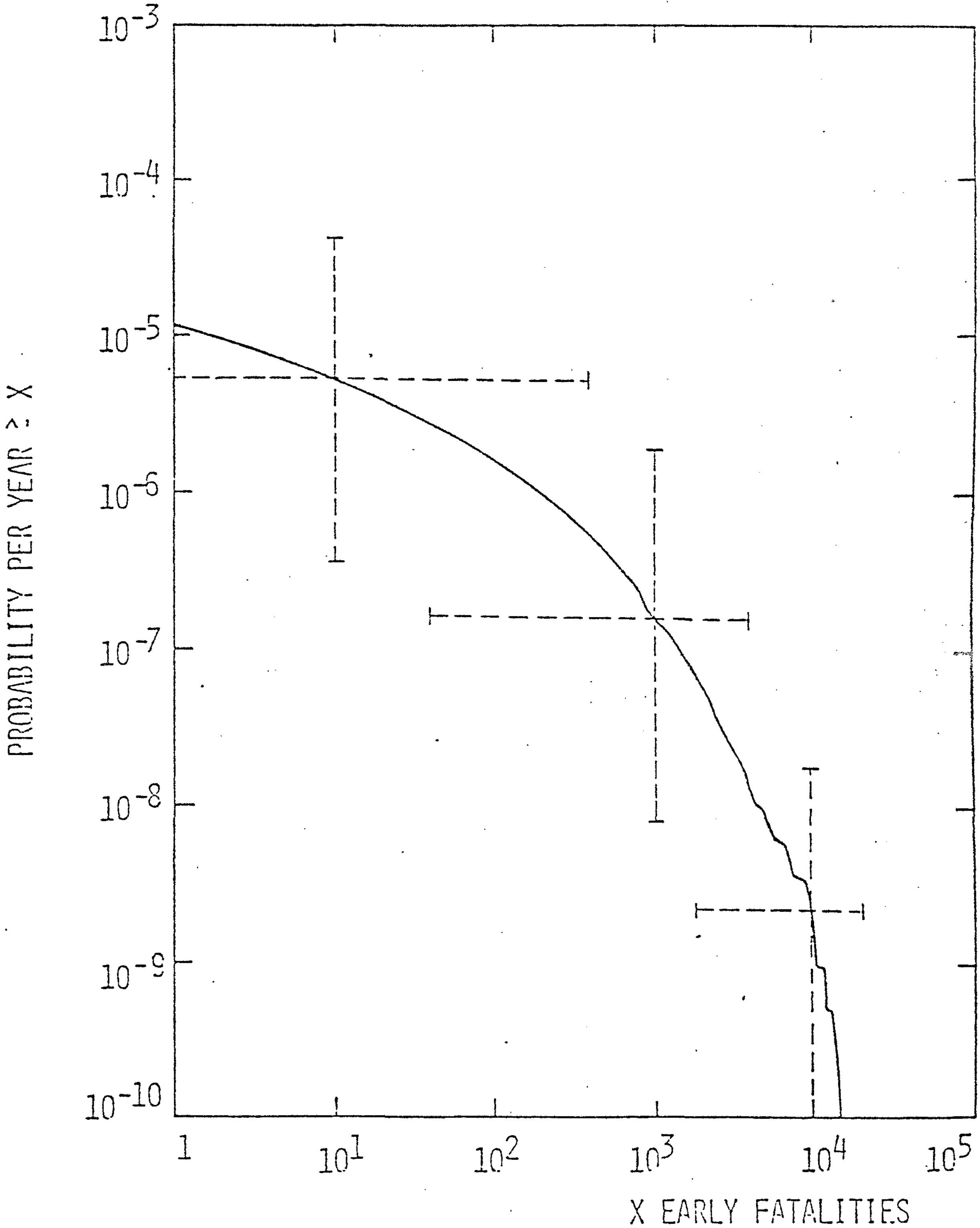
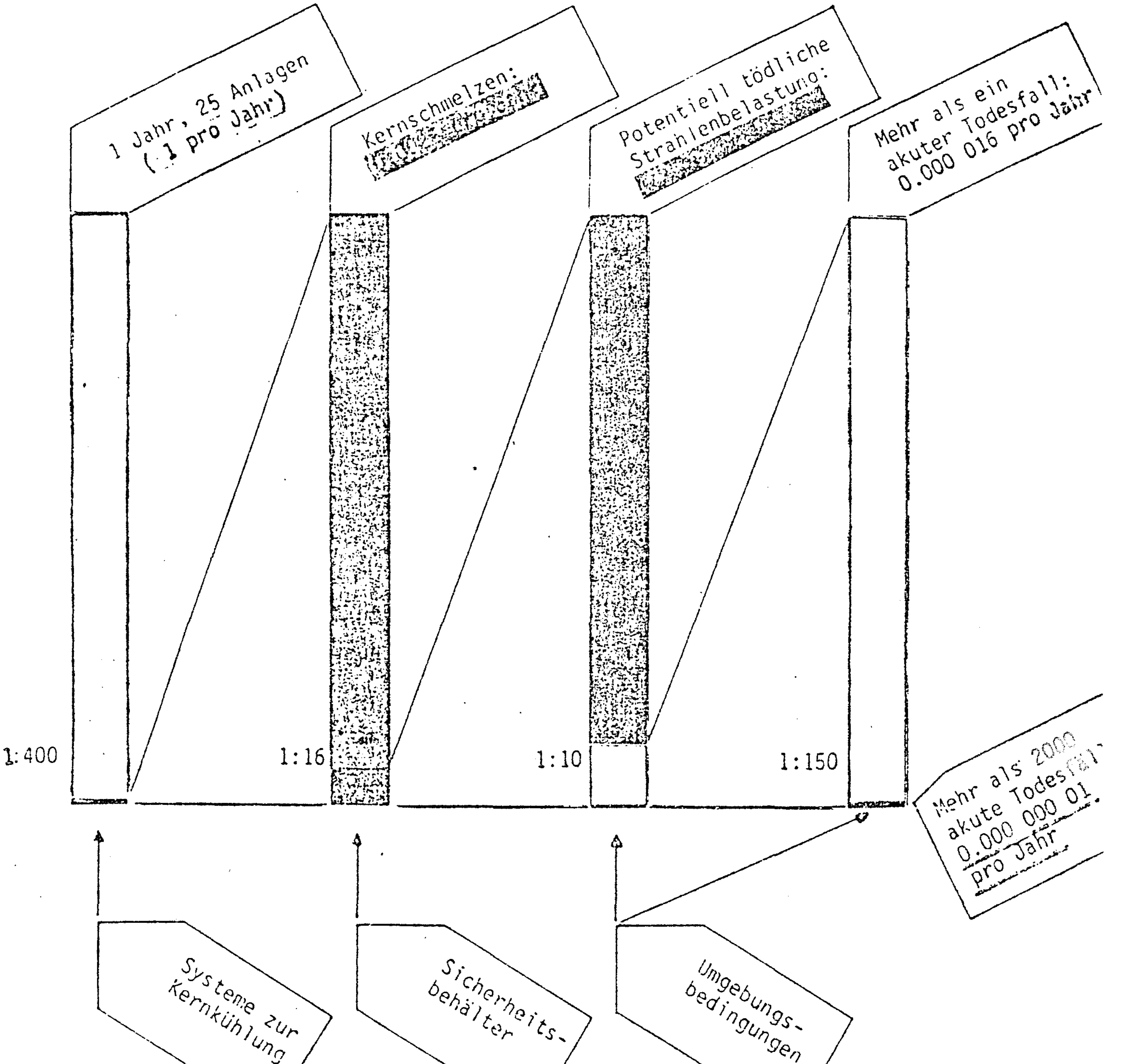


Fig. 4 COMPLEMENTARY CUMULATIVE DISTRIBUTION FUNCTION FOR EARLY FATALITIES PER YEAR FOR 25 PLANTS
THE DASHED BARS INDICATE 90 % CONFIDENCE LIMITS



1 zu 0.000 000 01
entspricht dem Verhältnis
10 Kilometer zu 1 Millimeter

Fig. 5 Wahrscheinlichkeiten für Unfallschäden

(pro Jahr bei 25 Anlagen)

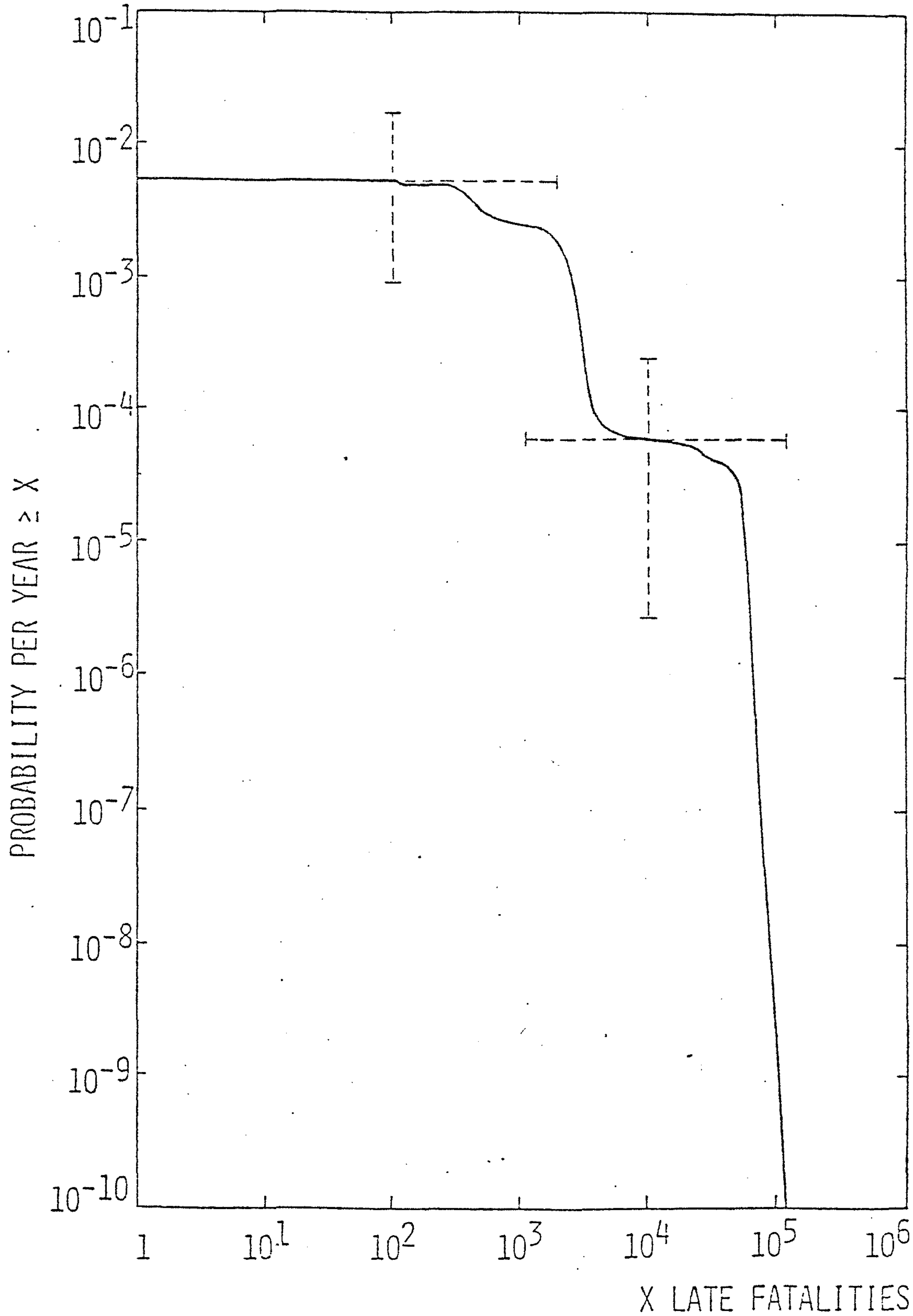


Fig. 6 COMPLEMENTARY CUMULATIVE DISTRIBUTION FUNCTION FOR LATE FATALITIES PER YEAR FOR 25 PLANTS

DASHED LINES INDICATE 90 % CONFIDENCE LIMITS

RESPONSE OF PRESSURIZER RELIEF VALVE BECAUSE OF VARIOUS ACCIDENTS

Accident	Response of Pressur. Relief of Valve (Response Pressure = 166 bar)	Comments
Reactivity Disturbance	no	
Turbine Trip	no	1. Power Reduction to 45 % by Control Rod Assembly Inj. 2. Response of Turbine Bypass Station
Turbine Trip without Response of Turbine Bypass Station	no	1. Power Reduction to 45 % by Control Rod Assembly Inj. 2. Reactor Trip initiated by Reactor System High Pressure ($\rho s \geq 166$ bar)
Turbine Trip without Response of Turbine Bypass Station and without Rod Injection	yes	Reactor Trip initiated by Reactor Coolant High Pressure ($\rho s \geq 166$ bar)
TMI 2 Accident Complete Loss of Main Feedwater	no	1. Reactor Trip initiated by Steam Generator Water Level $< min_1$ 2. Start of Emergency Feed-water Pumps initiated by Steam Generator Water Level $< min_2$
Loss of Normal Power Supply	no	Reactor Trip initiated by Low Reactor Coolant Pump Speed (< 94 %)
ATWS Loss of Normal Power Supply without Reactor Trip	yes	Reactor Coolant Pressure Maximum $\rho_S = 191$ bar