[COMMITTEE PRINT]

EUROPEAN OVERSIGHT TRIP

REPORT

OF THE

COMMITTEE ON
SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
NINETY-FIFTH CONGRESS
FIRST SESSION

Serial D

JUNE 1977

Printed for the use of the Committee on Science and Technology

U.S. GOVERNMENT PRINTING OFFICE
92-187 O WASHINGTON : 1977

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LETTER OF TRANSMITTAL

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, D.C., June 30, 1977.

Hon. OLIN E. TEAGUE,
Chairman, Committee on Science and Technology,
House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: I am forwarding herewith a report of the recent Committee trip entitled, "European Oversight Trip." The report includes a summary of findings on Committee meetings held and a description and analysis of the various foreign facilities visited.

Prior to departure, the Committee made a commitment to conduct a thorough and detailed review of the program areas within the Committee's jurisdiction beyond that which had been carried out during the authorization hearings. This includes such diverse areas as Energy, Science, Space, Aeronautics and International Science Policy oversight activities. Pursuant to your instructions, that review has been accomplished.

In preparation of this report, I wish to acknowledge the support of the Committee staff for a job well done.

Sincerely,

JOHN L. SWIGERT, Jr.,
Executive Director.

CONTENTS

	Page
Letter of transmittal	iii
Introduction	1
Summary of findings	3
Committee meetings:	
May 28, 1977:	
International Atomic Energy Agency (IAEA)	5
International Institute for Applied Systems Analysis (IIASA)	8
United Nations Industrial Development Organization	40
May 30, 1977: Westfield Coal Gasification Facility	42
May 31, 1977: Phénix Breeder Reactor and Waste Management Facilities	44
June 1, 1977:	
International Energy Aegncy	54
French Atomic Energy Commission	55
Organization for Economic Cooperation and Development (OECD)	58
United Nations Educational, Scientific and Cultural Organization (UNESCO)	63
Interpol	66
British CO–GAS plant	71
European Space Agency	76
Super-Phénix Breeder Component Testing Facility	80
Solar Furnace Testing Facility	85
June 2, 1977:	
High temperature gas reactors and applications	87
ERNO: Spacelab program	98
Long-term nuclear waste disposal facility	106
June 3, 1977: Paris Air Show	108
Additional material:	
Background information on International Atomic Energy Agency	113
Transcript of International Atomic Energy Agency meeting May 29, 1977	129

INTRODUCTION

The Committee on Science and Technology has as its jurisdiction all civilian Research and Development activity taking place in the United States. This responsibility covers such diverse areas as Energy, Space, Aeronautics, Science and Science Policy.

Subsequent to the completion of Fiscal Year 1978 Authorization Hearings, the Committee conducted an oversight trip to Europe to review parallel activity taking place in Germany, England and France, respectively. Although the major emphasis of the trip was placed on Energy Research and Development, generally all areas of Committee responsibility received review. As can be seen in the Contents page of this report, the Committee conducted parallel meetings with various agencies and institutions on June 1st and 2nd. In order to accomplish this, the members chose their participation by Subcommittee activity and assignments.

The Committee was ably complemented by members of the Committee on Public Works and Transportation who greatly added to the success of the various meetings. Their outstanding support and participation provided another dimension to the depth of knowledge gained by this visit.

Members participating in the European Oversight Trip were:

Committee on Science and Technology

Olin E. Teague (D-Tex.), Chairman
John Wydler (R-N.Y.)
Dale Milford (D-Tex.)
Gary Myers (R-Pa.)
James Scheuer (D-N.Y.)
Tom Harkin (D-Iowa)
Robert Dornan (R-Calif.)
Harold Hollenbeck (R-N.J.)

Committee on Public Works and Transportation

John Breaux (D-La.)
John Paul Hammerschmidt (R-Ark.)
Norman Mineta (D-Calif.)

SUMMARY OF FINDINGS

The Committee on Science and Technology expressed concern over the changes in U.S. nuclear energy development policies announced by President Carter on April 7, 1977 and in the Energy Policy Message of April 20, 1977.

The April 7, 1977 policy change called for a halt in U.S. efforts to use plutonium as a fuel. The announced purpose of the change was to induce other nations to terminate their efforts to separate and cycle plutonium and thereby limit the potential of further proliferation of nuclear weapons. The second policy change announced on April 20, 1977 called for an indefinite deferral in U.S. efforts to build the Clinch River Breeder Reactor demonstration plant.

As a result of these developments, the Committee decided to conduct a thorough review of the recommended policy changes and to assess their impact on the nation's long-range energy planning options under its jurisdiction. This review included a European oversight trip, the summary of findings follows:

(1) France, West Germany, and Japan do not intend to go along with the United States' position on the Breeder Reactor program.

(2) With the discovery of the oil and gas deposits in the North Sea, Great Britain can now afford to side with the U.S. Breeder Reactor policy for the time being.

(3) Officials of the International Atomic Energy Agency were not consulted before the policy changes were formulated.

(4) France presently has an operating Breeder Reactor, the Phenix, which is approximately the size of the proposed U.S. Clinch River Project.

(5) It was the concensus of the European countries that the U.S. is 5 to 8 years behind in Breeder Reactor technology and that the gap is widening.

(6) The United States possesses the greatest amount of known uranium reserves and therefore it is looked upon as having motives of self-interest particularly by developing nations who must sustain high energy growth rates with limited domestic resources of energy.

(7) Almost all foreign nations must rely on the United States for uranium resources for light water reactors. To provide some degree of independence, the nations feel they must press forward with the Breeder Reactor technology and the plutonium fuel cycle.

(8) Everyone agrees with the idea of the non-proliferation goal as expressed by the President. The issue is whether the U.S. cannot afford to terminate technology demonstration and delay the availability of Breeder technology.

(9) The International Atomic Energy Agency was established 20 years ago with the basic objective of safeguarding the development of the peaceful atom and provides existing mechanisms for maintaining safeguards through the Non-proliferation treaty.

(10) The European Community agrees the U.S. Clinch River Breeder Reactor program is the next logical step in the U.S. Breeder Reactor Technology Program and this view is based on the historical development trends both in the U.S. and foreign countries.

(11) The Europeans stressed that the world is running out of potential energy resources of oil, coal, gas and uranium. Alternative energy sources must be developed and the pressures are greatest in countries with limited fossil supplies.

(12) The vacillation of the U.S. policy by the Carter Administration has left leaders of foreign countries confused and apprehensive, The February Carter position was to fund the Clinch River Breeder Reactor Program up to $150 million. The revised Carter position of two months later reverses that position. Both of these positions differ from the original Ford position on the Breeder Reactor program.

(13) The nations possessing some nuclear capability will continue to keep security and safeguards of nuclear fuel as a top priority item in their plans.

(14) The French feel confident about Breeder technology development and expect that development problems which are being resolved in the normal course of a research program with Phenix will not be encountered in the Super-Phenix operations.

(15) The U.S. agreement with the Federal Republic of Germany has important implications for technology development of the High Temperature Gas Reactor concepts and their ultimate commercialization.

(16) The West Germans have considerable experience with the thorium fuel cycle which is important for the U.S. since we are interested in determining the degree of proliferation-resistance which this cycle offers.

(17) In examining the long-term nuclear waste disposal problems, one of the critical factors is the determination of the age and stability of the salt formations to be used as underground storage for the deposit.

Additional review included other subjects, the summary of findings follows:

(1) The European Space Agency (ESA) will deliver the Spacelab system per its schedule commitment to the U.S. for incorporation into the Space Shuttle Transportation System.

(2) ESA has committed substantial financial support ($88 million) to participate in the planned NASA Space Telescope Program.

(3) The Committee received an excellent briefing on the strategy for energy transition in the 1985–1990 time period by Professor Wolfe Haefele, Deputy Director, International Institute for Applied Systems Analysis. (Briefing included in this report.)

(4) The 1977 Paris Air Show emphasized the growing world aerospace market by a variety of countries. As recently as 1970, the U.S. held a dominant 80 percent share of the $28 billion global market. By 1985, the sales total is projected to grow to over $50 billion, but the U.S. share is expected to decline to 60 percent.

(5) Considerable gasification technology has been developed in the United Kingdom and recent actions by ERDA indicate that the U.S. is moving toward utilization of this technology base in coal conversion.

COMMITTEE MEETINGS

INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA)

Date of visit: May 28, 1977.
Location of visit: Vienna, Austria.

HIGHLIGHTS

Members of the IAEA are in almost unanimous agreement that the world will need breeders and the world will have to close the nuclear fuel cycle.

IAEA estimates that the world reserves of uranium are 4 million tonnes, but world consumption will use up 10 million tonnes by 2025, even with the breeder.

Nations such as Britain, France, Russia, West Germany, and Japan must all eventually turn to the breeder, because of a lack of any other fuel source. Developing nations are not interested in the breeder, but rather conventional light water reactor technology.

Members of the IAEA were not involved in discussions with the administration prior to the decision to terminate the Clinch River Breeder Reactor Project.

REPORT

The meeting took place between officials of the International Atomic Energy Agency and Members of the House Science and Technology Committee and the House Public Works and Transportation Committee.

Representing the House Committees, were Chairman Olin E. Teague, Mr. Dale Milford, Mr. Jim Scheuer, Mr. Gary Myers, Mr. John Hammerschmidt, Mr. John Breaux, and Mr. Norman Minetta. Representing the IAEA were Mr. John A. Hall, Deputy Director for Administration, and Members of his staff. (A full listing of IAEA staff present is attached to this report.)

The IAEA is 20 years old and contains 110 members, 102 of whom have signed the non-proliferation treaty. The organization has an annual budget of $43 million. The staff contains 65 nationalities, with approximately 20 percent Americans. A general conference of all members is held annually in September, and a board of Governors (34 members) meets and approves the budget every year. The board of Governors has been steadily expanding since the beginning of the IAEA, and a move is now being made by several members of the agency to expand it further. A new chairman is selected for the board every year. The Chairmanship is rotated among the different regions of the world, with the exception that none of the big powers are allowed to hold the chair.

Mr. Rurik Krymm, of France, next described the immediate and long term prospects for nuclear power. He pointed out that at present the world annual consumption is 6 billion tons of oil equivalent per year (btoe), with nuclear power accounting for approximately 2 percent of the total consumption (approximately 8 percent of electricity production). By the year 2000 world consumption will increase to between 12 to 18 btoe, with the nuclear share between 10 and 20 percent. Nuclear power is essential for some nations because of the fact of their low fossil fuel resources. For example, France's fossil fuel resources would last only 2 years, at their consumption rate; Italy's situation is even worse. To become less dependent, France and nations similarly situated must use nuclear power. The IAEA estimates that there are 4 million tons of uranium remaining in the western world, or 40 btoe. Therefore, the breeder becomes very attractive, in being able to stretch the remaining uranium resources.

Presently, Sweden has the highest installed nuclear capacity per capita in the world. However, the light water reactor technology is limited by its vessel technology, to a maximum of 1300 MW. The Russians are developing a boiling water tube technology for present use, which can be built in modules, but this is not yet available.

Therefore, to answer the declining uranium resources and the limitations of LWR technology, nations such as Britain, France, Russia, West Germany and Japan are turning to commercialization of the breeder. Developing nations are mainly interested in light water reactors, with little or no interest in the breeder.

Chairman Teague and Mr. Hall next discussed the Carter proposal for limiting the breeder and eliminating reprocessing. Mr. Hall confessed that there was considerable confusion about the Carter policy on nuclear energy. He said that in a luncheon with Mr. Nye of the State Department, he was told by Mr. Nye that the United States was not against the breeder for other nations. Mr. Hall then said that the one aspect of the Carter policy with which he was familiar and could agree, was the legislation proposed by Mr. Carter to limit export of nuclear materials. However, he said that the IAEA was in unanimous agreement that the world will need to develop breeders and the world will have to close the nuclear fuel cycle. He further stated that unilateral action by the United States will not delay the commercialization of breeders by other nations, nor will it stop proliferation. Mr. Hall then noted that the United States proposed several years ago that the international community should do something about proliferation. He said that the IAEA has great potential to answer the proliferation problem. When asked about India, Mr. Hall defended the IAEA by noting that the plant which was used to reprocess and separate the plutonium was not under a safeguards system. Safeguards systems in India were imposed on a piece-meal basis and not included at that particular plant.

Next, Mr. James Cameron discussed the IAEA work on estimating uranium resources. The IAEA requires a report every two years from each country. These figures are provided by the countries themselves. The IAEA estimates that there are 2 million tonnes of proved reserves and another 2 million tonnes of estimated reserves. The IAEA estimates demand by the year 2000 to have used up 3 million tonnes and by the year 2025 used up 10 million tonnes. However, if the world decides not to utilize the breeder then 30 million tonnes will be required by the year 2025.

Of the world's known uranium resources, 85 percent are in the United States, South America, Canada, and Australia. Mr. Cameron commented that this statistic reflects the fact that money for exploration has only been spent in these countries. Other favorable geological formations are found in the south slope of the Himmalayan mountains, Africa, South America, and Coreedde Lina. However, serious problems prohibit further delineation of the world's uranium resources. It is estimated that approximately $20 billion will be needed for exploration of the world's resources. Furthermore, many nations inhibit the issuing of exploration permits as a national policy. At present, the IAEA is doing a world-wide bibliography study of the world's resources.

Mr. Robert Catlan next discussed the reprocessing and waste management activities of the IAEA. He said that the cladding now around our spent fuel will not last forever and we must be prepared to store the waste that we have. The United States by the year 2000 will have accumulated 38,000 tons of spent fuels. Mr. Catlan then said that the IAEA estimates that there will be a world capacity of 64,390 tons of uranium reprocessing available by the year 1990.

Finally, Mr. Vladimir Shmelev discussed the IAEA's activities to prevent proliferation of nuclear weapons and weapons materials. He is head of the Department of Safeguards, which collects information and inspects nuclear facilities throughout the world. Member countries send their transactional balances of nuclear materials to the IAEA where they are processed. Follow up inspection is done by professionals and reports are filed. Approximately 150 facilities are reporting to the IAEA under the non-proliferation treaty; an equal number report under nonproliferation guidelines. The Department of Safeguards has an $11 million annual budget and 11 professional officers for inspection of facilities and development of new safeguard items. The IAEA uses the supply of nuclear materials as its basis of control. The IAEA has extensive statutory authority to set up more comprehensive safeguard activities.

International Institute for Applied Systems Analysis (IIASA)

Date of visit: May 28, 1977.

Location of visit: IIASA Site, Schloss Laxenburg, A–2361 Laxenburg, Austria.

IIASA: Dr. Roger Levien, Director; Prof. Wolfe Haefele, Deputy Director; Dr. Janusz Kindler; and Prof. Ferenc Rabar.

The Committee heard talks on IIASA itself, energy, food and water.

HIGHLIGHTS

IIASA brings together scientists from many nations having widely differing economic, social, and political systems to consider the important problems facing mankind, and makes their findings available to national and international decision-makers, the scientific community, and the public.

IIASA's internal resources include about 70 scientists, the Schloss Laxenburgh where it is housed, and an annual budget from dues of about $6 million.

IIASA extends its activities through guest scholars, external funds, collaborative research, catalyzed research and information exchange.

Energy

The IIASA energy study considers worldwide energy demands, resources, and constraints for the middle range of 15 to 50 years from now and is trying to find feasible options for energy supply using proved or clearly feasible technology.

Oil and gas are insufficient in supply to meet world energy needs. All renewable resources together, except solar energy can provide only a modest fraction of the energy needed.

Coal appears to be a solution for the medium run. Solar, fission, fusion, and geothermal all have potential as long-run solutions.

Constraints considered included pollution, manpower, capital and others.

Food

The IIASA effort, which is just beginning, will try to build descriptive, dynamic models of the agricultural structure of selected, representative countries. It will attempt to measure the impact of agricultural policies on:

- Production structure and input requirements;
- Consumption and diet patterns;
- Food prices and trade activity;
- Investment;
- Employment, and
- Environment.

The model will connect the national models and try to evaluate the effect of different sets of national policies on the global food situation.

The food field differs from the energy field in that there is a very large number of primary products and technologies, foods are region specific, and the production inputs (soil and water) are geographically bound.

Water

The water project involves five tasks, namely, examination of:

Regional water demand and management;

Interregional water transfers;

Water quality;

Regional environmental policy and management, and

Global climate.

The project is concentrating on forecasting water demand. Demand forecasting is difficult because it is possible to substitute for water in many industrial processes. Future technology changes are a basic issue.

There is difficulty in maintaining interest in water problems unless there are current water problems.

REPORT

IIASA is an international research institute founded in 1972 at the initiative of the academies of science of 12 countries (later increased to 17).

There are now about 95 scientists working at IIASA. The objectives of IIASA are to focus the techniques of systems analysis on problems of mankind in an atmosphere of international cooperation.

The research programs of IIASA are focused on:

1. Energy systems—with particular focus on the period 15 to 50 years from now when a transition must occur from petroleum and gas to more abundant energy forms.
2. Food and Agriculture.
3. Resources and Environment.
4. Human Settlements and Services.
5. Management and Technology.
6. System and Decision Sciences.

IIASA is housed in Schloss Laxenburg, former summer residence of the Hapsburg emperors, about 15 kilometers south of Vienna (a half-hour drive).

The budget of IIASA comes from dues of member countries and from charitable foundations. The U.S. dues in fiscal 1977 are $1,440,000, paid by NSF through the National Academy of Sciences.

The Committee has legislative jurisdiction over the National Science Foundation which provides U.S. dues to IIASA. In part the purpose of the visit was oversight of how this money is spent. The Committee has legislative and special oversight jurisdiction of several matters considered by IIASA studies—most prominently, energy research. Another purpose of the visit was to determine how IIASA studies might help the Committee in consideration of these matters.

Dr. LEVIEN. Having you here we thought you would be interested in hearing a bit about the IIASA Program. I'm proud to say that we can't tell you all about it in this hour and a half. It would take several times more than that to do it, so we selected some highlights. I have spent enough time in Washington to know that Congressmen don't just like to be talked at but like to ask questions, too. So, I hope that you'll feel perfectly free to interrupt as we go along and ask questions. Each of the speakers is well equipped to change his direction somewhat to respond more to your interests. So, if you want more detail, if you feel a certain aspect of the discussion should be treated in some more thoroughness, then just raise your hand and we will be happy to respond.

I'm going to speak first and tell you a bit about IIASA, some of you, I hope, will have had some background information but I'll go over it quickly just to set the perspective. Professor Wolf Haefele who is the Deputy Director of IIASA from West Germany and the leader of our Energy Program will tell you next about that program. Then I've asked Professor Ferenc Rabar from Hungary, who is the leader of our Food Program, to tell you about that, and Dr. Janusz Kindler from Poland who is leader of our work in Water Resources to speak about that activity. This will be a bit of a reconnaissance of IIASA. I hope that will stimulate questions. Immediately after these talks we will have some cocktails, at least a glass of wine, and you'll have a chance to go into more detail with some members of the staff.

IIASA contains organizations and is made up of institutions representing Canada and the United States in North America, a group of Western European and Eastern European countries, and Japan. I'd like to begin by talking a bit about IIASA's history. (Figure 1.)

It began about 11 years ago in 1966 when the then President Lyndon Johnson proposed the establishment of an institute to work on common problems of developed countries. His idea was that this would serve as a bridge between East and West. This was before the era of Dentente and he sent his former National Security Advisor, McGeorge Bundy to Moscow in the beginning of 1967 to see if there was interest in the Soviet Union in this idea. Bunday met with Jerme Gvishiani who was the Deputy Chairman of the State Committee on Science & Technology (and some of you may know also was Kosygin's son-in-law), the central authority in the organization of management of science & technology in the Soviet Union, very much interested in East/West trade and negotiations. He and his associates had a very positive response to the proposal and there then followed a series of negotiations which extended over 5 years and engaged an ever increasing number of nations in the discussion which finally terminated in 1972 with the conclusion at the Royal Society in London of a charter signed by representatives of 12 national scientific oragnizations to establish what had then been named the International Institute for Applied Systems Analysis.

In the course of these negotiations, a number of very important decisions were made. The first was that this would not be an intergovernmental organization. The reason that this came up was that, at the time, the U.S. proposed that West Germany participate in the institute, and as a consequence the Soviet Union proposed that East Germany participate (and at that time the U.S. did not recognize East Germany), so as a compromise the decision was made that IIASA should be a non-governmental organization. That inadvertent decision was one of the key decisions in creating IIASA. What that means is that we are an Austrian association with membership by scientific institutions, but the individuals that came here do not represent their nations as they might if they were participating in U.N. agencies. They come as individual scientists to work in a non-governmental scientific environment on important issues which indeed, do have political and substantial importance. We are therefore, an organization of governments—different from the IAEA which you visited this morning.

In June of 1973, scientific work began here in the Schloss. That was the second important decision made in this period. The decision to accept the Austrian government's offer to accomodate IIASA at this Schloss. When the decision was made in 1972, this Schloss was in terrible shape as some of you may have seen in the pictures in the halls as you walked through. It had been decaying for a number of years. The Austrian government very quickly moved at the end of 1972 to undertake its renovation, and you can see the results now. We're exceedingly pleased with their generosity. As I mentioned to you earlier at lunch, we pay only one Schilling a year for this institute's use.

Last May we had the first IIASA conference which was an opportunity to sum up the accomplishments of the first three years.

To give you a sense of the membership of the institute, here's the names of the member organizations of IIASA. (Figure 2.)

Notice that it includes in the U.S., the National Academy of Sciences, and in the Soviet Union, the Academy of Sciences, The German Democratic Republican Academy of Sciences and in some places there are special committees. This past year we had three new members—The Netherlands, Finland, and Sweden which brought the total to 17.

Well, that's a bit about the history. You might be interested in our organizational structure. (Figure 3.)

As a non-governmental organization, we have, first of all, a Council which is made up of one representative of each of these national member organizations. Its chairman is Jermen Gvishiani from the Soviet Union, the man I mentioned to you that McGeorge Bundy had met with. The Council meets annually, sometimes more often. It has three Committees, the Finance Committee chairmed by Gvishiani, Membership Committee by Kingsley Dunham. Andrei Bykov from the Soviet Union is the Secretary. These bodies set the basic overall policies for the Institute. When they meet, they approve our budget, they approve our research plan. But the operations of the Institute are the responsibility of the Directorate. I am, of course, the Director, Professor Haefele from the Federal Republic is the Deputy Director, Oleg Vasiliev from the Soviet Union is the Second Deputy Director.

The important point for us is that these Council meetings have taken place over the last 5 years with a great deal of harmony. I come from a Quaker institution and the kinds of decisions that were made in that Quaker institution in the U.S. were "sense of the meeting" decisions. After long discussion, we would decide by the sense of the meeting, and that's exactly the way the Council meets here at IIASA. After our discussion, a sense of the meeting decision is taken, very few votes. The Directorate, as I said, takes care of the year by year activi-

92-187 O - 77 - 2

ties which are most importantly our research activities. The other thing to say about the member organizations is that they provide the financial support for IIASA. Each year the U.S. and the Soviet Union give the major part—$1.4 million this year from each of them. This is the only international organization in which both the U.S. and the Soviet Union give the same amount. All of the other 15 member organizations contribute this year $216,000 dollars which means a total budget in dollars of about $6.12 million dollars. Now, the unfortunate decision our founders made was to set the dues in dollars, because we spend schillings, and as you know these days when you change a dollar you get 16.7 schillings. At the time of the foundation of IIASA, you would get 23.18 . . . so we've had about a 30 percent decline in the value of our contributions simply as a result of the decline of the value of a dollar in relation to the schilling.

Now let me turn from these organizational matters to some of the operational aspects of IIASA. (Figure 4.)

First, I want to emphasize what I've just said, that we are international but non-governmental, and especially importantly we span both East and West. Secondly, our focus is on inter-disciplinary questions, not the pure single science aspects, but the ways in which sciences interact are important, especially in the applied sciences. So the first aspect of IIASA's character is important—that we are trying to cut down barriers and boundaries . . . to cut across East/West boundaries and to cut across disciplinary boundaries. Frequently, we find that it's easier for scientists from East and West to talk when they share a discipline, for example: an American physicist and a Soviet physicist than for scientists from the same nation to talk when they're from different disciplines. So, it's easier for an American physicist to talk to a Soviet Union physicist than for an American physicist to talk to an American economist.

IIASA's focus is given by its name. We are an international and applied institute and we're a systems analysis institute. International and applied means that we're interested in addressing problems of international importance. We define 2 such kinds of problems. (Figure 5.)

The first are those which we call Global, inherently involving more than one nation and which cannot be resolved by the actions of single nations. Problems of the global climate, problems of ocean, more general problems of global development coming as a result of increasing population, forces affecting our demand for resources, energy, food and so on. But secondly we're concerned with universal problems. There are issues which are within national boundaries but which all nations share, for example: the problems of designing a health care system, an education system, a transportation network. IIASA is interested in these issues because we can exchange information about the solution of such problems across national boundaries.

We can exchange methodologies and particularly since we cross East/West, political, social, and economic boundaries we have a wide range of experience. So we undertake studies of important problems of international character, both global and universal. Today you're going to hear about the two global problems (the energy problem that Professor Haefele will discuss and the food problem that Professor Rabar will discuss) and a universal problem (the problems of water resources and management which Professor Kindler will discuss). The second part of our name is Systems Analysis, and by that we mean that in studying any of these problems, we attempt to adopt a comprehensive approach. (Figure 6.)

When we study energy we're not interested in just technology of energy, not just in the economics of energy, just in the environmental impact of energy. We're interested in the interactions. We don't study the problem the way a single discipline would, we don't study a problem the way a single bureaucracy would, but rather, we try to draw a boundary around a problem which encompasses those aspects which are important to the kinds of decisions we think decision-makers have to make. You'll see this particularly when you hear Prof. Haefele talk about the energy program, because he'll talk about not only energy technology, but about population and its impact on energy, he'll talk about climate and climate effects and he'll talk about economic questions. So the Systems Analysis in our title means nothing more than a comprehensive approach drawing many pieces of a problem together within a single boundary in order to address the issue the way the decision-maker has to study it.

Now to do this, we've undertaken a two dimensional structure. Rather than the usual tree network, you see in organizational charts, we have this which is called a matrix which has two aspects. (Figure 7.)

First, these horizontal rows which are our major programs. I've mentioned energy and food. These are interdisciplinary cross-cutting studies looking at the problem at a long time horizon. In order to do such studies, one needs to draw on talented people, specialists in a wide range of disciplines. The other dimension of our matrix is pools of people called our research areas which are specialists. For example: In this area called resources and environment we have water resources specialists, environmental specialists, agricultural specialists, and so on. In the area of human settlements and services, specialists in population, in urban planning and regional planning. In the area of management technology, engineers and management specialists. And in this last area of system and decision sciences, mathematicians and computer specialists whose function it is to tell us about the tools for studying complex problems. Now when we work, we draw together a team made up of these different kinds of specialists and focus them on a cross-cutting issue like energy or food. In addition, each of these separate areas has its own research program and the water resources work that you'll hear about falls in this part of our area. So we have, from 17 nations, scientists in all these disciplines working together in international inter-disciplinary teams focused on these major problems. That's the effort we have under way at IIASA.

Now as compared to that effort, which is rather ambitious I'm sure you'll agree, the resources available to use are limited. (Figure 8.)

We have 70 scientists at any time, we have this marvelous Schloss, the library, the computer, and about 6 million dollars a year in our basic finances.

But the important thing about IIASA is that we are not trying to be self-contained. We're not concerned only with what goes on within these walls. The focus of this institute is to serve as a linkage aid among the activities underway in many separate countries. Again, as you hear each of the people speak this afternoon you'll hear them say, we're doing this in collaboration with a group in Hungary, we're doing this in collaboration with a group in the Soviet Union. Its IIASA's purpose to serve as the visible part of an international invisible network, to multiply these 70 scientists through many functions. (Figure 9.)

For example: we call the 70 scientists the core group of IIASA. We have around that 70 scientists already about another 10 within the Schloss whose way is paid by their home institutions. These are scientists from Siemens, from Shell Oil, from IBM, from the CNNRS in France, and so on, each of which is here on the salary of his home institution who extends our capability to work but also links us with his home institution. In addition, each year we have about a million dollars of money provided by outside agencies like the Ford Foundation, the VW Foundation, The United Nations Environmental Program, the Austrian National Bank, and so on. And this enables us to hire another 15 scientists bringing our total staff to about 95 within the Schloss. We add to this our collaborative research activity; this is where the true amplification of IIASA's efforts occurs. In studying coal we have about 2 people here at the Schloss, but they are linked through an international coal task force to scientists in 4 or 5 other countries, a far larger number than the effort within the IIASA institution. On top of this there's what we call catalyzed research which is going in such places as the National Center for Atmospheric Research which was stimulated by IIASA's work but which is not carried out closely in conjunction. The final ring in this network is information exchange. Each year we hold about 30 or 40 conferences here in the Schloss bringing together scientists from East and West and increasingly scientists from North and South to exchange information about topics like major made hydrocarbons, like water resources management, food, implications for the environment, and so on. So the amplification of our 70 scientists is through this international network intended to link scientific institutions in at least the 17 countries of our members but in many cases, countries outside this group as well.

I want to turn very quickly from this overview of the nature of our work to the more specific details, so let me try to summarize what I've said very briefly here. This institution brings together scientists from many nations having widely differing economic, social and political systems to consider the important problems facing mankind and attempts to make their findings available to national and international decisionmakers, the scientific community, and the public.

Now with the background, let's turn to the more specific issues at hand, some of the substantive results of IIASA's work. I'd like to turn now in particular to the energy program. This is the oldest and largest program at IIASA. It began in 1973 with the arrival of Professor Haefele. It has a five-year lifetime and has now reached about 3 years through its efforts. Let me say while he is coming up here that Professor Haefela was the leader of the fast breeder reactor development project in the Federal Republic of Germany before coming here and Director of the Institute of Reactor Physics and Systems Analysis at Karlsruhe.

FIGURE 1

BRIEF HISTORY

1966	PROPOSAL
1967	US/USSR DISCUSSIONS
1967-72	MULTI-NATIONAL NEGOTIATIONS
	SCHLOSS LAXENBURG, AUSTRIA SELECTED AS IIASA'S LOCATION
OCT. 4, 1972	CHARTER SIGNED BY REPRESENTATIVES OF 12 NATIONAL SCIENTIFIC ORGANIZATIONS
JUNE 1973	SCIENTIFIC WORK BEGINS AT LAXENBURG
MAY 1976	FIRST IIASA CONFERENCE

FIGURE 2

MEMBERS OF IIASA

	DATE JOINED
• THE ACADEMY OF SCIENCES, UNION OF SOVIET SOCIALIST REPUBLICS	1972
• THE COMMITTEE FOR THE INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS, CANADA	1972
• THE COMMITTEE FOR THE INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS OF THE CZECHOSLOVAK SOCIALIST REPUBLIC	1972
• THE FRENCH ASSOCIATION FOR THE DEVELOPMENT OF SYSTEMS ANALYSIS	1972
• THE ACADEMY OF SCIENCES OF THE GERMAN DEMOCRATIC REPUBLIC	1972
• THE JAPAN COMMITTEE FOR THE INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS	1972
• THE MAX PLANCK SOCIETY FOR THE ADVANCEMENT OF SCIENCES, FEDERAL REPUBLIC OF GERMANY	1972
• THE NATIONAL CENTRE FOR CYBERNETICS AND COMPUTER TECHNIQUES, PEOPLE'S REPUBLIC OF BULGARIA	1972
• THE NATIONAL ACADEMY OF SCIENCES, UNITED STATES OF AMERICA	1972
• THE NATIONAL RESEARCH COUNCIL, ITALY	1972
• THE POLISH ACADEMY OF SCIENCES	1972
• THE ROYAL SOCIETY, UNITED KINGDOM	1972
• THE AUSTRIAN ACADEMY OF SCIENCES	1973
• THE HUNGARIAN COMMITTEE FOR APPLIED SYSTEMS ANALYSIS	1974
• THE SWEDISH COMMITTEE FOR THE INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS	1976
• THE FINNISH COMMITTEE FOR THE IIASA	1976
• THE FOUNDATION IIASA – NETHERLANDS	1976

FIGURE 3

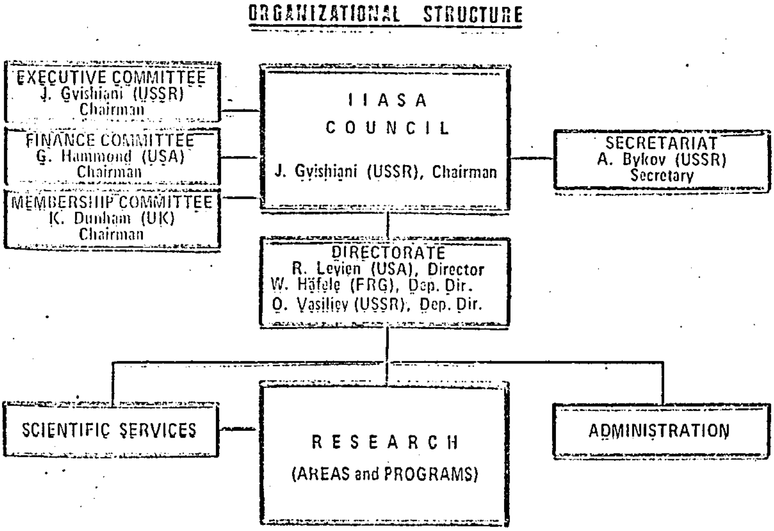


FIGURE 4

IIASA's CHARACTER

- INTERNATIONAL, *but* NON-GOVERNMENTAL.
  (spanning East and West)
- INTERDISCIPLINARY, *and* APPLIED
  (spanning natural and social sciences)

FIGURE 5

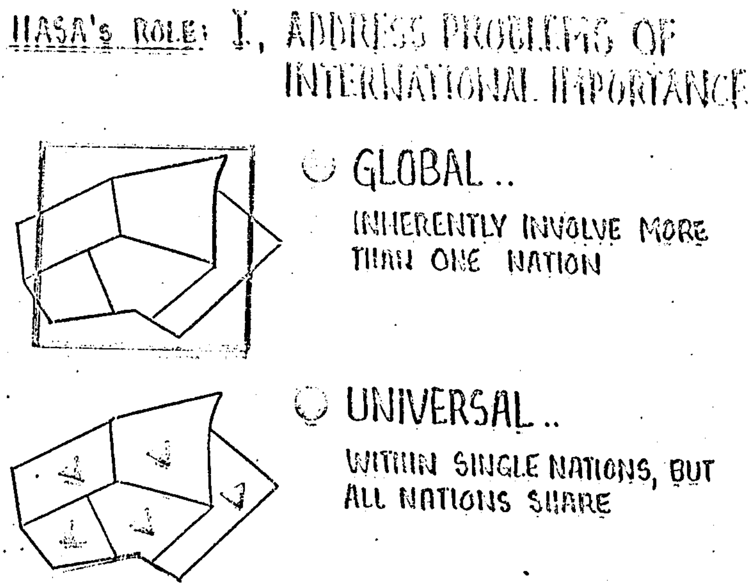


FIGURE 6

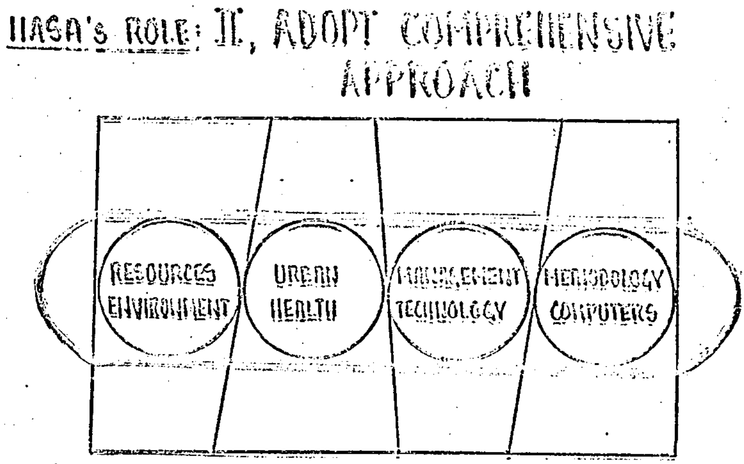


FIGURE 7

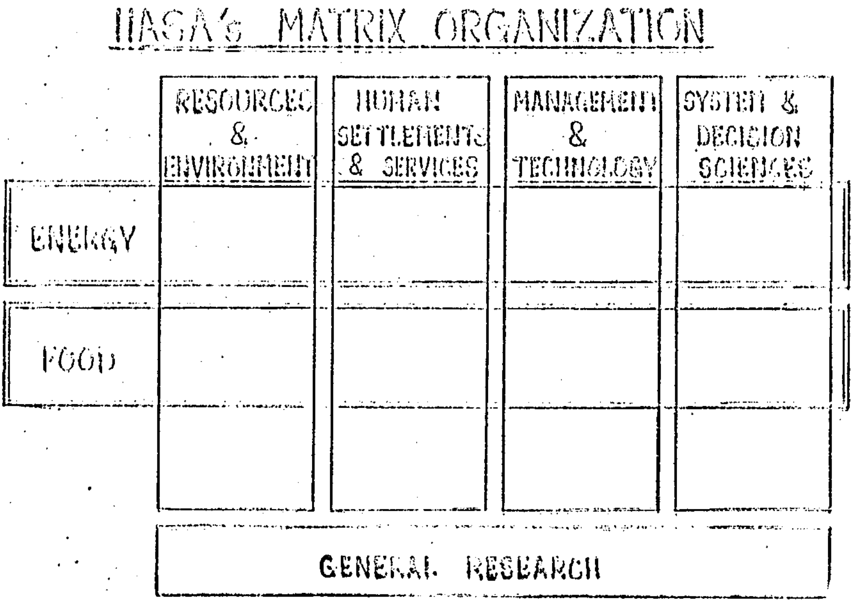


FIGURE 8

IIASA's INTERNAL RESOURCES:

PERSONNEL ... 70 scientists

FACILITIES ... Schloss Laxenburg
Library
Computer

FINANCES ... 110 million AS or
$6 million

FIGURE 9

IIASA's EXTERNAL RESOURCES:

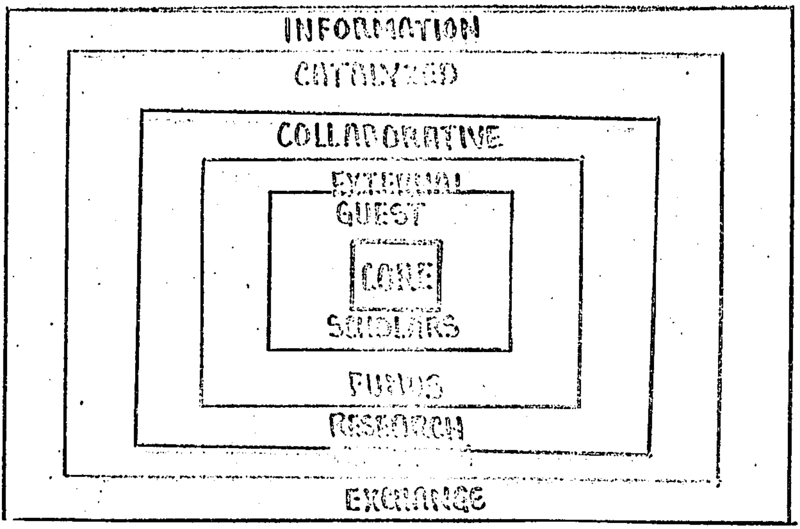


FIGURE 10

IN SUMMARY

IIASA brings together scientists from many nations having widely differing economic, social, and political systems to consider the important problems facing mankind, and makes their findings available to national and international decisionmakers, the scientific community, and the public

Mr. MYERS. How do you arrive at a consensus on what to study and what not to study?

Dr. LEVIEN. It's known as ticket balancing. I think there was a problem at the beginning of the institute as to what topics to cover. The first director, Professor Raiffa, started asking questions among the member organization countries as to what they were interested in. He started out with the hypothesis that we should do studies only that every country was interested in. He soon discovered that there was nothing included under that heading. So, he chose, I think, a good political strategy, which was to set up a portfolio or a ticket of topics so that every country was interested in enough of the things on that ticket to keep their interest in the whole institute. Essentially that has continued. Over time we have evolved that set. It isn't necessary that every country be interested in a topic as long as there is enough support so as to pursue it. Each year we present to our council a research plan for the coming year. They, in turn, then approve it, usually as a whole or suggest some revisions that might be made.

Mr. SCHEUER. What do you do with the results of the studies?

Dr. LEVIEN. We try to disseminate them in a variety of ways. First of all, we have an extensive publication program. Secondly, we do a lot of visitation, a lot of talking with decisionmakers. We have people here and we try to inform them. We are now beginning a program of communications studies, that is, ways of communicating our results other than in the written form. We want to use slides, tape shows, TV tapes, films, all of the media that we can, because we are well aware that the major impediment to the application of these scientific findings in policy is the communications process. While I was aware of that when I worked in the United States for RAND, and it was a problem there, can you imagine the difficulty when you have to make these results available to decisionmakers in 17 different countries (and that does not include the developing world, the UN agencies or the multinational corporations). As we reach conclusions, particularly as in the energy study, which is now reaching its concluding stages and which has a lot of importance, we are looking for more and more mechanisms for communication, ways of getting the message across in an understandable, comprehensive way in each country, not only to the decisionmakers but to their aides, to the scientific community, and so on. One way we do this in each country is through our collaborating institutions. The Institute of Energetics in Leipzig in the GDR. The Siberian Power Institute in Irkutsk, Resources for the Future in the United States, all these institutions are aware of what we are doing. They have free license (in fact we encourage them) to use it, embody it in their work, and make it available to the decisionmakers in their own country.

Mr. SCHEUER. What are you doing to get the developing world involved in, not only your results, but your process? So many of the lessons here are of tremendous application to decisionmakers in the developing world.

Dr. LEVIEN. The Institute was founded, as I said earlier, with an East/West axis and an emphasis on the common problems of the developed countries, but it has become very clear to all of us as we proceed that these common problems are problems of the whole globe, and that rather than East/West, the axis has to go North/South. Membership in the Institute is now exclusively from the developed countries, and it will be hard to extend the membership much beyond that for financial and space reasons. Our emphasis has instead been on bringing scientists from developing countries to participate in our program. We have a financial difficulty here, however, because we are already under severe financial limitations. We have to use our basic resources to bring to IIASA two or three scientists from each of our member countries. That is what they are paying for—to have participation. We therefore have no funds with which to bring scientists from developing countries to IIASA. We were helped by the Rockefeller Foundation which gave us $150,000 to start a program of bringing such scientists here. We really need about $1,000,000 a year, and that is what we are seeking to build up the participation of scientists from these countries. Otherwise the credibility of our results will be suspect, and in fact the results should be suspect, because it is impossible for a scientist from a developed country to truly understand the system aspects of the use of energy or food in these countries. So we are trying vigorously to bring scientists from the developing countries, but it is a financial problem right now.

Professor HAEFELE. After quite some time of reflection, we here at this institute decided that it would be an appropriate role for the energy project to look into the medium and long-range future of the energy problem. The short and medium range aspects are most developed and taken care of in many countries but the long-range and medium range orientations are not always there, specifically so because such an orientation always tends to be global in nature, and therefore does require the multi-nationality that we enjoy here at this institute. I will explain a little bit about how this leads together and perhaps you will get the overall picture.

In so doing I will constantly use units. Specifically I will use the unit one terawatt which is a thousand gigawatts or a million megawatts. One terawatt is equilavant to 1 billion tons of coal per year. In order to provide you with another yardstick you recall that in the United States your yearly production of coal is roughly .6 billion tons of coal per year. The energy consumption of the world is today 7.5 terawatts. 5.5 out of that are based on coal on oil and gas. 3.5 out of these 5.5 are based on oil where 1.8 is indigenous (mostly in the U.S. and the Soviet Union), but 1.7 terawatts are coming from the OPEC countries, mostly the Persian Gulf, and shipped around the globe over tens of thousands of kilometers. That means already today we have a sharply and strongly localized and centralized supply system for oil and thereby for 50% of the energy demand of the OCED countries. Therefore, in the forthcoming years, centralization versus de-centralization may be a point of debate, but one should realize that already today we have a sharply centralized supply system.

In Figure 1 some indication is given of how much time it really took to arrive at the situation where oil and gas are the predominant features of the supply system. We have plotted here the market shares. Taken together, oil and gas today make up roughly 70 percent of all the supply. In 1850, 125 years ago, it was essentially wood that provided for the energy supply—on a different scale, but in terms of the market shares, it was by far the greatest contributor. Now, the interesting feature to observe here is the slope of the curve. It essentially means that in the world it has taken 100 years to switch from one supplier to the other suppliers; from wood to coal, and from coal to oil and gas. In the United States such penetration periods were consistently 50 to 60 years and this automatically introduces the time scale that we are talking about. That means we have to envision something like a period of 15 to 50 years when we are really serious about talking of the global energy supply system.

Figure 2 shows per capita consumption in 1971. It is useful to recall what the per capita contribution is. The per capita consumption in various part of the world; 6 percent of the world are more enjoying than 7 kilowatts per capita, 22 percent (essentially in Europe and Japan) have values between 2 and 7, but more than 80 countries, each with a vote in the United Nations have a consumption of 0.2 kilowatts per capita which is essentially 2 percent the value of the United States. Now without very much mathematics, just by looking at the curve, one can conclude that this very uneven distribution, just by the laws of the nature, would tend to become smoother. The present average value is at 2 kilowatts per capita, but if you smooth the curve, then it will be 2,3, 4,5 kilowatts per capita. Then the questions come up—if that is the case, how large will the population be, can we provide this amount of energy, and within what period?

Now energy is energy consumption, that is not a point in itself, instead it goes along with economic growth. Only once you have economy, you have energy demand and therefore all these issues are linked to the international development strategy of the early 70's or the new economic order which is now so hotly debated in the United Nations or the group of 77. Another key word is UNCTAD. All these issues are highly political, just to recall the political debate in the United Nations and elsewhere these days.

What are the consequences? (Figure 3.)

The consequences that are expected at close range are still very significant. That is another language for saying that the distribution curve for energy per capita is very uneven, and presses for a change. Now the Leontief study that has been published recently, studies two schemes, one for the new economic order and one for the international development strategy. We have on the average in both cases 4.6 percent as the growth rate all over the world. The new economic order anticipates 7 percent per year growth rates in the developing countries. I'm not saying that this would happen necessarily, because most of you, if not all of you, are aware of the intricate, immense difficulties that go along with such an economical order. But the political pressures will be in that direction.

Now, if that's the case, one can ask the question, how does this reflect on the evolution of the mean value of two kilowatts per capita? (Figure 4.)

Figure 4, I think, captures the essence of it. Now of course nobody can predict the population growth. Whether it will be 12 billion people or 8 billion people or 10 billion people, nobody knows. But it is very important that in order of magnitude considerations the last 10 percent will be taken care of anyway. What we are talking about are factors of 10 to make sure which ball park we are entering. Ten or 12 billion people doesn't make a difference in that context. If you assume the new economical order or other schemes that have been proposed specifically by the developing countries, then you do come to the value of 5 kilowatts per capita. If you do that, then you evolve from today's 7.6 terawatts into 64 terawatts or roughly a factor of 8. Now you may say I'm pessimestic and that it might not happen. Indeed one has to look into these matters more carefully. I will report to you in a second what we do about it. But for the moment the message is comparatively clear. We have to expect an energy demand for the next 50 years, which is a natural time horizon for our energy systems considerations, which is on the order of 3,4, or 5 times as large if not more and let me stress I do think these are lower figures. So if we are talking of modern energy systems, we have to take into account systems that are able to provide dozens of terawatts not single terawatts. That is the message.

Now how can that be done? The present system is based on cheap oil and gas and everybody (specifically the developing countries) is enjoying it because it is cheap in capital investment. $50 per kilowatt is the capital investment for cheap oil and gas. (Figure 5.)

Figure 5 shows that proven oil reserves are 90 billion tons or roughly 120 terawatt years. From that curve given in Figure 4, if you say 20 terawatts over 50 years, you get a figure of orientation that you have to provide for a thousand terawatt years. What we have as cheap oil is 90. Now this is oil so you add 30 percent and you have 120 billion tons of coal, instead of a thousand. Now out of these 45 have already been consumed. Now there is more oil; there is undiscovered oil and there is subeconomic oil indeed, and definitely we have to go into it. Therefore, we are not bound to that limited value but if you take that altogether you will have something like 300 or 350 terawatt years. Therefore, you can see that on the present basis we will have a problem. We have to evolve into a different kind of supply by necessity

Figure 6 identifies the renewable resources where so much is talked about (for instance, by Friends of the Earth or in the article of *Foreign Affairs* "The Road not Taken" which goes into the soft options of solar power, wind power and very much stresses the point of renewable decentralized resources). Now let's have a look at them. If you are about to harvest all the hydropower of the world—this implies the schemes in which all of Greenland has to be engineered for hydropower—you have a total of something like 2.9 terawatts. If you go to large scale deployment of wind power facilities, the upper limit is 1,2, or 3 terawatts. Tidal power for .04, wave power, if you want to have 1 terawatt, you have to provide a linear facility almost of the length of the perimeter of the earth. Ocean thermal gradient within ten kilometers of the coast line—.35 terawatts. Therefore, the renewable resources all have a similar thing in common: namely to be on the scale of 1 terawatt but not dozens of terawatts. That is the message. Energy conservation can bring you 1 terawatt and it falls in line with the soft options, but not dozens of terawatts.

So what do you do then when dozens of terawatts are at stake? Fortunately there is more than one option to provide, but they all have their problems. (Figure 7.)

Coal is half an option, because 7,000 billion tons or 7,000 terawatt years is the geologically existing amount of coal. More pragmatically and realistically you have a thousand terawatt years of coal. But if you do it, you have land requirements, you have the problem of working conditions, safety, CO_2, and other pollutants. Another option is the fast breeder reactor, or nuclear power based on the fast breeder. This could provide 200 million terawatt years. Solar essentially is infinite, fusion is essentially the same thing as the fast breeder, contrary to the widespread belief. It is the same ball game, probably under better conditions, but qualitatively the same thing, that is several hundred million terawatt years. Geothermal is not so clear. It is definitely larger than coal but its not in the hundreds of millions of terawatt years or like solar. That means we do have principally speaking a number of options for the essentially unlimited supply of energy; coal, solar, and nuclear being the most prominent ones.

Now, if that is the case, we have to master a transition. We have to go from the present equilibrum between cheap resources ($2.00 per barrel at production costs or even less) and demands, to one of these options or, better, combinations of these options. That is the transition for 50 years. What the energy project is about is to identify the transit strategies to do it. Contrary to the past, optimization is not the name of the game. Instead, feasibility of the transition is the name of the game—and feasibility is characterized by constraints. So we are strongly studying the contraints, specifically: man's impact on climate by Dr. Williams who is here among us, risk and risk perception by society drawing on the IAEA (that means almost a sociological project), market penetrations, and capital cost requirements. These are the four predominant constraints selecting the feasible strategies for that transition for which we have 50 years to come.

Now let's have a short look at solar because that might be a case in point. (Figure 8.)

Here we have identified the square kilometers that we need to substitute for one gigawatt electric. A typical figure for European latitudes is 2 kilowatt hours per square meter per day. In Phoenix, Arizona, you find 5 kilowatt hours per square meter per day, better by a factor of 1.8 or so. In this case, depending on the system's efficiency, you need something between 80 square kilometers and 34 square kilometers depending on the conditions. It is true that solar power requires a lot of surface, a lot of land provided you are after a large scale deployment of solar power, and not a marginal use on the roofs.

However, the real big problem is energy storage. The difference between summer and winter in our latitudes here in middle Europe is 7 to 1. In Phoenix, Arizona it's fortunately only 2 to 1. But in either case, you have to go into storage. (Figure 9.)

Figure 9 shows hydro-storage at the largest possible scale that is available today on a global basis. That is thirty terawatt hours in Bratsk-ilimsk in Siberia that is the Lake Baikal area in eastern Siberia. But what you have to have are not 30 terawatt hours, but thousands, 10,000 terawatt hours to bridge the summer/winter cycle. So it's a different ballgame if you want to deploy solar power on a large scale. You can't do it if you don't produce electricity for the end use or a secondary energy carrier like a gas or a liquid. (Figure 10.)

Figure 10 shows what you are after if you do this. You have to cover several millions of square kilometers if you want to have the global option for these dozens of terawatts that we are talking about. In this scheme we have 100 terawatts. We can give you the scheme for 50 terawatts. This is not impossible. I want to stress that. It is possible in principle. The amount of land is available; you can go to a liquid secondary energy carrier, but, it is a global activity. The present political system doesn't necessarily permit for it easily. My point is that you are driven into the global considerations when you want to satisfy the global energy demand. That observation sounds fairly trivial but the implications are significant. You have to do the same thing for coal. Coal can provide a thousand, three thousand terawatt years, but coal is unevenly distributed. Most of the coal is in the Soviet Union, the United States, and China. If we now go to coal at the global scale you have to envision a situation where perhaps the U.S. will have to assume an OPEC function for coal—that means to distribute that raw material all over the world in the same fashion as the OPEC countries now distribute their oil all over the world in fact a truly global operation. Large scale uses of coal have their waste disposal problems too. Anything that you do on a truly large scale has problems.

For instance; the CO_2 problem is such a limiting case if, and I think it is the case, you have to limit your CO_2 production such that the content of CO_2 in the atmosphere wouldn't double. (Figure 11.)

The case of CO_2 doubling is shown on the middle curve of Figure 11. Coal use could increase to 40 terawatts for a limited time period, but after the year 2030, you have to go back down again in order not to more than double the CO_2 content of the atmosphere. What is at stake is the residual risk of fossil waste disposal, namely melting the ice caps due to the temperature increase caused by atmospheric CO_2. So the logical structure of residual risks is very much the same as the case of nuclear power and other big options. Now all this wouldn't happen globally from the very beginning. In conjunction with the Soviet Academy of Sciences we are anticipating considerations for the various regions of the world. I want you to study Figure 12 in some detail—because the situation in the various world regions are quite different. (Figure 12.)

In North America, we estimated the consumption up to the year 2025 to be 177 terawatt years. On the basis of indigenous oil and gas you couldn't do it. You have to go into coal. In the case of the United States, you have the possibility by enjoying your coal for yourself alone to cover this 177 terawatt years, with 10 percent of the geological resources, although after the year 2025 it looks different for the case of the United States. The USSR and Eastern Europe are in even better condition. There are 150 terawatt years estimated demand up to the year 2025, and their oil and gas all taken together roughly make it. You'll probably have to go into coal, but there is more coal in the Soviet Union than the U.S. Western Europe and Japan look drastically different. They have the highest demand of 230 terawatt years. Their indigenous resources make up for only 20 or 30 terawatt years and all their available coal wouldn't make it either. If you now think of the long lead times—50 years for making a change (I've shown you the market penetration curves), it translates into the necessity to go beyond fossil resources, and there is nothing else but nuclear or solar. In Latin America, Africa, and East Asia the situation is similar.

In the case of OPEC they do have a surplus but not more than 150 terawatt years. The big question, politically speaking, is who gets these 150 terawatt years of easy fuel? But it can only help to master the transition. Only strategically placed would it make sense to consume these easy fuels. Roughly speaking a thousand terawatts is the consumption—500 terawatt years on existing bases and the other 500 terawatt years from a different source and this can be only solar or nuclear. In either case, solar or nuclear will be a global undertaking.

Figure 13 shows you what we are doing about it. What I've shown you is the zero order approximation. We have a large modeling effort here which is not so detailed but is comprehensive. (Figure 13.)

The key word here is comprehensiveness. We take into account what the OPEC people are telling us here in Vienna, what we get from the Soviet Union, and from the developing countries. We are under contract with the United Nations environmental program in Nairobi.

We are modeling the United States. The point is to be complete. We cover the globe in a complete fashion not leaving out this or that area. The essence of our modeling is an energy supply model identifying technology priorities—when does electrolysis have to come in, how soon is coal gasification necessary? What is the role of the fast breeder in these various world regions that I've shown you? The western Europe situation as compared with the other situations?

We repeat this modeling effort that I'm explaining now for each world region separately.

MUSE and MEDEE are models that give us energy demand once we have economical activities. Voss you should realize is German, Agnew is British, Schrattenholzer is Austrian, Grenon is French and Zimin is Soviet. We have the resources model driving the energy supply model. We have a macroeconomic model by a U.S. citizen, an Indian, and a German. Professor Keyfitz from Harvard provides a model of population as an input. Dr. Zimin from Moscow has a Pi-model which translates macroeconomic activities into energy demand. The Impact model to study the consequences of energy in terms of investment, materials, and environmental impacts, is done by Dr. Kononov of the Soviet Union. So you see how truly multi-national this modeling effort is, not only in taking care of these world regions but also by the participants for this modeling effort. Figure 14 shows that we do that in strong conjunction with the Soviet Union, which has largely decided to have logically the same approach. The long-range planning of the Soviet Union is taking place on the same basis: Macroeconomic model, energy demand, energy supply, resources. Sometimes the very same models that we use here are used in the Soviet Union because they come from the Soviet Union.

Now, if that is the case, we must then also look into the nuclear option from that global point of view. If we talk here of this region or that region, we cannot dismiss nuclear power, because we don't know where the terawatt years will come from otherwise. Solar power is definitely very expensive. This whole scheme is meant also to look for capital availability with the time period in which we can provide the capital. What we are after is this: to conceive a global scheme which makes the transition from today's situation which is characterized in Figure 15 to a future characterized in Figure 16. (Figure 15.)

What is expensive is the consumer system—the infrastructure for consuming energy shown at the left of Figure 15. There we have the megawatt domain and we are covering distances between 5 and 50 kilometers—say in Chicago or New York. In the secondary energy system we have overhead lines, we have high pressure pipelines, we have barges and railways. To serve that consumer distribution we have power lines for electricity, we have gas handling storage, we have refineries. They are operated in the gigawatt domain, and they are operating between hundreds and thousands of kilometers. But they

92-187 O - 77 - 3

are served by coal fields and by gas fields, and there pipelines of a distance of some thousand kilometers are in between, and crude oil is transported over ten thousand kilometers—that means global distances. Solar is presently pursued at the consumer end and I think that is wrongly so because it can only marginally help. It must come in as a substitution for primary energy and therefore has to fit into a different context.

What we are envisioning instead is in Figure 16. (Figure 16.)

You'd like to maintain the consumer structure to the largest possible extent to save time, to save capital, to minimize the disturbance.

What we have to make use of is solar power, coal, and nuclear power, but we have to do it in the terawatt domain, and we are envisioning the bridge of 10,000 kilometers. Instrumental to that are islands, for instance: nuclear islands where out of solar power or coal power or nuclear power liquid hydrogen would be produced, or where we have fossil fuel cycle centers for provision of methane or for methanol. On this basis we can feed the existing infrastructure by concentrating and also adding multi-national approaches to the new side of the coin . . . the new primary energy supplies. They are then consistent with what we have in the infrastructure.

That is the strategic approach we have in mind, and it will be global and multinational in nature. We hope that a year from now we have the details of it for all the world regions including the timing of the transition, which in some parts of the world is more pressing than in others. Thank you.

Mr. MYERS. Are you suggesting that the end use distribution should remain the same?

Dr. HAEFELE. Essentially, yes. For instance, what we are saying here is that hydrocarbon liquids which are serving the transportation sector should to the largest possible extent be maintained and served instead by electricity. Probably Methanol should be used because it requires less capital investment.

Mr. MYERS. Well, if you make that assumption then you've got to make the assumption that the developing world is also going to adopt the same main use characteristics, which might be open to question.

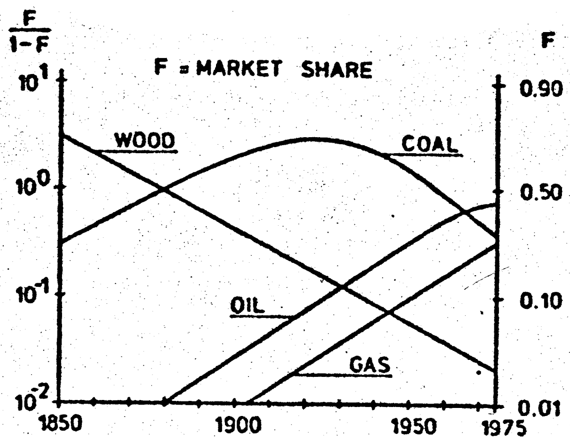


FIGURE 1.—Energy market penetrations, world.

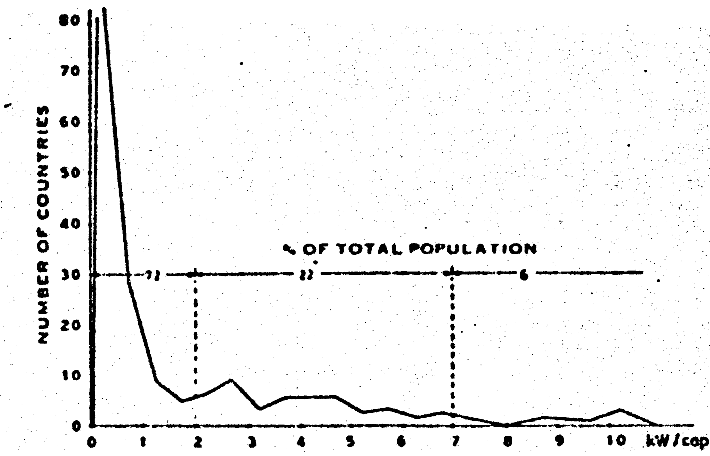
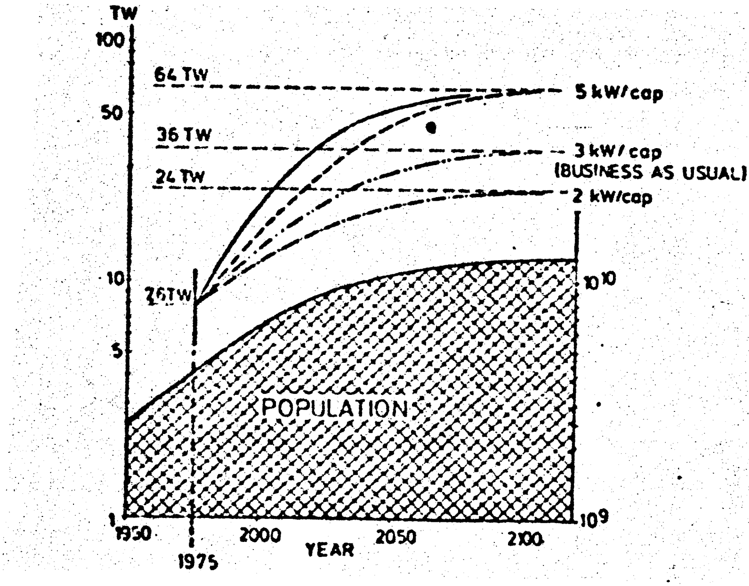


FIGURE 2.—Distribution of per capita energy consumption in 1971. After: Charpentier, IIASA.

COMPARING GOALS AND IMPACTS OF DIFFERENT WORLD ECONOMIC ORDERS

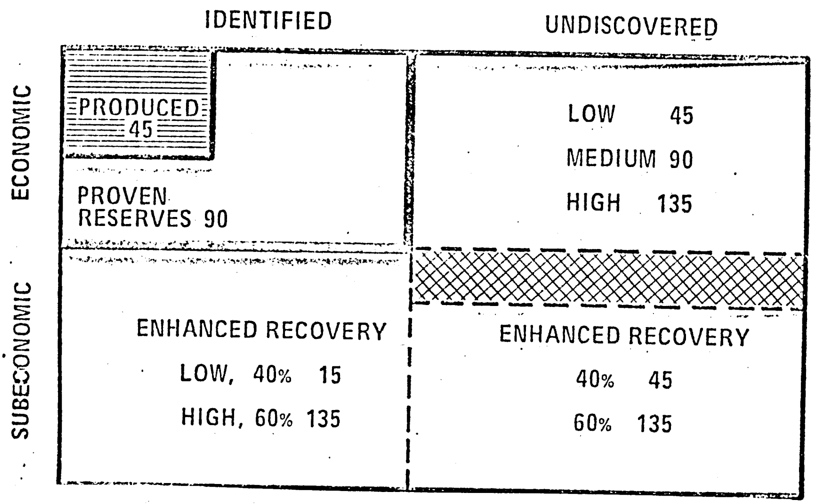
	SHARE IN WORLD GDP (%)			ECONOMIC GROWTH RATE (%/a)	
	1970	2000			
		IDS	NEO	IDS	NEO
DEVELOPED COUNTRIES	85	82	72	4.7	4.3
DEVELOPING COUNTRIES	15	18	28	5.4	7.0
W O R L D				4.6	4.6

After W. Leontief et al., 1976



Source: [2].

POSSIBLE TARGETS FOR THE OIL RESOURCE MODEL (10^9 t).



RENEWABLE ENERGY SOURCES

	GLOBAL TECHNICAL POTENTIAL TW*	TECHNOLOGICAL MATURITY	SYSTEMS EFFECTS
HYDROPOWER (GREENLAND)	2.9 (0.1)	MATURE ECON. POTENTIAL: 1.1 TW NOW UTILIZED: 13%	ECOLOGY, SAFETY
WIND	1-5?	NO BASIC PROBLEM	REGIONAL PLANNING, STORAGE
TIDAL POWER	0.04	240 MWe INSTALLED	?
WAVE POWER	1 per 35,000 km	TO BE DEVELOPED	?
OCEAN THERMAL GRADIENT	70? 0.35°	TO BE DEVELOPED	CLIMATE, ECOLOGY?
COMPARE: ENERGY CONSERVATION ≈ 1 TW			

*1 TW = 1 TW · a/a °Within 10 km from coastline

Options for "unlimited energy supply".

	Reserves TWa	Technological Maturity	Side Effects
Coal	$7 \cdot 10^3$	Mature at present scale To be developed for large scale	Unfavorable working conditions Land requirements CO_2 waste & other pollution
Fission (Breeder)	$\approx 2 \cdot 10^8$	Sufficient for power plants Not yet sufficient for large Scale fuel cycle	Storage of fission products Emission of radio nuclides
Solar		To be developed for large scale	Land & materials requirements Climatic disturbance? Storage & transportation
Fusion (D-T)	$\approx 4 \cdot 10^8$	To be developed	Storage of activated material Emission of radio nuclides
Geothermal	$2 \cdot 10^5$ (???)	To be developed	Storage of waste? Emission of pollutants? Earthquakes?

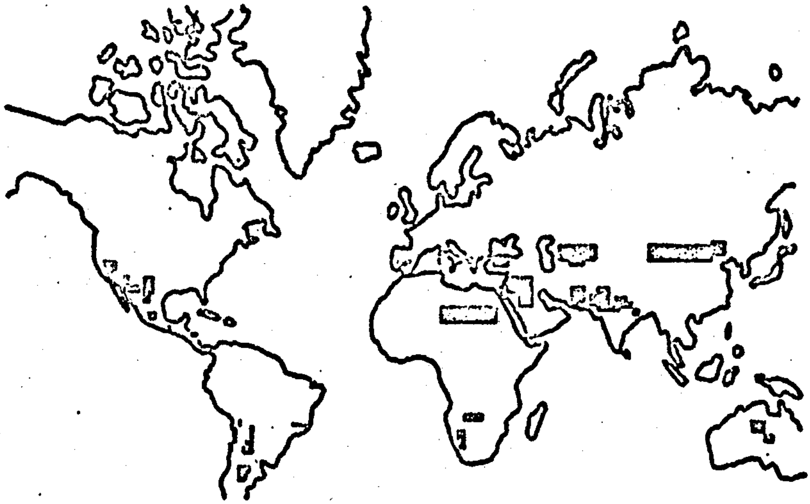
LAND DEMAND FOR SOLAR ENERGY SUPPLY OF 1 GW(e) AVERAGE POWER

SYSTEM EFFICIENCY		INSOLATION (kWh/m^2 day) 3	4	5
0.1	area (km^2)	80	60	48
0.2		40	30	24

ENERGY STORAGE IN ELECTRIC GRIDS

GRID	TOTAL GENERATION	STORAGE CAPACITY (HYDROPOWER) TWh	%
ELECTRICITÉ DE FRANCE	180	12	6.7
BRATSK-ILIMSK, SIBERIA	135	30	22
AUSTRIA	34	2	6

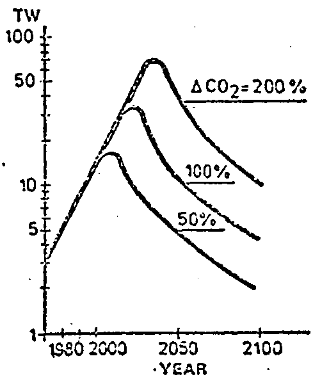
100 TW Solar Energy Scenario



D. Davidson, D. Grether, und J. Weingart, 1977

NECESSARY CONTROL OF FOSSIL ENERGY CONSUMPTION, IF SUPPLIED IN THE FORM OF COAL, TO STAY BELOW CERTAIN CO_2 LEVELS IN THE TROPOSPHERE

After: W.D. Nordhaus, IIASA



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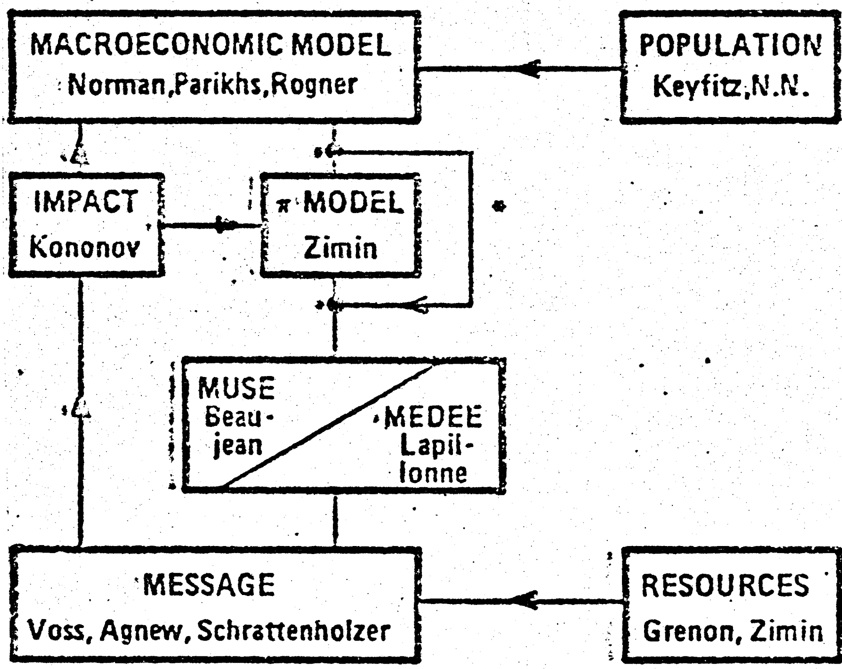
WORLD ENERGY DEMAND AND SUPPLY

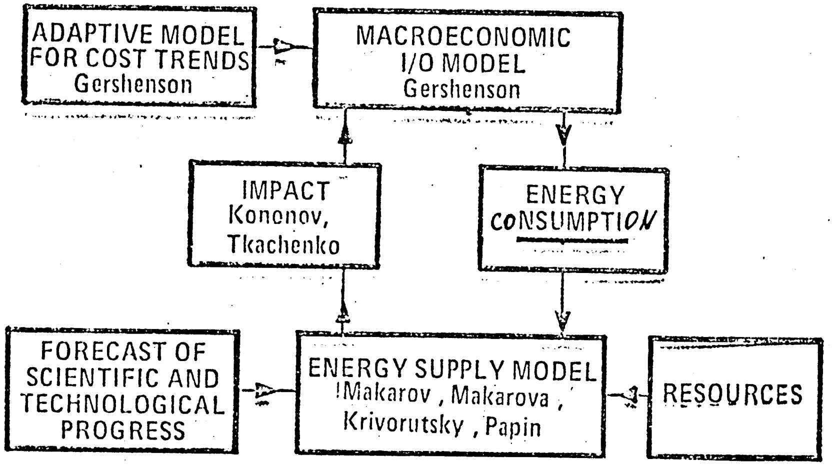
		UNTIL 2025 (TWY)		RESERVES/RESOURCES (TWY)		
		LOW	HIGH	OIL	GAS	COAL 10 / 50%
I	NORTH AMERICA	177.5	177.5	38.5	37	260 / 1228
II	USSR + EAST. EUROPE	152.0	152.0	78.4	73	527 / 2709
III	WEST. EUROPE JAPAN	229.4	229.4	15.3	12.4	41.2 / 205.8
IV	LATIN AMERICA	63.8	80.6	71	58	27.9 / 139.4
V	AFRICA EAST ASIA	107.9	138.0			
VI	O P E C	24.0	30.1	106	46.5	-
	TOTAL	754.6	807.6			
	CHINA	204.8	262.4			
	W O R L D	959.4	1070.0	310	227	857 / 4282

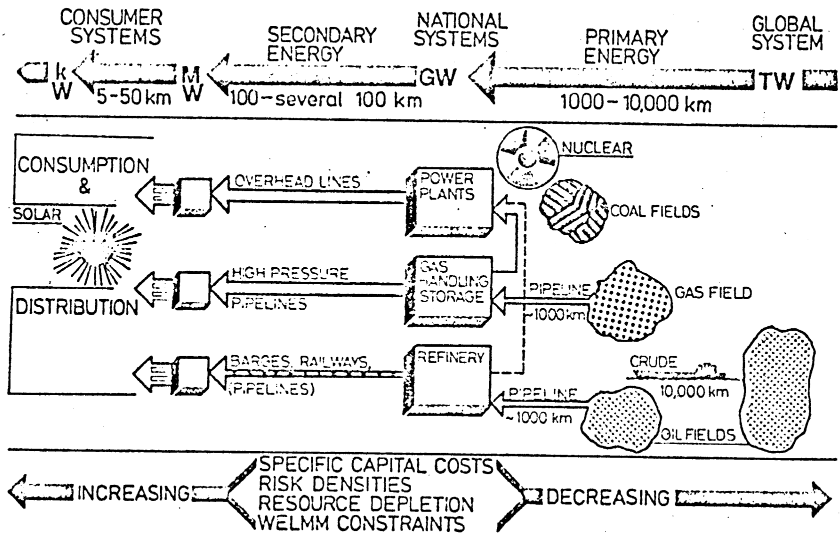
IIASA's MODELS OF ENERGY STRATEGIES



*present shortcut

SPI's MODELS OF ENERGY STRATEGIES





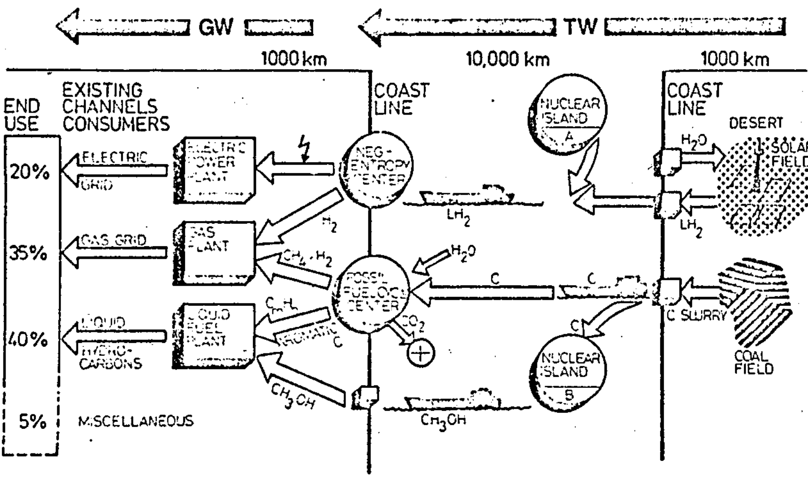


Figure 16.—Opinions for structuring a global energy system.

Dr. Haefele. We looked into that in great detail and the present message is that this is the mode of development in the developing countries. The developing countries are not developing evenly. They are developing through urbanization and you have to distinguish between the agricultural sector of developing countries on the one hand and the other developing parts. They are developing heterogeneously, not smoothly all at once. They are building centers of development, and in their case these are the cities.

In case of Pakistan you have the city Karachi where all the industry is aggregated, a similar situation to other countries. There we studied the characteristics—for instance the power consumption in watts per square meter. The watts per square meter in Karachi are very much the same as in Hanover in Germany. Now there is more data and more evidence that we can give, but the message is that the mode of evolution in the developing countries follows the same characteristics as ours. That means a similar ratio of electricity to gas to liquids. The situation is different in the agricultural areas, where say biogas or wind can take over for a while, but only to maintain and ease the present situation—not to support their evolution into a prosperous society.

Mr. Myers. The point I'm trying to get at is this: A large portion of the industrialized world is dependent upon oil and natural gas. I agree that replacing the end use capital investment would take a long period of time even if you wanted to do that, but I question whether or not the form in which they consume energy is necessarily the best way to consume the energy. If it isn't I would guess that the developing world might want to make a conversion before they make the original investment. Maybe they are constrained by what's in the market place available to them right now. But would you expect the developing world especially in urban areas to lay pipelines for gas distribution when in fact, they may instead of doing that just lay larger cables for complete electrification?

Dr. HAEFELE. Complete electrification is more capital intensive, and capital availability is the driving factor, so we look for the least capital investment. For that we do have our Message model to study these equilibriums but according to our present level of knowledge, it will be very close to what we have. I don't think that total electrification is cheaper or easier for them, though I do think they will live on liquid secondary energy carriers like gasoline or methanol, partly. They will live on electricity to some extent and on gas with secondary energy carriers as the third possibility.

Mr. MYERS. What does that do to CO_2 build up?

Dr. HAEFELE. I did mention the CO_2 build up and it now depends on what view you take. It may well be, and maybe Dr. Williams could elaborate on that for a minute, that the CO_2 problem for fossil fuels comes out to be by far more serious than those of a nuclear base. Before ringing the alarm bell we would like to study that further to convince ourselves more.

But in the last 2 to 3 years the concern has risen tremendously and this in turn indeed would limit the consumption of fossil fuels. In that case, you shouldn't ship methanol but ammonia—that means a carbon-free secondary energy carrier. Here the choices are reassuring. If you don't want ammonia take hydrazine or there are many other liquid secondary energy carriers that are carbon-free. That means even if the CO_2 thing comes out to be so serious as some of us expect, you are not driven into a dead-end road. There are technological possibilities to escape that, although the transition is more severe in that case because then the local infrastructure has to be changed as well, and it will be even more capital intensive.

Mr. MYERS. That is the point I was trying to get at.

Mr. SCHEUER. Are those other secondary energy sources renewable?

Dr. HAEFELE. No, you have to produce them artifically by either solar or nuclear power, probably a combination of these. You will be lucky if you combine all the possible sources and you just make it.

Dr. LEVIEN. But they can be generated ad infinitum. They don't have any inherent limitation to the amount.

Dr. HAEFELE. Yes, you can produce them indefinitely. I think the cleanest case logically and environmentally is hydrogen. When you burn hydrogen you get water, so that is the cleanest and perhaps the asymoptotic situation—where the secondary energy carrier is hydogen. Splitting the water could be done in concentrated places under the conditions that you determine. What you enjoy, then, in the infrastructure in the cities is hydrogen. That would be the long-range perspective, indeed.

Mr. MYERS. The chemical process of solidifying hydrogen for safe use, I guess is a chemical-bonding process. What pollutants do you expect from that process, or are they insignificant?

Dr. HAEFELE. Compared with what we suffer from today it is significant. These are the NOX's that you have to expect.

Mr. MYERS. You don't think NOX is a problem?

Dr. HAEFELE. Not at the present scale and for quite some time. Should you run in 50 or 60 or 80 years from now into a situation where that becomes intolerable for one reason or the other, you still have the possibility to burn hydrogen with oxygen directly in a stoichiometric formula and then there is no impact whatsoever in it.

So, the impact of burning hydrogen goes along only when you burn it in air. When you burn it with a oxygen partner, which is of course more expensive, but it is technically readily feasible, then there is no impact whatsoever, after all there are rockets that do it. I'm not advertising this particular step for tommorow, I'm very much concerned that our project doesn't promise you everything with technologies of the day after tomorrow. Instead we would be concentrating on technologies that are essentially available and still provide us with the possibility to make the transition.

Dr. KRAMER. Are there any feasible technologies at this point that would take carbon dioxide out of the air and use it to create a secondary energy carrier? That way you could recycle the CO_2 through the atmosphere.

Dr. HAEFELE. We looked into that. Specifically Dr. Marchetti of our team is doing that. It comes into the picture at energy costs roughly 4 times as high as today. That means at $40 a barrel you can consider even that. It's a question of capital cost in particular. The order of magnitude is by a factor of 4 such processes become feasible.

Mr. HAMMERSCHMIDT. What do you envision the energy cost in this system as it would be delivered as compared to today's cost.

Dr. HAEFELE. A factor of two higher. All this flies at $25 per barrel.

Mr. MYERS. In your analysis, have you ever given any consideration to the energy expenditure we need to make just to develop the energy facilities in the future?

Dr. HAEFELE. There have been quite a number of people who have looked into that. The situation is essentially like this. When you consider a power plant with a 30 year lifetime, in the past energy investment was worth a month or so of power operation of that plant. With the new technologies and specifically enrichment of uranium, that means the separative work requirements, the equivalent to make up for the energy investment in on the order of one year, one and a half year, out of 30 years. That means the energy amplification factor has remained between 10 and 20.

Mr. MYERS. A slightly different slant on it is what load do you put against the present energy producing facilities to produce sufficient energy, to produce the steel, to produce the cement and everything to employ the new energy source?

Dr. HAEFELE. That is being studied specifically here by Dr. Kononov as part of our modeling effort. There the question is whether we run into limitation by that as compared to the question of capital availability. In all the computer runs that we had so far the real limits are rather manpower and capital but not the availability of the energy and material investments.

Mr. MYERS. You've also in that assumed a continuing increase of standard of living associated with the production of energy in current facilities.

Dr. HAEFELE. Yes, we do that with this model. If you are asking what's the message from the computer runs that we had so far, then it is that we have to increase the share of investments. In the U.S. we have a total investment rate of 14 percent or so at present. Our calculations indicate that you have to envision 17, 18 percent investments instead at the expense of consumption. That is the order of magnitude that one has to envision to master these transitions.

The United Nations Industrial Development Organization (UNIDO)

Date of visit: May 28, 1977.
Location of visit: Vienna, Austria.

HIGHLIGHTS

UNIDO would like to serve as the broker between developing countries and industries in developed countries.

Changes in tax structure and fiscal and monetary policies are required in the structure of developing countries in order to spread the benefits of development.

REPORT

As its name implies, UNIDO's objective is to further the industrial development of less developed countries. Because of the Committee's interest in international technology transfer, the Committee is concerned with UNIDO.

Needs

Mr. Gouri sees two particular needs in developing countries to enable industrial development: (1) training of potential workers, and (2) building of an institutional structure to use technologies.

Problems

1. Technology transplantation (transfer without alteration) is not always appropriate. Neither the giver nor the receiver is necessarily at fault; the process just doesn't work well. The trick is to transfer technologies that are appropriate to conditions in the receiving country. Just giving money will not accomplish this.
2. It is difficult to provide incentives to industries in developed countries. Most companies do not want to take time to work on technology transfer unless there is something in it for them.
3. UNIDO's concerns are with industry, but its direct links are with governments, many of which are not much committed to UNIDO's purposes. A better mechanism for involving industry is needed.
4. Better and more appropriate technology is needed for resource development. For example: (1) paper technology is based on soft wood; developing conutries have hardwoods; it would be helpful to have a method of making paper from hardwoods, (2) developing countries often have no coal but are able to produce charcoal; a method of using charocal in steelmaking would be useful, (3) a better way to make biogas is needed, (4) an improved design for simple kilns for firing bricks is needed.

UNIDO activities

1. UNIDO is building a framework now for working as a broker between developing countries and industries in developed countries.

The idea is to know which industries are doing what and to match them with needs in particular countries. UNIDO would like to have an in-house capability for assessing the potential of such matches.

2. A program has been submitted to the UNIDO board proposing about 40 ideas for projects. It includes, for example, development of jojoba farming (the jojoba plant produces an oil like whale oil) and development of the uses of palm oil.

Questions

Mr. SCHEUER. Population growth has a tremendous effect on development. Population growth must be reduced in order to raise per capita consumption. What is UNIDO doing about population?

Mr. GOURI. There are two approaches to the population problem. One is to curb population growth, but this often involves religious and social problems. The other is to accelerate development. It would be helpful in this regard if the benefits of development could be more evenly distributed. Frequently the benefits of development are captured by those who are already rich.

Mr. SCHEUER. What changes in the social structure of developing countries are needed to spread the benefits of development?

Mr. GOURI. Tax structure and fiscal and monetary policies should be changed. This is hard to do because the wealthy often control these things. Where governments are elected it is the wealthy who support the candidates. New approaches are needed. Cost-benefit analyses based on money, especially, break dow in rural areas.

Documents requested

Program plan submitted to UNIDO board.

Westfield Gasification Facility

Date of visit: May 30, 1977.

Location of visit: Westfield, Scotland—British Gas Test Site for Medium High Btu Gasification.

HIGHLIGHTS

The Westfield facility is developing one of the two finalist technologies which will be used in the first U.S. coal gasification demonstration plant.

The plant, once a commercial "town gas" facility, has been converted to the largest coal gasification research facility in the world.

The Westfield facility is now undergoing modifications to run the first large scale tests of American slagging coals in coal gasifiers.

The Westfield facility has recently successfully completed tests on the crucial methanation step, which is necessary to raise the quality of coal gas to the standards of the U.S. market.

REPORT

The Westfield Center was one of two Lurgi coal gasification plants (low and medium Btu) operated in Britain for town gas production for approximately 14 years. The plant operated until 1974 when the surrounding area was converted to natural gas. In 1974 the site was refurbished as a development center for coal gasification techniques and an agreement concluded with British Gas and 14 North American sponsors to operate one of the four Lurgi gasifiers as a slagging bed gasifier.

THE WESTFIELD PLANT TODAY

The present Westfield plant contains three full size Lurgi gasifiers which are not operating but maintained in a state of readiness, and one experimental slagging gasifier. The Lurgi gasifiers are based on the process developed in the 30's by Lurgi for high pressure gasification of coal.

At the present time the plant is undergoing refurbishment to begin new operations for the first phase of an ERDA sponsored project with the Continental Coal Development Company which is commonly referred to as a "Technical Support Program." The plant has been riding on a previous AGA contract and completed operations in March of this year. The new contract was announced when the Committee was in Scotland.

The technical work that is being done for the new support program will lead to the detailed design for a 60,000 mcf per day demonstration plant which would utilize the slagging gasifier on caking coals. In the past the gasifiers have only worked on brown coal and/or noncaking coals which are common in the eastern United States.

The Westfield project underscores the advantage which exists for the experiment or testing of various coals in different modes since the equipment is in place. The transport of U.S. coals in sufficient quantities to develop reliable data is expensive, however, as is the alteration of the Lurgi gasifiers to accept the American caking coals.

Lurgi itself has had personnel working in Scotland since few Lurgi gasifiers are actually being operated and none, except in Westfield, on an experimental basis. Lurgi has actually offered to purchase the gasifiers, but British gas claims it is not interested in selling them.

The procedure of cutting the gasifier in two, removing it to fabricate new inlet ports, and then welding it back together with a modified stirrer mechanism seems rather primitive. Although the persons who briefed the Committee seemed highly confident, the degree of back-up data and process engineering for the decision on the specific design appeared to be very sketchy.

Companies which have been involved in the fixed bed slagging gasifier program are:

Cities Service Gas Co./Northern Natural Gas Co.
Continental Oil Co.
El Paso Natural Gas Co.
Gulf Energy and Minerals Co.
Michigan Wisconsin Pipe Line Co.
Natural Gas Pipeline Co.
Panhandle Eastern Pipe Line Co.
Standard Oil of Indiana.
Southern Natural Gas Co.
Sun Oil Co.
Texas Eastern Transmission Corp.
Tennessee Gas Pipeline Co.
TransCanada Pipelines.
Transcontinental Gas Pipe Line Corp.

Companies involved in the Methanation Demonstration Program which has been completed were:

Amax Coal Co.
Cities Service Gas Co.
Colorado Interstate Gas Co.
Columbia Gas Transmission Corp.
Continental Oil Co.
El Paso Natural Gas Co.
Exxon Corp.
Gulf Oil Corp.
Natural Gas Pipeline Co.
Northern Natural Gas Co.
Pacific Coal Gasification Co.
Panhandle Eastern Pipe Line Co.
Peabody Coal Co.
Rocky Mountain Energy Co.
Transcontinental Gas Pipe Line Corp.
Transwestern Coal Gasification Co.

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Phénix Liquid Metal Fast Breeder Reactor and Nuclear Waste Management

Name of institution: French Nuclear Industrial Center.
Date of visit: May 31.
Location of visit: Marcoule.

HIGHLIGHTS

French technical people are extremely confident about the progress of breeder technology and feel that none of the problems encountered in Phénix operation are unsurmountable.

French engineers would not admit to having certain technical problems (e.g. pump vibration) which ERDA international programs group had mentioned in pre-trip briefing.

French don't expect any surprises with component behavior in scaling up from Phénix, 300 Mw electric, to Super Phénix, 1200 Mw electric, even though steam generators are major departures from Phénix design.

Although Phénix has not operated since October 1976, it is apparent that the French took the shutdown opportunity to evaluate the condition of all parts of the system after nearly 3 years of operation. This does not seem unusual for a technology demonstration plant such as Phénix.

In calculating the plant factor, the French do not include planned 2 weeks shutdown (every 3 mos.) so their number for running Phénix (.82 or so) is larger than the ERDA-supplied numbers (.62–.64).

REPORT

The Science and Technology group was briefed on the history of Phénix construction and operation experience to date. The group then toured the facility which has been down for repairs and maintenance since October 1976. Reactor operation will resume in July. The most recent problem was a material failure in the secondary sodium loop near the secondary pump. The previous major problem was in the intermediate heat exchanger which provides for heat transfer between the primary and secondary sodium loops. The group visited the reactor building and control room but since the reactor was down, there was little to learn. Certain members of the group had an opportunity to see a cut-away of the Phénix fuel rod which has the sodium tube wound helically about the fuel element.

The French did not admit to experiencing any pump vibration problem with primary or secondary pumps although ERDA had indicated they had such a problem.

The Marcoule group has presented results of their Phénix safety program at an international meeting. The exposure of personnel has been well below the recommended limits and in agreement with predicted levels.

phénix fast neutron reactor

Phénix is located just north of the Marcoule establishment. The site was opened in December 1968, and the plant was put on load in 1974.

Phénix is a prototype power reactor associated with a standard turbo-alternator rated for 250 MWe. The reactor itself is a sodium-cooled, fast neutron breeder. It represents an intermediary phase of development between the Rapsodie experiment, and the future large power reactor of this concept. Rapsodie was the first demonstration of breeder reactor theory and technology, particularly with regard to fuel and sodium coolant.

Phénix is operated by a combined C.E.A.-E.D.F.* staff. The highly satisfactory operation of this reactor, since the day it was commissioned, has encouraged the launching of a 1,200 MWe commercial reactor project, baptized "Super-Phénix".

Fast neutron breeder reactors like Phénix, have a small core, and do not employ a moderator.

They use a rich fuel, basically either plutonium 239 or (possibly) enriched uranium. The chain reaction is sustained without any need of moderating the neutrons, which are very abundant, a high proportion of the mass of nuclei being fissile.

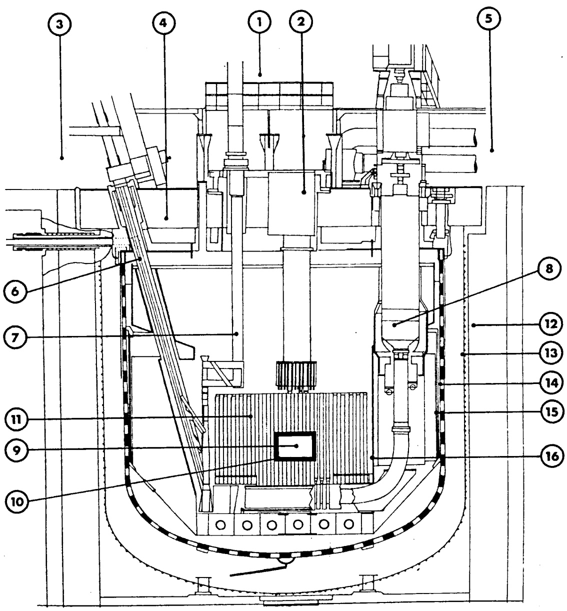
Natural or depleted uranium (1) elements are arranged around the core, to form a fertile (2) "blanket". Neutrons from the core are captured by the uranium 238 nuclei of this blanket,

*French Electricity Authority.

(1) This is uranium of which the isotope 235 content has been depleted. It comes either from spent fuel reprocessing plants, or from isotope separation facilities.
(2) Plutonium producing.

Vertical cross-section of Phenix

1 Reactor building working floor
2 Rotary plug
3 Air-lock
4 Slab
5 Loft
6 Fuel ramp
7 Transfer arm
8 Pump
9 Fissile core
10 Fertile blanket
11 Neutron shield
12 Lateral biological shield
13 Primary containment
14 Double-wall containment
15 Main tank
16 Core tank



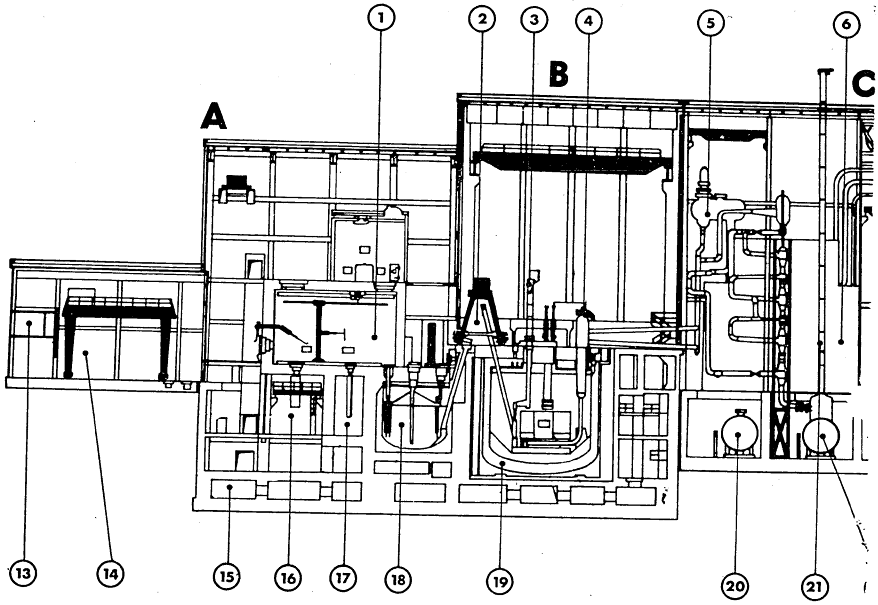
which therefore become plutonium 239. Of the 2.9 neutrons emitted at each fission, one on the average sustains the chain reaction, and a little more than one produces plutonium as outlined above.

Thus, a breeder reactor produces more fuel than it consumes, while generating power.

To remove all the thermal power generated (as much as 1 MW per liter of core volume), a highly efficient "coolant" is used; a liquid metal, sodium. This liquid metal possesses quite remarkable characteristics with regard to neutron flux and heat. In particular, its very high boiling point, 883°C, makes extremely high operating temperatures feasible, without having to pressurize the coolant to prevent its ebulition.

This is at the basis of the very high efficiency (ratio of output to input) of fast neutron reactor power stations, which is 42 % (net), in the case of Phénix.

Moreover, fast neutron reactors are capable of a 50 times greater efficiency in the extraction of the energy potential of natural uranium, and are thus unique in this respect, at present.



the reactor

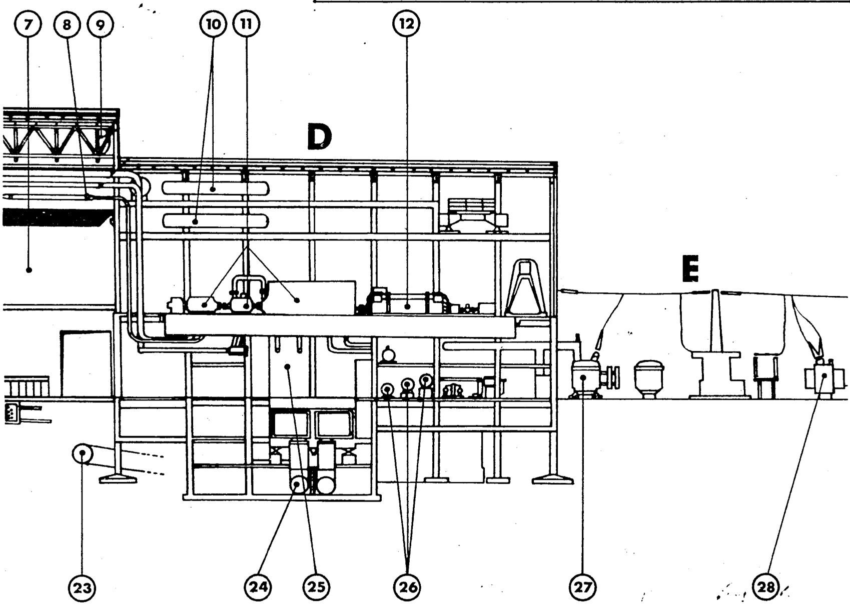
Phénix is of the "integrated" design, which means that the core, primary sodium pumps, and intermediary heat exchangers are all housed within a common, outer containment.

The core itself consists of fissile, blanket,and neutron protection elements.

Longitudinal cross-section of Phenix

A **Handling section**
B **Reactor building**
C **Steam generator building**
D **Turbo-alternator room**
E **Switchyard**

1 Spent fuel hotcell
2 Handling air lock
3 Transfer arm
4 Primary sodium pump
5 Secondary sodium pump
6 Steam generators
7 Steam generator module dismantling zone
8 Steam collectors
9 Buffer tank
10 HP reheaters
11 Turbines
12 Alternator
13 Offices
14 Store
15 Buffer space
16 Lead castle exit
17 Spent fuel washing room
18 Storage drum
19 Reactor block
20 Secondary sodium tank
21 Dump tank
22 H/Na separator
23 Water circuit return line
24 Water circuit supply lines
25 Condenser
26 LP reheaters
27 Bus transformer
28 Tapping transformer



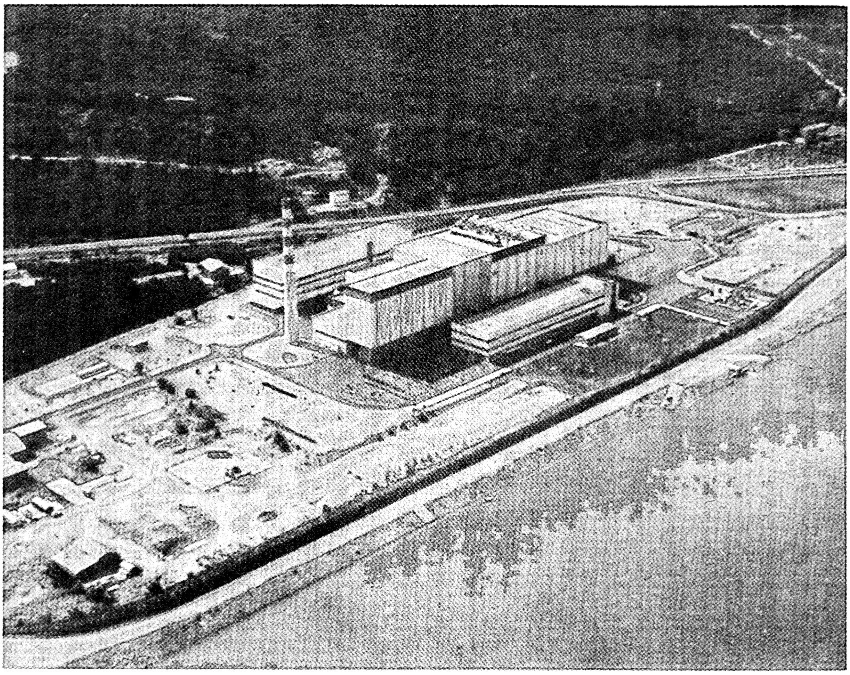
• The core is contained in a "primary", central tank;
• A double-wall vessel contains the primary sodium circuit and primary core tank;
• An outer containment encloses the first two vessels.

Considered as a unit, the above constitutes the "reactor block".

Mixed UO_2-PuO_2 is the fissile fuel, used to a burnup of at least 50 000 MW days/tonne, and the fertile blanket elements are of natural or depleted uranium oxide. It is to be noted that the core volume is no more than 1200 cubic decimeters, for 563 MW thermal power.

6 control rods regulate the chain reaction in the core.

Phénix.



The Pilot Plant Department is a research unit attached to the Chemistry Division of the C.E.A., and situated at Marcoule. It is mainly active in two special fields:

- spent fuel processing;
- solidification of fission products.

spent fuel processing pilot

This pilot plant is designed for study at the semi-industrial level of spent fuel processing problems encountered by the C.E.A., and is equipped with two independent processing lines:

- a line for the processing of natural uranium-based fuel, of a capacity of 50 kg per day, and which is used in research on behalf of the plants at Marcoule and La Hague, concerning either the fuel itself or the development of facilities;

- a line for the processing of oxide fuels, of a capacity of 10 kg per day of fissile material. The geometry of this line is sub-critical throughout.

Despite their size and complexity, both pilot processing lines are capable of modification to suit changing research requirements.

Thanks to its flexibility, the pilot can be used in a wide range of radioactive chemistry studies of an industrial nature, and likely to obtain valuable information in both chemistry and technology.

The pilot is also used in special systematic reprocessing.

hotcells

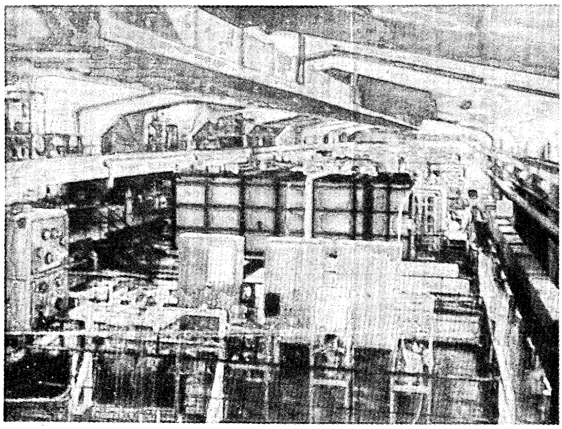
The various stages of the chemical process are contained in 300 m^3 α hotcells of stainless steel, measuring 10 x 3 x 10 metres. High density glass ports and concrete shields afford protection against gamma radiations while operating the remote controlled manipulators (in either maintenance of the equipment in the cells, or its adaptation).

remote handling equipment

This is equipment of an original design.

There are 3 manipulators, ranging in capacity from 10 to 50 kg and each mounted on a remote controlled pillar, which can be driven into each hotcell through communicating "pass-throughs". The front area of each cell floor is clear - for passage of the manipulators - and the process (tanks, columns, filters, valves, etc.) is mounted against the rear wall, all points being both clearly visible and accessible for remote controlled operations. Connection fittings between vessels, in piping, etc., can all be removed and replaced by the manipulators.

Hotcells of the S.F.P. pilot.



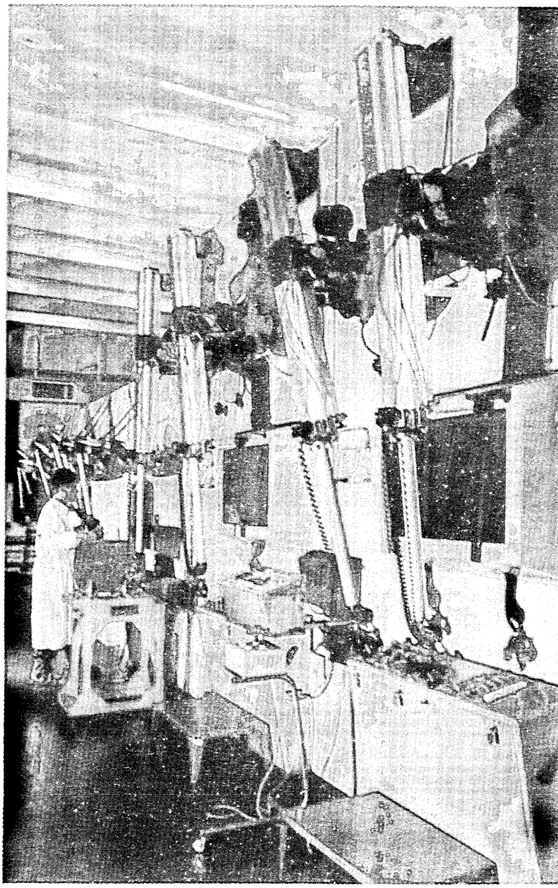
fission product solidification

Started at Saclay in 1957 and continued at Fontenay-aux-Roses in 1962, design-study of the vitrification process has been done at Marcoule since 1968.

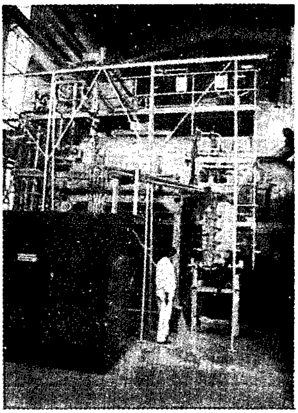
Laboratory study first resulted in the creation of the "active" industrial pilot PIVER, in which solutions containing fission products are mixed with the ingredients of glass-making, and poured with the molten glass (at 1,100 °C) into metal crucibles, in which the solidified mixture is sent to disposal storage. Each melt chamber can be used for a series of pours.

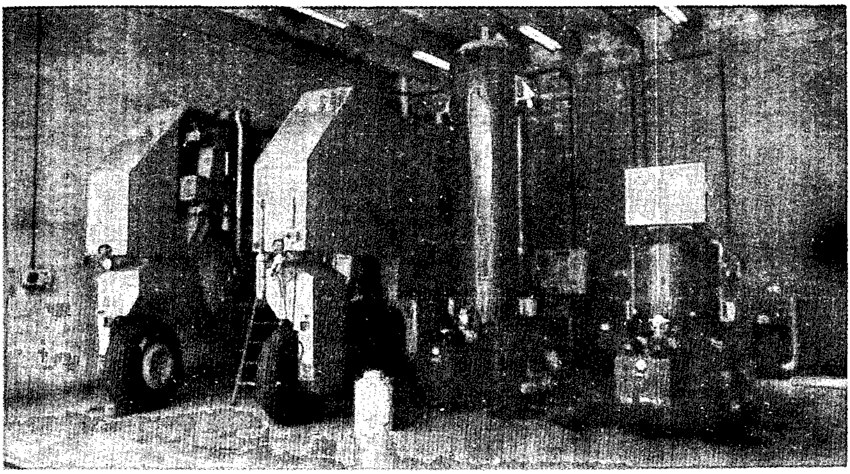
Apart from refining of the process itself, the pilot was used to improve the efficiency of the gas trapping system.

This first process had the demerit of being a "batch process". A new, continuous calcination process has since been developed, as described on page 31, and will be in routine operation by 1977.

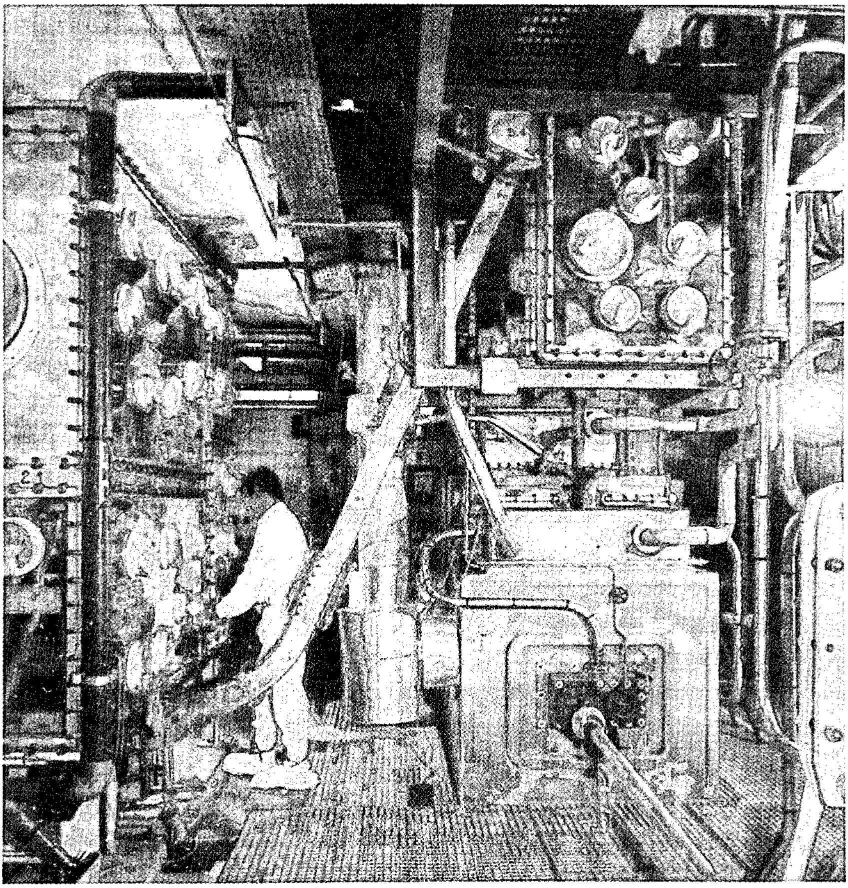


Shielded bank of hotcells for study of radioactive glass properties and long-term behaviour.


Non-radioactive vitrification process.


. Pilot disposal equipment for radioactive glass blocks.

Incinerator for alpha- emitter waste containing plutonium.



The tour of the Waste Management activity consisted of seeing vitrification facilities and waste management storage with brief presentations on each. The vitrification process reduces liquid radioactive waste into solid form. The vitrified waste is stored in lead caskets which are sunk in concrete pits to a depth of 10 meters. Cooling air is pumped through the pits to keep the core temperature of the lead caskets below 650 C. The French are building an industrial size plant in Marcoule which will allow for disposal within a few years, of all presently stored liquid waste.

CONTINUOUS PROCESS AVM FACILITY (MARCOULE)

This process associates a rotary roasting furnace at a 3 percent tilt and turning at 30 r.p.m., with a continuous melting furnace.

The processed solution is poured in through the upper funnel with the additives, evaporates in the upper section of the tube, the dry residue roasting in the lower section. The calcinate flows continuously through the lower funnel into the melting furnace, to join the simultaneously introduced vitrifying additives.

Final roasting and vitrification therefore take place in the melting furnace, which has a blocked pouring spout.

Glass pouring is periodic, i.e., at 6 to 8-hour intervals, when the glass accumulated in the furnace is sufficient. Pouring into the disposal container does not involve interruption of the process at the roasting level.

The flow-rate through the industrial AVM roaster unit is at present 40 liters per hour.

Two types of melting furnace are in use, one derived from the pot process uses a refractory metal alloy pot heated by induction, the other, capable of higher glass-making temperatures, employs induction in the charge itself.

Furnace capacity is in both cases about 20 kg glass per hour.

International Energy Agency (IEA)

Location: Paris, France.
Time of visit: June 1, 1977.

HIGHLIGHTS

There could be a deficit of as much as 15 percent in the world oil supply by the year 2000, according to a recent IEA study.

The U.S. policy on fast breeder reprocessing is a serious roadblock to the plans of West Germany to build a reprocessing plant.

REPORT

After the embargo of 1973, the United States and 18 other members of the Organization for Economic Cooperation and Development (OECD), (Australia is not a member of IEA), recognized the need to unite in a coordinated effort to decrease dependence on foreign oil. In order to reduce strategic and economic vulnerability the participating nations decided to set up cooperative R&D programs and to create a system for allocating imports in time of emergency. The percentage allocated is to be based on consumption prior to the cut-off. Although the IEA considers Emergency Questions, it is also concerned with supply projections for fossil fuels, long-term cooperatives in Energy R&D and the status of relations with producer and other consumer countries.

The IEA activities in which ERDA, NBS, U.S. Bureau of Mines, USGS. Department of Interior and EPA have been most involved have been conducted under the Committee on Energy R&D. This Committee is one of five groups which comprise the working structure of IEA. Under the chairmanship of various lead countries 15 working groups are conducting cooperative energy R&D projects. (List attached).

The U.S. has been designated lead country for working groups in the area of conservation, nuclear safety, ocean thermal energy conversion and energy R&D strategy. The basic goal of the IEA is to organize and influence economic policies. Matters of a technical nature in the nuclear area are reserved for the Nuclear Energy Agency. In other areas, the IEA has assisted in the creation of mechanisms for work between countries on coal and solar energy, but prefers not to actually be directly responsible for any hardware development. The Director was of the opinion that the U.S. policy on the fast breeder reprocessing makes it more difficult for West Germany to proceed with its arrangements to build a reprocessing plant. The IEA has recently published a report entitled, "World Energy Outlook" which agrees with most other projections of energy supply. That is, it projects a 3 million barrels per day shortfall in the western world and 3 million barrels per day shortfall in the USSR. In other words, by the year 2000 the demand will be roughly 42 MBD to the supply 36 MBD.

French Atomic Energy Commission

Date of visit: June 1, 1977.
Location of visit: Paris, France.

HIGHLIGHTS

France will adamantly refuse to buy uranium under the condition that they must not reprocess.

France feels that the U.S. decision to stop construction of the breeder in the name of proliferation is contradicted by another decision: to commercialize the gas centrifuge process for enriching uranium.

France has recently developed a new enrichment process which practically eliminates the risk of proliferation.

REPORT

1. Safeguards are working—the community only has power within the community. There has been no cheating. The shipload of uranium which went to Israel was a deception because they said the purchase was not from Italy, but from a non-signor nation.

2. France is in full agreement with President Carter on the necessity of non-proliferation. France has as great an interest as any other country in non-proliferation. No interest in other countries having weapons. The difference in policy is how to handle the case. When it comes to the point of trying to control reprocessing and breeder reactor development in other countries, France feels differently:

(*a*) French energy needs.

(*b*) Not an efficient way to stop proliferation.

President Carter has said he would "try to convince France to do the same." France does not plan to accept, and will never accept natural uranium only on the condition that they do not reprocess. (France receives it under contract up to 1979, and even afterwards, by choice). France imports enriched uranium from the U.S. and U.S.S.R. and will export what it produces to other countries.

In sum, American policy is no reprocessing, no fast breeder. To prevent others from going that route, the sale of natural uranium is to be on condition that there is no reprocessing and no fast breeder.

France views the issue as an international one, lessens investment, encourages cooperation. France will sell to Belgium, Spain, Italy, Iran, West Germany and Switzerland. If U.S. wouldn't sell—do it by itself.

France was not consulted—there was two days notice before the decision was announced. Restricting the supply of enriched uranium unless promise of non-reprocessing—"we fight against that."

Pakistan: France is ready to drop the contract if the Pakistanis decide to do so.

Giraud interprets Carter's policy as being based on the fact of nuclear weapons proliferation (not the common opinion) (others think because U.S. is late with reprocessing and the fast breeder). It is idealistic.

A weakness of the argument is the gas centrifuge. "The easiest way by far to go to an atomic bomb . . ." "the policy makers are not nuclear specialists and did not realize that the highly enriched uranium route is probably more dangerous than the plutonium route."

3. Giraud suggests different modalities: Make nuclear fuel in sufficient quantities so that the U.S. can impose conditions on reprocessing and fast breeders. It will not work because it frees countries like France to do their own reprocessing, prospecting and enrichment.

He noted that as soon as the idea was put forth by Ford last fall, that the U.S. would not reprocess, Iran came to France and said it wanted to build a reprocessing plant.

Enrochemique—a plant built in Belgium by 14 countries, the plan was to scrap the plant—but on the 16th of December 1976 after the Carter amendment, the Belgium government decided to nationalize the plant.

4. The supply of uranium depends on how much money is put in it. But there isn't very much—not equivalent to our oil reserves. Responsible persons and governments should act with the most likely hypothesis: the physical shortage in the 1990's. Most agree except the Ford Mitre study which thinks it will be beyond the year 2000. Why should we use our oil reserves as soon as possible?

5. An inducing system should be used, not a denied system, to promote nonproliferation. Should not export plants or pilot plants using sensitive technologies.

6. Should suppress any good reason for other countries to feel the need for the sensitive technologies. To do that, enrichment services at decent prices must be made available without unacceptable conditions.

7. After a certain time other countries will be unwilling to rely on other countries even if fair. (Under Article 4 of the NPT they do have the right). France has approved a process for enrichment which cannot "in practice allow the manufacturing of highly enriched uranium." This process makes it possible to accept dissemination with appropriate safeguards. The French feel this fits with U.S. philosophy of making fuel available and, on that basis, conversations have been started with the U.S. (takes care of highly enriched uranium for atomic bombs). This was the idea announced at Saltzburg. (Fri and Giraud have talked about this).

8. Other drawbacks to Carter policy: (*a*) Spent fuel shortage is a problem—no one knows how to store it for eternity.

(*b*) Uranium resources are limited in France. After a certain time, the U.S. will become importers. "U.S. needs imports starting now." Uranium imports will become more and more important. There will come a time when they are more importer than producer.

France cannot depend on the cartel of Canada or South Africa. There is only one way of overcoming that—developing the fast breeder: "France, West Germany, Japan, Spain, Great Britain and everybody."

9. Plutonium is difficult—our proposal is going to be to bring spent fuels to reprocessing plants in the U.S., United Kingdom, France, West

Germany, Japan and others. The plutonium would stay there in the shape of a fuel; 17% if fast breeder fuel, or 3% if for recycling—it would be a mixture of oxides. Before letting it out it would be irradiated. The only thing that would circulate would be spent fuel.

10. The Pakistan agreement was negotiated by the U.S. to limit nuclear proliferation—what about the exchange of arms by the U.S. to Pakistan?

Organization for Economic Cooperation and Development

Place: 2 rue André-Pascal, 75775 Paris, Cedex 16, France.
Time: June 1, 1977.

HIGHLIGHTS

The Committee was given an overview of OECD in general and of particular activities in environment, industry, and science policy.

Twenty environmental projects are underway in OECD.

Sixteen of the 24 member countries gave as their highest priority in the environmental field the study of economic instruments that encourage good waste management.

OECD industry policy efforts are modest.

An examination of the shipbuilding industry is underway.

Study of the steel industry is beginning.

Studies of the future structure of industry are in progress.

Science policy studies underway include: how technology plays a role in change in industry, how new technology is spurred by legislation, whether declining industries may be helped by technology, how government policy can affect the setting up of new technologies, and aspects of technology transfer to developing countries.

OECD's principal interest in technology transfer to developing countries is to determine whether such transfer may have backlash effects on OECD countries.

Findings are available on why policy-makers do not use the results of social sciences research.

A comparative evaluation of practices in involving the public with science and technology decisions is in progress.

REPORT

The OECD is an organization of 24 developed countries with free-market economies (including the U.S.) OECD was established in 1961 to replace the organization which had been responsible for administration of the Marshall Plan. Its objectives are to promote policies designed to (a) promote development of the world economy (b) promote economic development of each member country, and (c) expand fair world trade. OECD has about 600 professional employees.

OECD has a ruling council and some 13 "directorates." Three directorates of interest to the Committee on Science and Technology are (i) Energy Policy, (ii) Environment, and (iii) Science, Technology and Industry. In addition, the International Energy Agency is a semi-autonomous arm of OECD.

Each Directorate serves one or more committees of governmental representatives which meet to discuss common problems, examine possible solutions, and develop recommendations for national policies.

OECD is housed in several buildings in Paris, France.

The budget of OECD in 1977 is about $68 million, about $17 million of which is provided by the U.S. through the State Department.

Under the Committee's special oversight function of "reviewing and studying, on a continuing basis, all laws, programs, and Government activities dealing with or involving nonmilitary research and development," the Committee has interests in international technology transfer and international cooperation in science and technology.

OECD has extensive activities in international cooperation in science and technology. Many of these regard subjects for which U.S. activities fall within the Committee's legislative jurisdiction.

The purpose of the visit was to meet OECD personnel working in relevant fields and to learn what OECD is doing in those fields.

The meeting consisted of descriptions of OECD activities given by Dr. Roderick, Mr. Hill, Mr. Bell, and Mr. Ferne. Mr. Scheuer asked questions and made comments.

General information about OECD and discussion of the Environment Directorate

Dr. Roderick

OECD in General—OECD is an economic organization of 24 developed countries with market economies. Russia and other non-market economy countries are not members. The main thrust of OECD activity is to further economic growth of its members. The principal output of OECD is recommendations aimed at getting member countries to behave a certain way. The member countries can follow these recommendations or not. OECD recommendations can stimulate governments to act if the governments are willing. OECD has no police force but does follow up its recommendations, with questions, for example, to see what was done. OECD has a special category of recommendations, known as "decisions," which carry more moral force.

Payments to OECD are based on gross national product, with a ceiling of 25 percent of the total budget to be paid by any one country. The United States provides 25 percent of the total budget.

Mr. Scheuer. How do you make your findings known to the world?

OECD publishes its reports. Some are given away to those who ask, some are sold. In general the distribution system is poor. OECD is well-known in small member countries but not in the United States. Reports may not be made publicly available until they are de-restricted by the OECD council, which may take months.

OECD Environment work—Environment efforts are supplementary to OECD's principal objective of economic growth. The question of how environmental factors fit into economic growth is addressed. The Environment Directorate's annual budget is about $1 million. During 1976 the Directorate published 19,000 pages of reports. The output of the Directorate is summarized in "OECD and the Environment" which gives about 20 recommendations in areas such as noise, mercury emissions and the "polluter pays" principle (each industry rather than taxpayers should pay for cleaning up the pollution it creates; the cost is passed on to the consumer; this gives industry incentive to stay clean which is not present if the taxpayer pays).

An example of OECD action and problems with having its recommendations implemented: Three years ago OECD had a decision that polychlorinated biphenyls (PCB) should be used only in closed systems. EPA was unaware of the decision three years later. When the toxic chemicals act was passed, the United States began to clamp down on PCB use.

Mr. SCHEUER. Do countries outside OECD (eastern bloc countries and less developed countries) frustrate OECD environmental efforts by ignoring them?

In general, no. The winds blow from west to east. There are no evident effects from LDC's pollution, but some Russian pollution blows into Scandanavia. There are indications that acid rain from SOx pollution may be a worldwide problem.

Currently 20 environmental projects are underway in the broad areas of: energy and the environment, cities and the environment and industry and the enviroment. Studies cover SOx, NOx, and automobile emission, for example.

A recent study in waste disposal showed that if a bottle is reused five times, it is advantageous in every way.

Sixteen countries of the 24 members gave as their highest priority in the environment field the study of economic instruments that would encourage good waste disposal or recycling.

Discussion of the work of the Industry Division

Mr. Hill

The OECD effort in industry policy is modest. There is difficulty in finding a common definition of industry policy because various governments go to different lengths in the control of industry. Japan and France go rather far, for example. A second difficulty is in distinguishing between industry policies and broad economic or trade policies. The latter have an impact on industry but are handled by other parts of OECD.

The Industry Division serves two bodies: The Industry Committee and a special shipbuilding Working Party.

The Industry committee is looking at short-term issues, for example, how can industrial policy help labor policy in solving structural unemployment.

Mr. SCHEUER. In the United States the structurally unemployed are blacks, Chicanos, Puerto Ricans, and the poor. Is the problem similar in Europe with "guest-workers" and the like?

In Europe an additional group, the older workers, is affected, especially those who are not mobile.

The Industry Division may look at particular sectors of industry, shipbuilding for example, where there is a problem of overcapacity. At the request of the United States delegation the Division is starting a look at the steel industry's international problems.

A project is underway on the future structure of industries. A look at 1980 is being completed, and 1985 will be examined next. There may be areas of overdevelopment which create trade problems. In other areas (food manufacturing, for instance) development may be insufficient.

Finally, the Division may look at a broad set of policy measures. A comparative analysis of the regional development policies of various countries is underway with the objective of helping Portugal with its development.

Discussion of work in Science Policy

Mr. Bell

There has been evolution in the principal focus of OECD's science policy efforts. In the beginning the objective was to further the use of science and technology for growth. European countries were concerned with the technology gap between the United States and Europe. By the early 1970's there was change to concern with the style and type of growth. That trend did not last long. In 1973 or 1974 the energy and economic crises turned interest back to growth. Current interests are in (a) how to handle these crises, (b) the new economic equilibrium between developed countries and developing countries, and (c) how to handle trade with eastern countries.

Studies underway concern:

How technology plays a role in change in industry.

How new technology is spurred by legislation.

Whether declining industries (e.g. shoemaking) may be helped by technology.

How government policy can affect the setting up of new technologies; and

Aspects of technology transfer to developing countries (for example, what challenges to OECD countries will technology transfer induce?) The results of this study are due in fall of 1978.

Mr. Scheuer. What is the mission of OECD with respect to developing countries? Does it include technology transfer?

It does not include promotion of technology transfer, but rather an examination of whether technology transfer may have backlash effects on the economies of OECD countries.

Mr. Scheuer. What are international groups doing to look at the relation between population and economic development, environment, non-renewable resources, and energy?

The most recent study was done by Leontieff for the U.N. It was available in draft form in fall 1976. It is probably in the publishing process now. The model assumes that as people get wealthier they will want fewer children.

Mr. Scheuer. This is a dangerous assumption. Sometimes it happens, sometimes not. Mexico is an example. Mexico has had success in death-reducing programs but not in birth reduction, so its growth rate is the highest in the world. There are three stages in population development: (1) high birth rate and high death rate, (2) since it is easier to get the death rate down, death rates go down but not birth rates, (3) through the effects of industrialization, education of women, getting men into the money economy, and urbanization, birth rates go down. Getting from stage (2) to stage (3) is difficult. Acceptable birth control methods are needed.

Discussion of social sciences in Science Policy

Mr. Ferne

The social science activities of the Science Policy Division have two main thrusts: The economic dimension of science policy and the social dimension of science policy. Along the first of these thrusts a study re-examining the effects of old policies and gathering new information has just begun. This study will examine, for instance: the effect of technology on unemployment, the relation between technological development and inflation, and the relation between research and technological development.

In the social dimension of science policy an examination of why the results of social science research are not taken into account by policymakers has been completed and a report is available. Future studies will focus on more instrumental aspects such as evaluation research and policy sciences (where there is hope that social sciences can be fed directly into decision-making).

A project in progress, started about a year and a half ago, examines public involvement with science and technology decisions. The focus is: how do various governments explain decisions to the public and involve the public in decision-making? In Europe the main area of study is nuclear power decisions.

DOCUMENTS REQUESTED OR MADE AVAILABLE

1. "OECD and the Environment"—received.
2. Study which showed that reusing bottles is advantageous—requested.
3. List of U.S. experts used by Mr. Bell—requested.
4. Leontieff study taking population growth into account—requested.
5. OECD "interfuture" group's analysis of long term models—requested.
6. Studies of why social science research results are ignored by policymakers—requested.

UNESCO

Date of visit: June 1, 1977.

Location of visit: U.S. Mission to UNESCO, 1 Rue Miollis, Paris 15^{e}, France; and UNESCO Headquarters, Place de Fontenoy, Paris 7^{e}, France.

HIGHLIGHTS

UNESCO spends $5 million annually for population control education.

UNESCO has regional staffs for introducing population education, which help with curriculum preparation.

UNESCO believes technology transfer must be part of an integrated development program.

UNESCO assists in the establishment of national science and technology information and documentation centers.

The U.N. Conference on Science and Technology scheduled for 1979 will need much work to be useful.

UNESCO plans to assist in preparations for the Conference by helping countries formulate their national statements.

Political problems in UNESCO with respect to Israel appear to be past, but freedom of the press and scientific freedom will require vigilance.

The U.N. plans a conference on desertification in March 1978.

REPORT

UNESCO is one of about 14 specialized agencies of the United Nations. Its activities are very broad, but current emphasis is on education, science, and technology as factors for development. UNESCO was established in 1946 and has over 120 member countries.

UNESCO is governed by a biennial general conference and an executive Board. Operations are managed by a Director General. A staff including about 700 professional employees is located at UNESCO headquarters in Paris.

The most recent budget of UNESCO is about $120 million, $30 million of which is to be provided by the U.S. through the State Department. UNESCO has been involved in political controversies regarding (i) Israel and (ii) freedom of the press, and U.S. contributions have been delayed.

POPULATION

Mr. Fobes said he had worked for several years in the 1960's to get a population program into UNESCO, but it was hard to do. He was a member of an international commission working on the population problem, chaired by David Morse, which published a report in 1971. At the time of that study only 10 of 30 countries visited by the commission were willing to tackle population.

Mr. Scheuer said the situation appears to have changed and that all six countries he visited recently (Kenya, Tanzania, Zaire, Nigeria, Ghana, and Senegal) were eager to work on population control.

Assistance for countries in population control is readily available from AID, UNFPA, and the World Bank. UNESCO believes population control should be integrated with other features of development, such as general education, maternal education and health care.

UNESCO spends $5 million of FPA funds annually for population education. Another $2 or $3 million is put into media for getting the message across. UNESCO believes FPA could use more money well for regional education and communication programs.

UNESCO has regional staffs for introducing population education based in Bangkok, Dakar, Nairobi and Santiago. These groups prepare prototype curriculum materials and, upon request from a country, will send a team to train local people. UNESCO also organizes institutes, meetings, and seminars.

TECHNOLOGY TRANSFER AND DEVELOPMENT

UNESCO believes technology transfer must take place as part of the overall process of development. In particular, trained personnel and an adequate infrastructure are needed. A world information network alone will not suffice. UNESCO encourages medium and long-range science and technology development plans.

UNESCO has held regional conferences of ministers of science and ministers of planning in every world region to encourage development. A second round of these meetings is starting. The first is the Europe and North America regional meeting.

Through UNISIST, UNESCO is encouraging countries to set up national science and technology information and documentation centers. NSF and NTIS have assisted in this.

There was recently a demonstration in Morocco of the use of satellites for communications.

UN CONFERENCE ON SCIENCE AND TECHNOLOGY

The Conference is scheduled for 1979, although no firm date has been established and it may be postponed until 1980. The location has not been set; there are invitations from at least the United States, the Philippines, and Australia.

In the United States, OSTP has shown an interest in the Conference and is actively working on it. The NSF budget request for FY 1978 includes $1.2 million for U.S. planning for the Conference.

The Conference has several difficulties to overcome. Mr. Fobes said he is opposed to such a big conference because he is not sure how they really help. The Secretary General of the Conference, Mr. De Costa from Brazil, wants to manage the organization himself. He reports directly to the U.N. Secretary General and, on request, has been made independent of the science arm of the U.N. That group is dominiated by persons from developed countries while De Costa wants the Conference to be aimed toward developing countries. He has the political support of developing counties in this. The problem created is that De Costa needs help to do the organization, but he doesn't have it.

UNESCO has offered and is planning to help by going into each country and assisting in the preparation of a statement of the national science and technology situation and what the country wants from international cooperation. The Conference schedule requires that these country studies be completed by the spring of 1978. There are offers from three developed countries to perform on a bilateral basis the function UNESCO plans to perform.

UNESCO POLITICIZATION PROBLEMS

The problems with UNESCO actions against Israel appear to be settled. The issue of freedom of the press is still hot however. Untoward action on freedom of the press was narrowly averted at the last UNESCO general conference after 13 hours of debate. Mr. Fobes believes that freedom of science and free exchange of scientists are issues that must constantly be watched. The International Council of Scientific Unions is active in these issues, as is the National Academy of Sciences in the United States. UNESCO supports ICSU financially. Membership in UNESCO, however, is from the foreign ministries of countries, and national representatives tend to be more politically aware than concerned with science.

DESERTIFICATION

UNESCO began an arid zones project 20 years ago. There will be a U.N. Conference on desertification in March 1978.

DOCUMENTS REQUESTED AND/OR RECEIVED

"Education and Population," UNESCO's Activities in 1975, Background Information—received.

"Education and Population," UNESCO's Activities in 1974, Background Information—received.

"Education and Population," UNESCO's Activities in 1973, Background Information—received.

"Population Education: Problems and Perspectives," Bulletin of the International Bureau of Education, No. 193, 4th quarter 1974—received.

"Final Report of the Committee of Experts," Meeting of Experts Preparatory to the Second Conference of Ministers Responsible for Science and Technology Policy in the European Region (September 15–17, 1976)—received.

"Science and Technology in the Development of the Arab States," Science Policy Studies and Documents, No. 41, UNESCO—received.

"Draft Program and Budget for 1975–76, UNESCO general conference, 18th session, Paris 1974—received.

ECOSOC documents submitted to the U.N. General Assembly regarding the U.N. Conference on Science and Technology—requested.

Report of the preparations committee for the U.N. Conference on Science and Technology—requested.

Planning documents for the March 1978 desertification conference—requested.

INTERPOL

Date of visit: June 1, 1977.

Location of visit: Interpol Headquarters, 26 Rue Armenguad, 92210 St. Cloud, France.

HIGHLIGHTS

Interpol currently uses technology for communicating pictures and messages.

Interpol believes the technology currently in use for communications is appropriate. The technology must be matched to users' ability to handle it, and the ability to pay for it, and to the amount of communicating to be done.

The United States could help Interpol by assisting poorer countries in acquiring communications equipment.

The Interpol communications system would be improved by the establishment of additional regional stations.

Interpol is working towards computerizing its files. The United States could help by speaking in favor of computerization and by encouraging member countries to provide the funds needed.

Interpol conducts a symposium in forensic science every three years. The next one is scheduled for early in the fall of 1978 at Interpol headquarters.

REPORT

Interpol provides the coordination and communication channels that the police of its 125 member nations use to make criminal investigations. Interpol's chief function is to facilitate the interchange of information about criminals and crimes. Interpol has no international police or detective agents of its own. Each member country of Interpol operates a national central bureau. The U.S. central bureau, which had been in the Treasury Department, was recently moved to the Justice Department. Interpol international headquarters are located in the Paris suburb of St. Cloud. The staff numbers about 150.

The major national centers and the Paris headquarters are linked by a worldwide radio network (described by GAO as "slow and outmoded").

A large portion of the Interpol workload is involved with drug trafficking.

Interpol is currently considering how its central files might be computerized.

Interpol funds come mainly from member dues. In 1975 total income was $2.9 million, of which $2.2 million was from dues. The U.S. share of current dues is $214 thousand, and some back dues are owed. U.S. dues will be handled by the Justice Department.

The Committee is interested in how science and technology can aid in fighting crime nationally and internationally. Several days of hearings on crime are being held by the Subcommittee on Domestic and International Scientific Planning, Analysis and Cooperation during June 1977.

The purpose of the visit was to meet Mr. Nepote, to learn how Interpol uses science and technology, and to determine how the United States might help Interpol in the application of Science and Technology to its work.

[The testimony follows:]

Mr. NEPOTE. What is the purpose of your visit? I know you are very short of time. I am afraid we both have the same problem.

Mr. SCHEUER. How much time do you have?

Mr. NEPOTE. I must meet a big German delegation at 3:45—in 30 minutes.

Mr. SCHEUER. You have thirty minutes. That's fine. Do you remember meeting me with Cusack in this office five or six years ago? Now we have a special Congressional committee that has no other function than to look at the narcotics situation. I serve on that committee. I am also the Chairman of a committee of the Congress that has responsibility for all international scientific cooperation and all international technology transfer. It has jurisdiction over the use by international agencies of science and technology.

Mr. NEPOTE. I see what you mean.

Mr. SCHEUER. And on this trip we met in Vienna with the International Atomic Energy Agency and with UNIDO, The United Nations Industrial Development Organization. We met with an agency in Vienna called IIASA, The International Institute for Applied Systems Analysis where they are making long-run computer estimates of the need for energy, food, what-not. This morning we just left UNESCO. We met before that this morning with the International Energy Administration (Mr. Lanske), and with OECD.

Mr. NEPOTE. A lot of people, much more scientists than I am myself.

Mr. SCHEUER. Well, I am not a scientist, either.

Now I am here to see you about that mission. What can the United States do to encourage better international scientific cooperation? Or provide better technology transfer to give Interpol a more sophisticated scientific and technological capability to carry out its mission? Is there something that you could use in the way of science and technology, in the field of telecommunications for example? Could you use access to the international telecommunications satellite? Remember we met in Ghana. Before that I was in Nairobi where there was a big international conference on Intelsat, the International Telecommunications Satellite. I understand you do not have access to that.

Mr. NEPOTE. No.

Mr. SCHEUER. Would it help you to be plugged into Intelsat? What kind of more sophisticated telecommunications capability would you like to have? What other kind of scientific and technological capability would you like to have? What other scientific or technology sharing would you like to have between the United States and Interpol or European Nations and Interpol?

Mr. NEPOTE. I will try to explain to you my views on that. As far as Interpol is concerned we now use technology for telecommunications and in telecommunications we have two points of concentration. One is to transmit pictures. The pictures we have to transfer from one country to another in the field of international cooperation are mainly fingerprints. We built up a system of transmission of pictures by telephotography. You will see one piece of equipment functioning here. We built up this from zero. The manufacturers who built this equipment are from several countries in the world. The equipment should be compatible. The system consists of buying equipment and using telephone lines for transmission. The system works very well. For the time being the traffic is not very high. For instance between the Euorpean countries where the traffic is the most heavy in the world at the police level, Germans or French use this equipment once or twice a day for international purposes—not more. It's rather quick. In 15 minutes or twenty minutes you may transmit fingerprints from one country to another.

Mr. SCHEUER. How many fingerprints?

Mr. NEPOTE. The ten fingerprints for identification. Sometimes one print if necessary. The problem is we have to encourage the countries one by one to buy this equipment. Now we have, I think, 12 countries equipped with this system. It has been on the market two years or three years. The cost is about $30,000 for one piece of equipment. After that you pay just for your telephone calls. We hope year by year new countries will come into the network. It is obvious that for long distances the cost is much higher. If you transmit a fingerprint from Tokyo to Buenos Aires the cost would be more since you pay on the telephone rate. This is one problem. I think technically it is solved. It is just a question of expansion of the system throughout the world.

The second problem is to transmit messages. I think different points must be taken into account. When we work internationally we work as a team. Let me take an example that, I think, will explain the problem very well to you. If you take a very old DC–3 plane, and you put on that plane a quite modern jet engine, it does not improve the plane. You crash because the engine is not adjusted to the plane. We must take this point into account. You see, we have to work with the very developed countries—United States, Germany, Japan—and practically illiterate countries which have no techniques, no money, no technicians—nothing. With these countries, if you give them too sophisticated equipment you lose your money, your time, and you don't improve anything. In my experience we practically gave the money to Liberia to build up a transmitter and a receiver—the telecommunications. Now they are ruined because they have nobody to change a bulb when something is broken. And, point two, you must adjust your technique to the financial possibilities of the different countries. Point three, if you think reasonably well, you should not buy a big trunk to transport this. (Holding up a tiny ashtray.)

Mr. NEPOTE. This example means you have to adjust your technique to the possibilities of the users, to take all this into account. You know that our system of telecommunications was based on this old system—morse code. One, because in international traffic you cannot use radiotelephone due to the difference of languages. It is out of the question. If you ask an American policeman to telephone to a Frenchman they cannot understand anything, and we cannot afford to make mistakes. So we started to use morse code and we continued to use it for very long distances—between Paris and Tokyo. It works and it is quite enough for the amount of traffic we have to dispatch. For the region where the traffic is very heavy and with the countries which are more developed, I mean mainly Europe, Canada, and the United States, we built up a radioteletype network. It is not exactly telex. It is independent of telex. Now we have 12 countries in it.

What can the United States do to help? I think you could help in giving equipment or loaning equipment to some countries which should be in the network and which are not in the network because they have no money to buy. We may discuss the procedures later.

Mr. SCHEUER. Which countries are they?

Mr. NEPOTE. For instance, Pakistan. I know that in Pakistan they have technicians. If they could be linked with Teheran—it is rather simple—through Teheran they could be linked with 55 countries in the world.

In the far east—Malaysia and Singapore. Because in the far east we have Tokyo as a regional station. We work with Hong Kong, The Phillipines, India and Thailand. We need a contact with Malaysia and with Singapore. Perhaps we could do it through Kuala Lumpur. In South America we would like to have Ecuador and Colombia. In Ecuador, Peru is ready to loan small equipment to Ecuador. I don't know if they will accept it, because you know between Peru and Ecuador things don't work very well. In any case the equipment is not powerful enough to work reasonably well. So Ecuador is preparing to equip. Colombia wishes to do so, but it is not always easty to work with the Colombians. They should be linked to our regional station in Buenos Aires. You also could help some countries in Africa to build up there a regional station. Our network is decentralized by region. There is one region in the far east with Tokyo as the regional station, another one in South America with Buenos Aires. Now we are taking steps to build up regional networks in Africa. We think that in East Africa the problem is solved through Nairobi. In West Africa we are pushing The Ivory Coast, which, I think, is the most developed country in the area, and Nigeria to try to build up a regional station. We must have a regional station before pushing the others to come. Having a regional station in Ivory Coast means, for example, that Ghana, Sierra Leone, Senegal, with very short distance links would work through the network. If you could help, one way or another, Ivory Coast to develop its equipment we could make a very big step and and after that push other countries in the region to join the Abidjan station.

Mr. SCHEUER. Have you been to Abidjan? Ie would be a lovely post. I would like to be assigned to your regional headquarters in Abidjan.

Mr. NEPOTE. You are under contract now. Finally, I don't know if it is possible for the United States to help these headquarters to improve its own equipment—to buy some more equipment to improve our communications with our regional stations. We made very great steps in the past 4 years. If you could stay one or two days more I would bring you 100 miles south of Paris to show you our transmitters.

Mr. SCHEUER. I want to bring our committee here in the future.

Mr. NEPOTE. Please. You are welcome. I will organize with your embassy a short trip to Orleans, where we have our transmitters. Here you will see our receivers and our system of remote control for the transmitters which are in Orleans.

Mr. SCHEUER. What kind of new technology would you be interested in acquiring?

Mr. NEPOTE. I think with this modern radioteletype we have enough technology for our needs. The point at which we are working is to introduce a computer in this organization. The idea to be brief, is to build up something to compare to the NCIC, interantionally. Its created some problems because we have to take care about the different laws and systems in different countries, but we have a working group working on that. I hope in one year we will have built up a model of what we would like to have. After that we will have to go to the different governments and say, "Are you prepared to pay?"

Mr. SCHEUER. To raise your assessments.

Mr. NEPOTE. Yes. And at that stage the United States could help very much. Not only in preaching in the meeting for building up the system, but also in pressing the different governments, mainly in Europe, in order that they participate in the system. This is another difficult aspect of this type of technology on an international level. If you have only two or three countries you cannot benefit from it. Suppose for instance that you had a radio network for two or three countries. It would be no help—useless. It becomes of great use when a great number of countries are participating. These are the two fields.

Mr. SCHEUER. How would a computer capability help you?

Mr. NEPOTE. Studies made in the past proved that the computer would be of some help only if the system can be consulted by terminals from countries. Now we have an international file. To consult this file we must receive a cable, consult the file, send a cable. If we had a computer we could put the file in the computer, and with the terminal have an immediate answer.

Mr. SCHEUER. Information as to a known trafficker?

Mr. NEPOTE. Yes. Just to inform that we have a dossier, or there is a dossier in Germany or in United States or in Canada.

Point two is that with a computer we could build up some files which we cannot build up now with a manual system. Mainly two files: a file of wanted persons and a file of stolen properties—cars, for instance, cameras, and so on. The explanation is the following. If you take the European countries, it could be expected that if you add all the persons wanted by each European country, about one million persons are wanted—Frenchmen wanted in France, Germans wanted in Germany, Italians in Italy, and so forth. Among this one million you have a lot who are wanted for very petty things—things of only local interest. You have some of those who are wanted for very important crimes. This category, small, very important crimes are circulated by us through the classical means, by radio, then after that, by beautiful circulation with photographic prints and so on. Over this 1,000,000 persons this represents about 2,000 people.

Mr. SCHEUER. This is a very small group.

Mr. NEPOTE. A very small group which are wanted for extradition. I am quite sure that if we had a computer, even if the people are not wanted formally for extradition, you could build up a file of, perhaps 200,000 people for whom it is interesting to know they are wanted by some country. For instance, Mr. A is wanted in Germany. They don't ask for extradition, but it is interesting for the Spanish or for the British or the Americans to know that that man is wanted in Germany for something.

Mr. SCHEUER. And why he is wanted.

Mr. NEPOTE. After that the country concerned would be in touch with the mother countries to know the details and if they are wanted for extradition. This is one thing we could do.

Mr. SCHEUER. Would this be of interest, for instance, for international crimes of terrorism—nuclear theft, assassination, kidnapping, hijacking?

Mr. NEPOTE. Yes. The studies which have been made proved that this international system should be completely independent from any national system. In order that each country will put in the system what information they would like to put. They will control what they put in the computer. So every country is absolutely sovereign for the information which is put in the computer about its own citizens.

Mr. SCHEUER. Could you make a copy of that report available to us?

Mr. NEPOTE. Certainly. I will send you some documents.

I introduced this question in 1972 in the general assembly of Interpol. I will send you the report which I introduced, and the studies which were made proved that I was right as to the potential of the computer system, which is rather exceptional.

These are the two big fields in which we are interested in technology for the time being. You must know that every three years we organize a symposium of forensic science and for the top people of the big laboratories in the world. We are doing the following. The scientists discuss problems which have not found a good solution, and they build up a program of research which is given to laboratories which are well equipped and which are volunteers to do research in these different fields. Now, I think, we have 13 topics in the air. Certain of them are taken by the ATF laboratory, some others, perhaps by the FBI. The Americans participate in this program. In 1978 we will have our next symposium. There they will make research reports about their work and they will see if they must continue the research or if the question has been solved, and so on.

Mr. SCHEUER. Where will that meeting be in 1978?

Mr. NEPOTE. Right here in this building.

Mr. SCHEUER. Do you know the dates?

Mr. NEPOTE. Not yet. We know that it will be at the end of 1978, probably October or September. We must have it not more often than every three years because you must give time to the technology to evolve. If they meet too often they have nothing to say. Well, these are the basic problems. I had the privilege to give a speech in the U.S. Embassy in London about police and technology. I will send you a copy of this speech.

Mr. SCHEUER. That would be extremely helpful. I thank you for your kindness. We have been just exactly half an hour.

Mr. NEPOTE. I am extremely sorry we are both so extremely short of time.

Mr. SCHEUER. We will be over again and I will bring my committee along.

Mr. NEPOTE. Please. Would you have a very quick look at the telecommunications?

Mr. SCHEUER. Yes. Thank you very much.

After the discussion between Mr. Scheuer and Mr. Nepote, Mr. Nepote took the three guests on a brief tour of the equipment room. The equipment was a mixture of old and new machines. Perhaps a dozen people were at work in the two rooms which were shown. A telephotographic device was in one room. Samples of fingerprints and a mug shot received on the equipment were seen. The quality was excellent.

DOCUMENTS REQUESTED

Documents Requested

1. Speech by Mr. Jean Nepote concerning police and technology made at U. S. Embassy in London—requested.
2. Report on computerization introduced by Jean Nepote at the 1972 Interpol general assembly—requested.

British Co-Gas Plant

NATIONAL COAL BOARD—COAL UTILIZATION RESEARCH LABORATORY

Date of visit: June 1, 1977.
Location of visit: Leatherhead, England.

HIGHLIGHTS

Co-Gas process, being developed at Leatherhead, is one of two finalist technologies for the first coal gasification demonstration plant, to be built in the U.S.

Leatherhead has the largest Co-Gas plant in the world.

Pressurized fluidized bed combustors, being developed at Leatherhead, can easily reduce SO_2 and NO_X emissions from coal well below required levels and can reduce capital costs by as much as 75 percent in some parts of the plan.

REPORT

Members and staff received a briefing from senior members of the Leatherhead Research Laboratory on their research work on fluidized bed combustion of coal and oil, and on the Co-Gas coal gasification process work, at Leatherhead.

In fluidized combustion, coal or oil is injected and burned in a fluidized bed of particles of mineral matter (ash, limestone or sand). Its characteristics enable the fuel—irrespective of its ash or sulphur contents—to be burned efficiently at high combustion intensities, while keeping the emission of sulphur dioxide and nitrogen oxides well below any of the rigid standards which are either in force or proposed.

The relatively low combustion temperature and the environment in which combustion takes place minimizes the formation of corrosive substances which attack metal surfaces in conventional plants. The temperature of the bed is maintained by a working fluid passing through heat transfer tubes located within the bed. These features when coupled with the large reduction in heat transfer area that fluidized combustion makes possible, result in an overall reduction in plant size together with significant cost savings, and enable low quality fuels which have hitherto been difficult to burn in conventional furnaces to be combusted efficiently and cleanly. In visiting the facility, the members and staff observed retrofitting operations on the pressurized fluidized bed test facility at Leatherhead, which is approximately 2′ x 3′ and a total vessel depth of 8′.

Activities at Leatherhead

Leatherhead has been concentrating on the fluidized combustion of coal for steam and power generation and the gasification of coal via the Co-Gas process. The Co-Gas process would be used to produce both substitute natural gas and oil.

Great Britain is extremely interested in developing new ways of using its coal. It has coal reserves which are estimated to be sufficient for 350 to 400 years of consumption. Annual production of coal in Great Britain is approximately 200 million tons. The average sulphur content of this coal is approximately 1 percent.

Leatherhead operates mostly on contract income and has received $2,890,000 in the 1976 to 1977 period. This breaks down according to the following table:

Contract income at Leatherhead 1976–77

	Amount (approximately)
Co-Gas	$2,100,000
ERDA:	
Direct	540,000
Curtiss-Wright	140,000
Other: United Kingdom sources	110,000
Total	2,890,000

The staff at Leatherhead consists of 101 people, with over 80 percent engineers and professionals.

Leatherhead has had an extensive history of contract research on advanced coal technology. In the past, they have done considerable research on the combustion of coal for gas turbines for power generation. They have also done much work on the gasification of coal to make high Btu gas for industrial and domestic use; much of this work has been transferred to the Westfield, Scotland, facility. They have also done a great deal of research work on low Btu gas for power generation. They have performed contract work on the high temperature combustion for MHD power generating systems. Much of this work has been incorporated into the present U.S. effort; however Leatherhead is no longer working in MHD. They have also had extensive contracts in the fluidized combustion of coal and oil for steam and power generation with minimal atmospheric pollution. Following is a list of projects sponsored by the United States which are being conducted or have been conducted at Leatherhead:

1970–71: Fluidized combustion of coal for power generation. Sponsor: EPA and UK NCB.

1972 to present: Fluidized combustion of coal for combined cycle power plant. Sponsor: OCR/ERDA.

1972 to present: Production of synthesis gas from char as a part of the Co-Gas process for making oil and substitute natural gas from coal. Sponsor: Co-Gas Development Co. until 1977; June 1977 onwards, ERDA.

Fluidized combustion research at Leatherhead

Fluidized combustion consists of two types, atmospheric combustion and pressurized. In atmospheric combustion the uses will be for industrial boilers, power station boilers, waste disposal equipment, process heaters, and furnaces for closed cycle gas turbines. Pressurized systems will mainly be used for boilers and air heaters, because of the high efficiency involved. The work at Leatherhead has mainly been in the pressurized combustion systems.

Leatherhead has been providing technical support for the main pressurized fluidized bed combustion research program which is being conducted jointly by ERDA and the IEA. Their work goes to supplement the work being done at the component testing and integration unit at the Argonne National Lab outside of Chicago, at the 13 MWe pilot plant operated by Curtis Wright, and at the 20 MWe flexible test facility at Grimethorpe.

Work at Leatherhead has helped confirm the many advantages of fluidized bed combustion. The high rates of heat transfer, the controllable low combustion temperatures, the chemical reactions that take place in the bed and the ease of carrying out combustion under pressure lead to the following advantages of fluidized combustion compared with conventional plants producing the same amount of power:

Up to 75 percent boiler tube reduction.
Compact combustion area.
Smaller boiler volume.
Efficient operation at temperatures up to 750° Centrigrade.
Reduced fouling and corrosion of boiler tubes.
Lower capital costs.
Shorter construction period.
Reduced maintenance costs.
Simple and effective control of SO_2 emissions.
Reduced NO_x emission.
A variety of power generation cycles.
Multi-fuel operation.

To date, 20 different detailed comparative costings have been carried out by six different organizations, including consulting engineers, boiler manufacturers and turbine makers in Britain and the U.S.A. The relative cost savings are shown in the following table:

Percentage cost saving of fluidized combustion power generation compared with conventional practice in the range 120–660 MWe:

	Percent
Without sulphur emission control:	
Capital savings	12–20
Operational savings	10–14
With sulphur emission control:	
Capital savings	14–23
Operational savings	12–16

Many improvements have been made in the pressurized fluidized bed combustion boiler as a result of the work at Leatherhead. They have improved the efficiency of fines collection, combustor burner design, engineering construction of cyclones, and engineering contruction of Y–boxes. In addition they have been able to make modifications to allow for much longer runs than previously experienced.

As a follow-on to their program, Leatherhead is doing extensive design work on applications of fluidized bed combustors. For example, in certain applications there is a case for eliminating the steam cycle and using gas turbine for generation of all the power, where air is passed through tubes in the bed and mixed with combustion gases before being expanded through a gas turbine. Such a scheme, with power generating capacity of 66 MWe and incorporating a waste-heat recovery system of 116 MW for district heating with an overall thermal of efficiency of about 72 percent is at present under conceptual design. Secondly, a design study has been completed for an atmospheric pressure boiler with a capacity of 200,000 lbs. steam per hour, 20 MWe suitable for a small industrial power generating system.

The design concept is such that the boiler will be factory built, minimizing on-site construction time. This design can be used as a basis for a series of industrial boilers in the capacity range of 50,000–220,000 lbs. steam per hour.

Leatherhead and the Co-Gas coal gasification program

ERDA is presently in the phase one period of designing its first coal demonstration plant. The two contenders for the final contract are the slagging Lurgi process, being developed at Westfield, Scotland and the Co-Gas process being developed here at Leatherhead.

The slagging fixed bed Lurgi system being developed by British Gas is under the sponsorship of Conoco Coal Development Company. The Co-Gas system is being sponsored by the Illinois Coal Gasification Group. The Co-Gas pilot plant at Leatherhead is the largest Co-Gas facility in the World.

The Co-Gas Development Company is a consortium formed in 1972 by FMC Corporation to develop a process to produce either medium-Btu or pipeline gas and synthetic crude oil from coal. This is accomplished by a combination of fluidized bed pyrolysis and gasification of the char from pyrolysis. The consortium is made up of FMC, Consolidated Natural Gas Company, Panhandle Eastern Pipeline Company and Tennessee Gas Pipeline Company. In addition, Peoples Gaslight and Coke Company and Northern Natural Gas hold options to join the consortium.

Gasification via the Co-Gas method offers many advantages. The gas produced has a low nitrogen content without the need to use oxygen in the process. To avoid the high cost of bulk oxygen, heat is supplied for gasification by using a separate gasifier and combustor. Heat for the carbon-steam reaction comes from burning of char fines with air in the combustor. A circulating stream of hot char between the two vessels is used to carry the heat for gasification. Ash is removed as a slag from the combustor.

Co-Gas also offers the advantages of being able to produce high Btu gas without the need to gasify at very high pressures. Also hydrotreated oil is produced either as a fuel export or as a supplementary fuel for gas making at periods of high demand. Co-Gas, finally, offers a very high efficiency of converting coal to useful products.

The Co-Gas process represents both extensions of existing technologies and the development of new technologies. Fluidized bed gasification has been applied for the first time to char, which is a by-product of gasification. Cyclone combustion has been applied to the combustion of char fines. Circulation systems have been improved to handle gasifier bed material and at higher temperatures. New technologies which have been developed include a heat exchanger in a lift system, which is modified to handle slagging coals. Also developed is the ability to recover heat and power from flue gases.

The primary components of the pilot plant are:

1. A gasifier in which char is fluidized and gasified by steam.
2. A cyclone combustor in which char fines, separated in the secondary dust-collecting elements of the gasification and the char-circulation systems are burned to provide hot gases to heat char. The char ash is tapped from the cyclone combustor as a liquid slag.
3. A lift tube or heating tube in which char drawn from the gasifier

is heated by the hot gases from the combustor. The hot char is then returned to the gasifier to provide the heat to support the reaction between the steam and the char.

The char from pyrolysis is especially good feed stock for gasification. The use of char avoids operating problems in the gasifier. Many coals will tend to stick together in a fluidized gasifier making it inoperable. The use of char avoids the problem of tar in the make gas, and the necessity to clean the gas and handle the same quantity of tar. The use of char also minimizes the formation of fine particles, which occurs when coal is introduced into a reactor at gasification temperatures.

The calculated overall efficiency for the Co-Gas process, including pyrolysis as well as gasification and combustion, is 65 to 70 percent.

One of the potential problems in reheating the circulating char with the combustor flue gas is the reaction of the carbon in the char with the CO_2 of the flue gas to form carbon monoxide. The potential heat of the CO can be recovered and would be in a commercial plant. However, should the process already be in balance with respect to steam and power needs, CO formed would reduce the thermal efficiency. The process has yet to be optimized with respect to such items as the CO content of flue gas and the utilization of its heat value.

Attempts have been made to reduce the extent of CO formation. This can be done by several means, one of which is the geometry of the pilot unit which can affect the concentration, and thus, the residence time of the char in the system.

In conclusion, there are several factors which make the Co-Gas process attractive. These include the facts that Co-Gas is a low pressure process (4 to 6 atmospheres absolute), that the process uses air rather than bulk oxygen, and that the process yields substantial quantities of high value oil co-product, in addition to the pipeline quality gas. Further, both the coal pyrolysis step and the gasifier combustor step have been successfully demonstrated on a large pilot scale.

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European Space Agency

HIGHLIGHTS

The Spacelab schedule as defined in the 1973 agreement with the U.S. will be met.

ESA is participating in the Space Telescope Program.

Twenty-five percent of the ESA budget is directly related to NASA in the form of cooperative programs.

REPORT

On June 1, 1977, representatives of the United States Congress and the National Aeronautics and Space Administration (NASA) visited the headquarters of the European Space Agency in Paris, France. The purpose of the visit was to discuss the United States involvement in the European Space program.

The European Space Agency (ESA) is a ten member consortium of European countries. The members include Belgium, Denmark, France, Germany, Italy, Netherlands, Spain, Sweden, Switzerland, and the United Kingdom. Ireland has signed to ESA convention and will become a member upon ratification. Austria, Canada, and Norway have been granted observer status.

The purpose of the Agency is to provide for and to promote, for exclusively peaceful purposes, cooperation among the European States in space research and technology and their applications, with a view to their being used for scientific purposes of operational space applications systems.

The major components of ESA are, European Space Research and Technology Center (ESTEC), European Space Operations Center (ESOC), European and Space Research Institute (ESRIN).

Funding for the ESA operations is provided for by the member nations or states. The amount of funding depends upon the gross national product. Basically, two types of funding is required, overhead and program funding. Each state contributes a share of the overhead funding, while project funding is left to the discretion of the member states. When feasible, a member nation supporting some percentage of an ESA program will get an equal percentage of the contracts for that program.

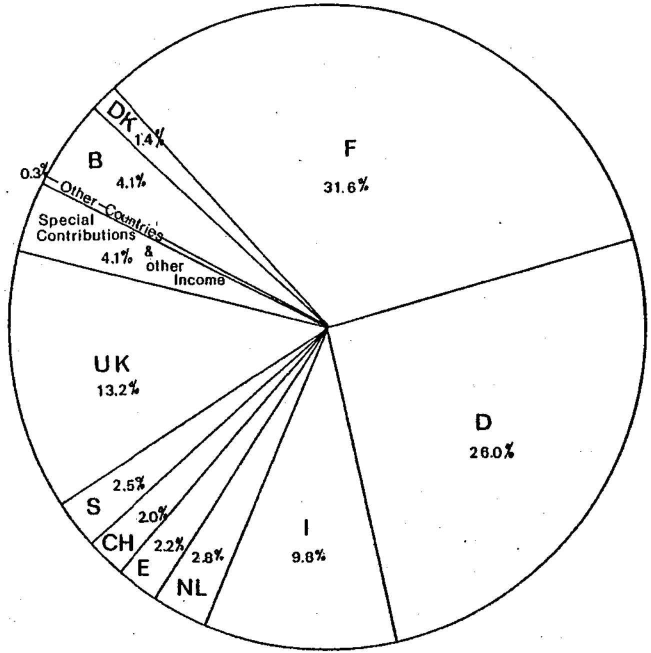
The primary programs that relate the United States space program to ESA are the Spacelab and the Space Telescope. The entire Spacelab is being developed by ESA with Germany providing 53.3 percent of the funding. Consequently, the development is controlled by a German contractor, ERNO.

The involvement in the Space Telescope is more limited. ESA plans to provide the solar array to provide 4 kilowatts of electrical power, the faint object camera, and 10 years of operational support.

MEMBER STATES & OTHER CONTRIBUTIONS

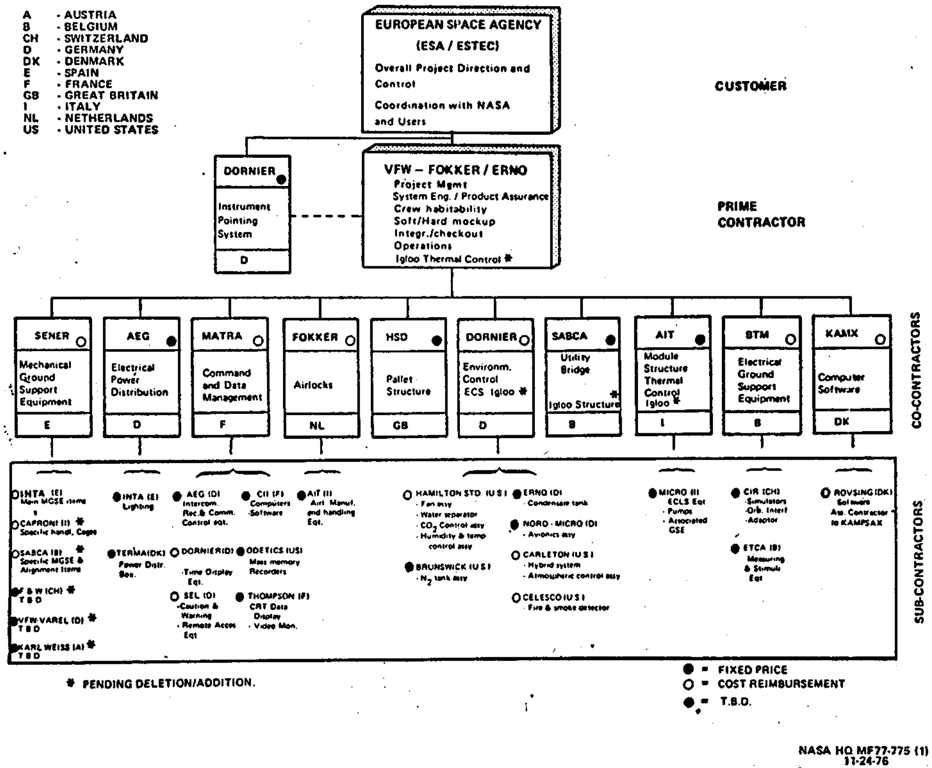
BUDGET 1977 487.8 MAU
535.8 M $

1976 Carry forward
not included



A - AUSTRIA
B - BELGIUM
CH - SWITZERLAND
D - GERMANY
DK - DENMARK
E - SPAIN
F - FRANCE
GB - GREAT BRITAIN
I - ITALY
NL - NETHERLANDS
US - UNITED STATES

SPACELAB INDUSTRIAL TEAM ORGANISATION



This visit was intended to give an overview of the current activities between the National Aeronautics and Space Administration (NASA) and the European Space Agency (ESA). The 1977 budget for ESA is 487.8 million accounting units or $535.8 million. (See accompanying table.) Twenty five (25) to thirty (30) percent of this budget is directly related to NASA in the form of cooperative programs.

The largest program related to NASA is the Spacelab program. The 1977 budget is $109.8 million. This facility will be utilized on the Space Shuttle in mid-1980. The organizational structure associated with its development is shown in the accompanying figure. Over forty (40) contracts with ten (10) countries have been written to develop the system. The prime contractor being ERNO, a German-based subsidiary of VFW-Fokker.

Discussions regarding the Spacelab schedule revealed that the schedules as defined in the 1972 agreement will be met.

Another very significant NASA/ESA program is the Space Telescope. ESA has committed $88 million to this program. Concern was expressed by the ESA Director that if the program was not approved by the U.S. Congress as a fiscal year 1978 New Start, the money would be used for other projects.

The Aerosat program, a joint ESA/FAA navigation satellite, was recently cancelled by the House Committee on Science and Technology. This topic was discussed in regards to the impact of that cancellation on future NASA/ESA working relationships. Because the Aerosat budget amounts to less than 1 percent of the total ESA budget, no serious problems are anticipated.

International cooperation was another topic of discussion. A growing concern for international technological cooperation has developed. ESA was asked to describe what programs they participated in that fostered cooperation with the USSR. Mr. Gibson, the Director of ESA, stated that ESA has always had open relations with all nations. However, there is no active cooperative program with the USSR. There is some participation with some of the border states on the meteorological programs.

Super-Phénix Breeder Component Testing Facility

Name of institution: Electricite de France Center at Renardieres (EDF).

Date of visit: June 1, 1977.

Location of visit: Renardieres, south of Paris.

Activity: Steam Generator Testing for Super-Phénix.

HIGHLIGHTS

The team at EDF has accumulated 4000 hours testing steam generator prototypes of the Super-Phénix design. About 3000 hrs. testing was obtained with the final design choice for the Super-Phénix (by Babcock-Atlantique). The EDF team seems as confident as the Phénix team at Marcoule about the progress of technology development for the large plant.

Although the design for Super Phénix is a radical departure from the Phénix steam generator in the sense of increased thermal capacity (a factor of 75), the EDF team expects no surprises. The critical flow parameters will be the same as their 40 megawatt prototype but the flow volume will be greatly increased.

The CGVS (the steam generator test facility) has been used for component testing since 1970 through the Phénix program. The team has experience in every facet of liquid metal loop testing.

Electricite de France, the national utility has mounted an aggressive campaign to sell electricity and has a strong commitment to nuclear power. The goal is to achieve 70% nuclear generation of electricity by 1985. This goal corresponds to 30 GWe nuclear electric energy in 1985. Fuel oil generation of electricity will peak in 1980 and is projected to drop off rapidly after that. Hydroelectric power is expected to reach 15% of total electric by 1985.

REPORT

The Science and Technology Group was accompanied to the EDF Center by Andre Madubost, Director of External Affairs and former Chief Engineer of EDF.

The S & T group was taken on a tour of the Sodium Loop Steam Generator Testing Facility by Jean Masse, the Chief of the Facility. He presented the history of the testing program for Super Phénix, compared the two competing designs and summarized the progress to date. The test instrumentation was extensive and an endurance run was in progress. Mr. Masse summarized their experience with sodium-water explosions and methods for removing the reaction products to minimize damage to components in the loop. He felt they had not had major problems with Phénix and anticipated Super Phénix would present few surprises in view of their accumulated experience.

HIGH POWER STEAM GENERATOR SODIUM PUMP

The development of fast-neutron breeder reactors began in France shortly before 1960. It was soon apparent that the heat-transfer fluid to be used in these reactors should be liquid sodium, for this metal makes it possible to retrieve the very large amounts of heat released in such small space as the core of a fast-neutron reactor; it can be used at high temperatures without having to be pressurized since it has a high boiling point; it does any major problems of aggressiveness toward conventional structural materials; finally, it possesses attractive nuclear properties both in terms of behavior under irradiation and its effects on nuclear reactions.

Thermal and engineering research was therefore undertaken from the beginning with a view to exploring the capabilities of this material and determining the design requirements of the systems in which to convey it. If the next stage, the design and construction of the atomic pile "Rapsodie" showed that the largescale manufacture of such systems was feasible and made it possible to develop the fuel elements to be used in this type of reactor. The path was now clear to initiate the planning of an experimental power plant, and the construction of the "Phenix" unit (250 MW) was decided upon. One major problem had yet to be solved, regarding the transfer of heat from the sodium fluid to a water-steam system capable of feeding a turbine. Preliminary laboratory tests provided the means required to determine the size of the steam generators in which such heat transfers were to take place, but it was still necessary to have facilities to control the quality of commercially manufactured apparatus and to ascertain its performance under all the possible operating conditions conceivable in a power plant, including the most extreme.

Acting in cooperation with the Commissariat a l'Energie Atomique in the development of this process, Electricite de France decided in 1967 to create a special unit designed to carry out the final adjustment of sodium-heated generators and to test them under actual operating conditions: this unit is the C.G.V.S. (high-capacity testing unit for sodium-heated steam generators). The location chosen for this unit was the Study and Research Center at Renardieres.

Designed for the development of this particular process, the C.G.V.S. was able to help complete the design of Phenix's steam generators, since its construction and initial operation took place rapidly. The programs formulated in conjunction with the Commissariat a l'Energie Atomique and the steam generator manufacturers concern with the equipment to be used in the 1,000 MW power plants scheduled immediately after Phenix.

The reason that such impressive facilities were committed to develop the design of sodium-cooled breeder reactors is that power plants based on such reactors are very likely to play an increasingly important part in electric power generation: their impact is expected to be felt by 1980.

CREATION OF THE CGVS TIMETABLE

Initial decision: 1967.

Construction and assembly on the site of loops and accessories: 1968–69.

Delivery: December 12, 1969.
Assembly of first steam generator: January–June 1970.
Initial steam generation: June 27, 1970.
Maximum capacity reached: July 31, 1970.
General tests: CGVS and steam generator: August–October 1970.

The next step: the CGVS undertook the program of tests of Phenix's steam generator.

SUMMARY OF MAIN FEATURES OF CGVS

Sodium System

Main System

1 sodium heater.

Natural-gas heater equipped with combustion air economizer. Capacity: 50 mw. Minimum capacity: 2.5 mw. Maximum temperature of sodium: 650 degrees C.

2 sodium mechanical pumps.

Centrifugal, single-stage, free-level and vertical sharg. Axial suction, lateral discharge. D.C. variable-speed motor drive (300 to 1,500 r.p.m.). These pumps are connected to an expansion tank, with an overflow pipe. At a motor speed of 1,500 r.p.m., the pumping capacity is 1,000 cu. meters per hour (d=0.8) and the discharge pressure is 10 bars.

1 sodium cooling plant.

Sodium-air exchanger, receiving air by means of motor-driven blower. Maximum capacity: 15 nw. Minimum capacity: 3 mw.

2 mixers.

Sodium-sodium exchangers. Their purpose is to equalize the outlet temperature of sodium.

Auxiliary Systems

Loading.

Worked by electromagnetic pump primed by Argon pressure in the storage tank. Tank capacity: 143 cu. meters. Weight of stored sodium: 100 tons.

Purifying.

By means of cold trap. Sodium circulation is maintained by two electromagnetic pumps operating in parallel. P ity is measured by plugging indicator. Capacity: 16 cu. meters per hour.

Argon system.

A manifold, which receives the gas from a series of expanders, maintains a neutral Argon atmosphere above the free levels of the sodium.

Preheating.

By means of electric heating cable. Its object is to obtain and maintain a temperature of not less than 150 degrees C. on the aggregate Sodium system.

Water-steam system

Steam system

First expander-desuperheater circuit.

Prepares the steam from generator for admission into the reheater. It includes: two pressure reducing valves, one desuperheater with water spray and live steam injection, two water-steam separators. Steam pressure at superheater outlet: 167 bars. Steam pressure at reheater inlet: 50 bars maximum, 45 bars minimum.

Second expander-desuperheater circuit.

Prepares the steam for admission into condenser. It includes: two desuperheaters and two pressure reducing valves. Steam characteristics: 565 degrees C. —50 bars at reheater outlet; 110 degrees C. —1 bar at condenser inlet.

Condenser.

The condenser transfers the heat originating in the generator to a water-cooled exhaust system. Steam processed: 72,200 kg per hour. Pressure: 1 bar abs.

Water system

2 condensate electric pumps.

One in service, one on standby with automatic startup. Capacity: 100 tons per hour.

Degasifier tank.

Used to degasify condensate and reheat it. Delivery pressure: 6 bars. Temperature: 160 degrees C.

1 condensate treatment plant.

Two demineralizing and filtration units (one in service, one regenerating) are used for the continuous treatment of condensate. Maximum capacity: 80 cu. meters per hr.

1 makeup water treatment plant.

One softening-demineralizing-filtration plant treats the well water stored in a reserve tank. Maximum output: 15 cu. meters per hour.

2 electric feed pumps.

High pressure, multi-stage pumps; as a rule, one in operation, one on standby with automatic startup. Maximum output: 105 tons per hours. Discharge pressure: 200 bars.

2 H.P. water reheaters.

Water-steam exchangers. Pressure: 280 bars. Temperatures in first stage: 160 degrees C. in, 230 degrees C. out; second stage; 230 degrees C. in, 281 degrees C. out.

Auxiliary systems

Cooling system

Serves the condenser, the various units of the plant and the water and steam bleeds. Total volume to be cooled: 4,625 cu. meters per hour. Water temperatures: inlet 40 degrees C., outlet 30 degrees C. Electric pumps working with two forced-draft air coolers. The cooling water is Sein river water, filtered and softened.

Auxiliary steam system

One natural-gas boiler. One electric feed pump. Saturated steam output: 7.7 tons per hour at 12 bars.

Plant operation and control unit.

Includes all facilities and electrical circuits needed for start-up, operation and testing, namely: relays and automation; metering; preheating; power distribution. Distinctive features: centralized facilities for operation and control (control room); elaborate automation, to shift from one operating pattern to another.

In the event of power failure, one power supply unit (Diesel), 1,000 kva., automatically supplies power to the vital components of the loop to place it on safety pattern.

Steam generator testing capabilities: Study of permanent operating patterns; study of startup and shutdown procedures; cleaning of steam generator; study of normal transitional conditions (load increases and decreases); study of steam generation regulation; study of static stability of steam generator; study of dynamic stability of steam generator; study of heat transfer matrix of steam generator; predetermined scaled quantities can be applied to each admission value of the steam generator, the other values being kept constant by regulation;

Study of violent transitions and shocks; it is possible to submit the steam generator to heat shocks, on the Sodium system side, of +5 degrees C. per second for a duration of 10 seconds, and cold shocks of −15 degrees C. and, on the water system side, of −1 degree C. per second for a duration of 30 seconds, as well as abrupt interruptions in Sodium supply and water supply.

It is moreover possible, on request, to perform special tests on steam generator accessories: hydrogen detection system, rupture dises, major gate valves, separator.

High Temperature Solar Furnace Testing Facility, Odeillo, France

HIGHLIGHTS

The High Temperature Solar Furnace at Odeillo, France, provides a unique and important facility for solar experimentation and demonstration.

Georgia Tech and the French National Center for Scientific Research are collaborating in materials research in the high temperature thermal energy environment of the 100 kilowatt solar furnace.

Solar research at Odeillo also includes work on solar homes, radiation cooling and solar refrigeration, and heat and electrical storage systems.

REPORT

On May 30, 1977, Congressman Tom Harkin, accompanied by Committee staff, made a visitation to the French solar furnace located in the Pyrenees Mountains at Odeillo, France. The purpose of the visitation was to meet with French officials and to tour the solar furnace facility. Mr. Bernard D'Utruy, deputy director, acted as our host.

The French Centre Nationale De La Recherche Scientifique (CNRS) solar furnace was located where the sun shines as many as 180 days a year and receives solar intensities as high as 1000 watts/square meter at the surface. The solar furnace was completed in 1970 at a cost of $2 million. The facility includes a parabolic reflector, which is 130 feet high and 170 feet wide, composed of 9,500 mirrors approximately 18 inches square. Because the parabolic reflector is too large to track the sun, 63 smaller mirrors (heliostats) set in eight tiers in the adjacent hillside are used to follow the sun and reflect its ray and parallel beams onto the parabolic reflector. Each heliostat is composed of 180 mirrors, each 20 inches square, making a structure of some 25 feet by 20 feet in size.

The solar energy incident on an area of about 23,000 square feet is concentrated by the parabolic reflector into an area almost two feet in diameter. Sixty percent of the total thermal energy (about 600 kilowatts) is concentrated in an area about one foot in diameter at the center of the focal plane of the parabolic reflector. This configuration produces an equivalent heat generation of 1600 times the sun's thermal equivalent at the surface of the earth.

The High Temperature Materials Division (HTMD) of the Engineering Experiments Station at Georgia Tech and the CNRS of France are collaborating in a research program to study the properties of materials in the high temperature thermal energy environment of the 1000 kilowatt solar furnace. This work is being conducted under a research services agreement between Georgia Tech and CNRS.

In addition to providing the necessary high temperature radiant energy environment required for the studies, the CNRS solar furnace is uniquely suited for (1) the evaluation and development of materials and prototype components to be used in dynamic conversion of high temperature solar energy into electrical energy, (2) the determination of the high temperature dielectric properties of ceramics, (3) processing ultra-high purity refractory materials, (4) the determination of the electrical performance at high temperatures of hypersonic radiums and electromagnetic windows, and (5) the evaluation of materials in the high energy thermal radiation environment associated with nuclear devices.

In addition to these studies, the CNRS Solar Energy Laboratory at Odeillo is equipped with numerous smaller solar concentrators for various laboratory scale high temperature experiments. These experiments can be carried out in various atmospheres or in a vacuum. It is also possible to use the thermal energy of the 1000 kilowatt solar furnace in certain controlled atmospheres other than air. Other solar research includes the design, construction and evaluation of solar heated houses, radiation cooling and solar refrigeration, and the studies of heat storage and electrical storage systems.

The Solar Energy Laboratory has a personnel staff of five teaching researchers, seven engineers, twelve general researchers, five graduate students, and fifteen technicians who work at the location. The laboratory's program is divided into four areas: energy studies, solar experiments, material treatment and testing, and general studies. The solar laboratory program has served as a center for international experimentation and demonstration of solar energy systems. As mentioned earlier, the cooperative exchange program between Georgia Tech and the CNRS solar energy laboratory has provided unique opportunities for scientists to study the feasibility of solar energy.

HIGH TEMPERATURE GAS REACTORS AND APPLICATIONS

Location: Jülich Nuclear Center, West Germany.

Date: June 2, 1977.

KFA-Jülich—Prof. Beckurts, Dr. Engleman, Prof. Schulten, DI Weisbrodt, Dr. Leushacke, Dr. Teuchert, DI Harth, Dr. Slemeyer, Dr. Noack.

HIGHLIGHTS

Although some fusion research is conducted at Jülich, the focus of the lab's energy activity (54 percent of the total effort) is on High Temperature Gas Reactors. The rest of the effort is about 25 percent basic research and 25 percent environmental R & D.

The US/FRG agreement is important in the sense that it would be a major undertaking for either West Germany or the United States to conduct the HTGR technology development alone and such cooperation could save 5 to 7 years on commercialization timetable.

EPRI has major reservations about developing a commercialization strategy for the HTGR. It is important to note that the utilities are jaundiced about HTGR because the initial attempt to commercialize the HTGR came at a poor time, in terms of available capital.

Germany has enough coal to make it attractive to consider nuclear heat applications for coal gasification and their major process heat requirements.

Heat process applications are important in West Germany since 70 percent of energy requirements are projected to be for heating through the year 2000.

Anti-growth group with major leftist support have pressed the theme of lower energy demand since population density in FRG is so high (1,000 people/mi^2).

There has been considerable cooperation with the U.S. both General Atomic and Oak Ridge National Lab on gas-cooled fast breeder R & D. If the collaboration were escalated to prototype plant activity, the West Germans would presumably perform fuel element R & D at Jülich whereas the U.S. Helium Breeder Associates would be responsible for Helium component technology. This makes sense in view of the absence of real turbomachinery expertise at Jülich. Safety R & D in the GCFR is being performed at the Karlsruhe lab.

REPORT

Despite the promise of high fuel conversion efficiency of uranium by use of thorium as well as inherent safety features the HTGR does not yet have the appeal that will guarantee a significant number of utility orders. Moreover, use of the thorium fuel cycle requires the build-up of a supporting industrial infrastructure.

The turbomachinery expertise for High Temperature Gas Reactors in Germany is confined to industry. Although turbines are tested at Jülich the laboratory is not a center of excellence in turbomachinery. There is no FRG counterpart of the NASA aeronautical labs since the West German share of the aircraft market has never justified the government investment in such laboratories. It is difficult to see how Jülich could manage component development for HTGR's without such major in-house competence.

The operating demonstration of the AVR 15 Megawatt electric high temperature gas reactor is described in the following section.

Concerning the 15 MWe Experimental Nuclear Power Station in Julich:

General

The AVR Company was founded on February 3, 1959 by a group of 15 electrical power companies for the purpose of building and setting into operation a large scale nuclear power station employing a high-temperature reactor. The goal of the undertaking is to gain scientific, technological and economic knowledge which will serve as a basis for the further development of this advanced reactor type in West Germany.

The contract for a prototype plant in Jülich was signed with the reactor construction firm, Brown Boveri/Krupp Reaktorbau GmbH. on August 13, 1959.

The electrical power production began in 1967. In 1974 the average coolant gas outlet temperature was raised to 950° C.

Important technical and physical data

The listed Data represent the stationary state with a thermal power of 46 MW and an average gas outlet temperature of 950°C (status at 1.1.1976). Full power operation is possible in a gas outlet temperature range between 770°C and 950°C.

PROTOTYPE HIGH TEMPERATURE GAS REACTOR

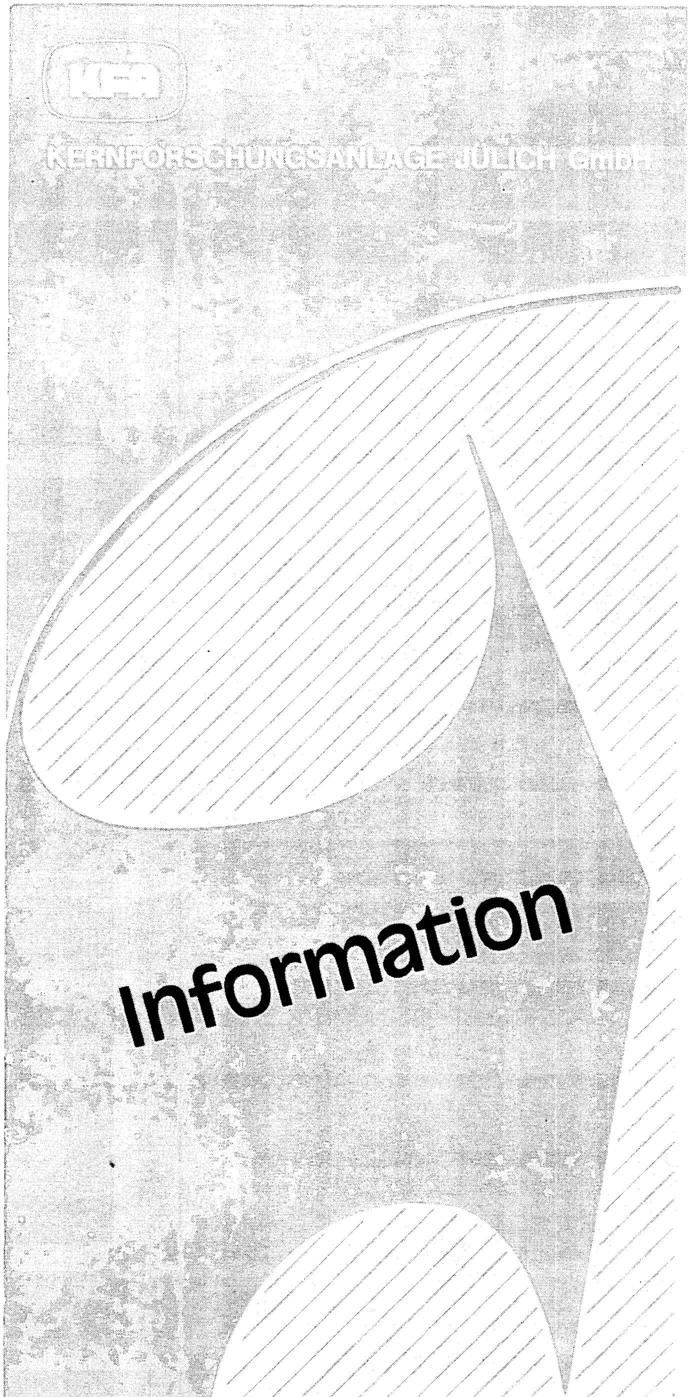
REACTOR PLANT

1. Plant data:		
Thermal power	46.0	MW.
Gross electrical power	15.0	MW.
Net electrical power	13.0	MW.
Gross efficiency	32.6	%.
2. Primary circuit:		
Coolant gas helium	1,600	m³ i.N.
Coolant gas pressure	10.8	bar
Blower speed	3,200	min⁻¹.
Power of the blowers	2×50	kW.
Pressure gradient	47	mbar.
Gas flow rate	13	kg/s.
Average gas temperature at steam generator outlet	155	°C.
Average gas temperature at core inlet	275	°C.
Average gas temperature at core outlet	950	°C.
3. Secondary circuit:		
3.1 Steam generator:		
Steam flow rate	56	t/h.
Steam outlet temperature	505	°C.
Superheater outlet pressure	73	bar.
Feedwater temperature	115	°C.
Feedwater pressure	156	bar.
Diameter of steam generator	3.5	m.
Height	5.5	m.
Surface	1,762	m².
3.2 Turbine-generator:		
Speed of ratation	3,000	min⁻¹.
Power	18.75	MVA.
Power factor, cosine	.8	
Voltage	6.3	kV.
4. Reactor core:		
Core diameter	3	m.
Diameter of inner core region	1.86	m.
Height of cylindrical part	2.5	m.
Height of cone	.7	m.
Height of free space above the core	1.0	m.
Number of absorption rods	4	m.
Diameter of rod position	1.0	m.

PROTOTYPE HIGH TEMPERATURE GAS REACTOR, REACTOR PLANT—Continued

5. Neutron physical data:		
Average thermal flux	$.60.10^{14}$	$cm^{-2}s^{-1}$.
Average fast flux (E_n>0.1 MeV)	$.174.10^{14}$	$cm^{-2}s^{-1}$.
Average power density	2.5	MW/m^3.
Average power per fuel element	.52	kW/element.
Maximum power of one element	1.66	kW/element.
Mass of fissile material:		
U 233	6.66	kg.
U 235	35.4	kg.
Pu 239	.22	kg.
Moderating ratio	8,388	
Ratio of fertile to fissile material	13.6	
Conversion factor	.34	
6. Maximum temperatures:		
Maximum fuel temperature	1,134	°C.
Maximum fuel element surface temperature	1,076	°C.
Maximum gas temperature	1,030	°C.
7. Reactivity values:		
Temperature coefficient of reactivity:		
Cold (T_M=130°C)	-14.10^{-5}	/°C.
Hot (T_M=686°C)	$-4.4.10^{-5}$	/°C.
Temperature effect (T_M=130°C—686°C)	−6.35	%.
Xenon poisoning	2.70	%.
Reactivity released from Pa 233—decay after shutdown	1.23	%.
Reactivity equivalent of the 4 absorption rods	9.8	%.
8. Fuel element data:		
Diameter of spherical fuel elements	60	mm.
Mass of 1 fuel element	200	g.
Number of coated particle in 1 fuel element (20,000–40,000)		
Heavy metal in AVR-fuel elements	1	g U 235.
	5	g Th 232.
Heavy metal in THTR-fuel elements	1	g U 235.
	10	g Th 232.
Average burn-up of the discharged fuel elements	90	% fifa.
	15	% fima.
	137,000	MWd/t (U+Th).
9. Fuel cycling:		
Number of elements in the primary circuit	110,000	
Number of elements in the core	97,000	
Graphit dummy elements	10	%.
Cycling rate (approximate)	600	Elements/d.
Charging rate of fresh fuel	60	Elements/d.
Fuel discharge	60	Elements/d.
Ratio of elements charged on the inner core region to the outer core region	2.66:1	

Type of element	Fuel	Number of elements in the circuit	Maximum burnup percent fima	Maximum fluence (0,1 MeV) 10^{21} cm^{-2}
Carbide fuel	(U, Th) C_2	35,400	19.2	4.1
Oxide fuel	(U, Th) O_2	41,500	15.7	2.5
Low enriched fuel	UO_2	1,800	13.0	1.4
Feed/breed elements	UO_2/Th O_2	3,000	55.0/1.0	1.2
THTR elements	(U, Th) O_2	20,000	5.9	1.1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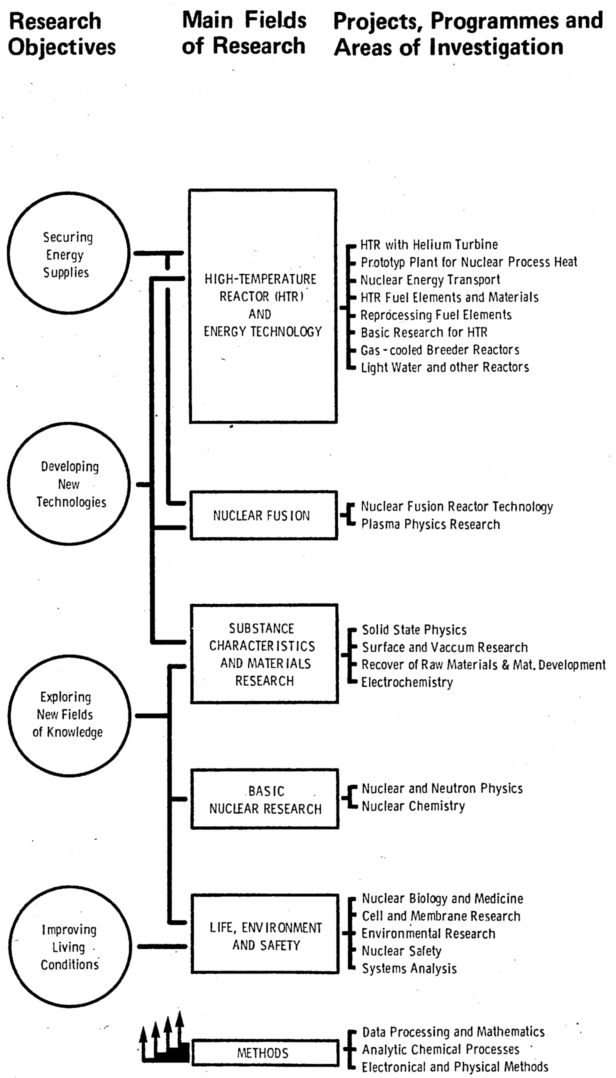
OBJECTIVES AND PROGRAMMES OF THE KFA



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JÜLICH NUCLEAR RESEARCH CENTRE (KFA)

The Jülich Nuclear Research Centre, one of the twelve major research centres in the Federal Republic of Germany, was founded by the state of Northrhine-Westphalia in 1956 as a joint nuclear research centre for the state's institutions of higher education. Since 1968 the government of the Federal Republic of Germany has been the principal partner in the supporting corporation, KFA Jülich GmbH, providing 90% of the operational costs and necessary capital investment, while 10 % is contributed by the state of Northrhine-Westphalia. At the present time the 14 institutes, the joint scientific and engineering facilities and the infrastructure employ approximately 3500, including 750 scientists. In addition, there are some 615 other persons (fellows, students in doctoral and diploma programmes, students in laboratory programmes, trainees etc.) employed by the KFA.

It is the function of the KFA to carry out basic nuclear research and engineering development as well as additional work in research and engineering. This includes the implementation of projects and programmes in collaboration with other research institutions and private industry, the development and operation of major scientific and engineering equipment as well as experimental nuclear engineering facilities.

In addition to nuclear work, non-nuclear research projects are carried out to an increasing degree and are aimed particularly at the securing of energy supplies, the advanced development of new technologies and the improvement of living conditions.

The research and development work of the KFA is supported by the major funding programmes of the Federal Government, and in particular the Fourth Atomic Programme and its successor, the Energy Research Programme of the Federal Republic of Germany. For a number of years there has been a collaboration agreement with the European Community concerning nuclear fusion. Close collaboration in many research and development projects exists with numerous research institutions and universities as well as private industry at home and abroad. Many KFA scientists teach at institutions of higher education in the state of Northrhine-Westphalia.

To an increasing extent, the KFA is also entrusted with arrangements for large-scale programmes of the Federal Government. In particular, the non-nuclear energy research programme and the development of high temperature reactors are examined and administrated by the KFA.

MAIN FIELDS OF RESEARCH

The KFA's main fields of research follow general scientific policy objectives of the Federal Republic of Germany:

- Securing energy supplies
- Development of new technologies
- Exploring new fields of knowledge
- Improvement of living conditions.

High-Temperature Reactor and Energy-Producing Technology

From the outset it was one of the KFA's major objectives to advance the development of nuclear engineering. One important contribution in this area is the work on a gas-cooled high-temperature reactor (HTR), carried out by the KFA Jülich in collaboration with private industry. The first experimental power station based on the pebble-bed reactor principle developed by R. Schulten, with an electrical output of 15 megawatts, has been operated successfully since 1967 by AVR (Arbeitsgemeinschafts Versuchsreaktor GmbH) in Jülich. In this reactor, helium is heated up to 950°C, the highest coolant temperature achieved to date in any reactor. (At the present time a thorium high-temperature reactor — THTR 300 — is being erected near Dortmund by industrial companies as a prototype.)

Development work in the high-temperature reactor is being continued by the KFA collaboration with industry. One key programme in this respect is the future use of high temperature reactors for process heat, where the first applications will be coal gasification and the reforming of methane with steam. Under the auspices of the KFA two projects have been established:

1. The project "Prototype Plant for Nuclear Process Heat", together with Bergbauforschung GmbH, Gesellschaft für Hochtemperaturreaktor-Technik, Hochtemperatur-Reaktorbau GmbH, Rheinische Braunkohlenwerke AG
2. The project "Nuclear Energy Transport System", together with Rheinische Braunkohlenwerke AG

The use of the HTR for power production is studied in the KFA in the project "High Temperature Reactor with Heliumturbine" (HHT). Compared with light water reactors, the HTR offers favourable possibilities for utilizing power station waste heat by means of heat-power coupling processes. Several institutes in the KFA also work on problems of the HTR-fuel cycle, in particular HTR-fuel elements and their reprocessing, the study of structural materials for high temperature reactors and the storage of radioactive waste products.

Nuclear Fusion

Projects in plasma physics, especially in the fields of high-temperature plasma confinement and heating, are carried out in collaboration with the European Community. Work on the technology of future nuclear fusion reactors has begun under national and international collaboration arrangements.

Nuclear fusion is seen as a long-term source of energy in the 21st century. In association with the European community, work in the KFA is concerned with fusion related plasma physics, in particular fusion reactor technology. On the way to a fusion reactor, solutions must be found to complicated physical problems concerning plasma confinement and technical problems concerning materials. The fuel reserves for a fusion reactor, deuterium (in water) and tritium, which can be obtained from lithium, are practically inexhaustible. In the KFA, there are particularly good opportunities for progress in fusion reactor technology by means of interdisciplinary studies involving plasma physics, reactor technology, nuclear chemistry, solid state physics and surface physics. A large scale experiment concerning plasmawall interactions (TEXTOR) is being planned.

Properties of Matter and Material Research

This major field of research includes basic and applied research. In solid state research the main areas of interest are research into knowledge of the atomic properties of solids, investigation of materials and the application of basic knowledge to technological problems. An objective of solid state research is the systematic development of the required know-how for the manufacture of substances having specified properties. The characteristic parameter of substances are determined and the mechanisms of elementary chemical processes are clarified in order to acquire an understanding of the reactive properties and the behaviour of substances and materials. Physical and chemical aspects of materials research are covered, giving special consideration to the development of nuclear fuels and reactor materials. In addition, the applied sector includes projects in interface and vacuum research as well as electrochemistry, and the advanced development of chemical and physical techniques.

Basic Nuclear Research

The KFA's isochronous cyclotron is used to accelerate light atomic nuclei up to 180 MeV energy for the investigation of nuclear reactions. These experiments complement basic theoretical work on reaction mechanisms, nuclear structure and nuclear fission. In the field of nuclear chemistry, major projects include the investigation and advanced development of techniques for the use of short-lived radionuclides for basic research in nuclear medicine. Particularly close collaboration with a large number of universities and other institutions of higher education exists.

Life, Environment, Safety

The interdisciplinary nature of the KFA and its substantial infrastructure offers favourable conditions for basic and applied researchs in life sciences, environmental problems and nuclear safety. Different biological activities involve cell biology, neurobiology, radioagronomy, analytical techniques for studying environmental dangers on the ground and in the atmosphere and the development of new techniques in nuclear medicine. A small, fully equipped hospital for nuclear medicine is attached to the medical centre of the KFA. Work related to systems analysis is concerned with the long term securing of energy supplies, energy demand and distribution and raw materials supply for the Federal Republic of Germany.

Support Facilities and Infrastructure

Within the scope of the above research and development extreme demands are continuously imposed on instrumentation. This requires the availability of the latest instrumentation techniques, especially in electronics and analytic chemistry, and special irradiation techniques. Moreover, mathematical methods and data processing techniques must be developed to find solutions for complicated problems arising throughout the KFA. These special methods and techniques are an important element of the KFA's research and development programme. Special-purpose equipment and facilities are available to solve many different tasks, of which only most important ones can be named here: the two research reactors, MERLIN and DIDO, are used as powerful sources of radiation particularly neutrons, in many experiments carried out by basic and applied research departments. The hot cells are used to study and process highly radioactive objects (such as irradiated fuel elements).

Facilities are available to decontaminate equipment and to process radioactive waste for storage; low-temperature facilities supply the laboratories with refrigerants. The central library (195 000 volumes, 265 000 reports) assists the research and development efforts with documentation and information.

ERNO (Entwicklungstring NORD)

June 2, 1977—Bremen, Germany

HIGHLIGHTS

The European Space Agency (ESA) and ERNO have completed agreement on a number of descoping actions to maintain a Spacelab development cost ceiling of 462 MAU (million accounting units).

ESA will serve as the purchasing agent for all Spacelab hardware which NASA purchases. ERNO would like to negotiate directly with other countries but this has not been decided between ESA and ERNO.

To avoid the cost penalties of an extended gap in production, a decision by NASA for any follow-on buys is needed in October, 1978. Therefore, follow-on Spacelab hardware procurement will be an issue for consideration in the NASA fiscal year 1979 budget authorization.

ERNO believes that with the descoping actions taken, the Spacelab development cost and schedule can be maintained.

ERNO (ENTWICKLUNGSRING NORD), BREMEN, GERMANY

ERNO is part of the Zentralgesellschaft VFW—Fokker holding group and is the prime contractor for development of the Spacelab. Development of the Spacelab was started in 1974 and the first mission is scheduled for 1980. ERNO is responsible for project management, system engineering, integration and testing.

Spacelab is a manned space laboratory being developed by European industry under the auspices of the European Space Agency (ESA). Spacelab's missions, of 7 to 30 days' duration in orbit, are devoted to space research, performing scientific, application, technical and technological experiments.

In the past, both unmanned satellites and manned space stations, such as Skylab and Salyut, were lost forever (together with their costly instruments) once the mission had ended. Spacelab, in contrast, is re-usable, being launched, transported into orbit and brought back to Earth by the Space Shuttle.

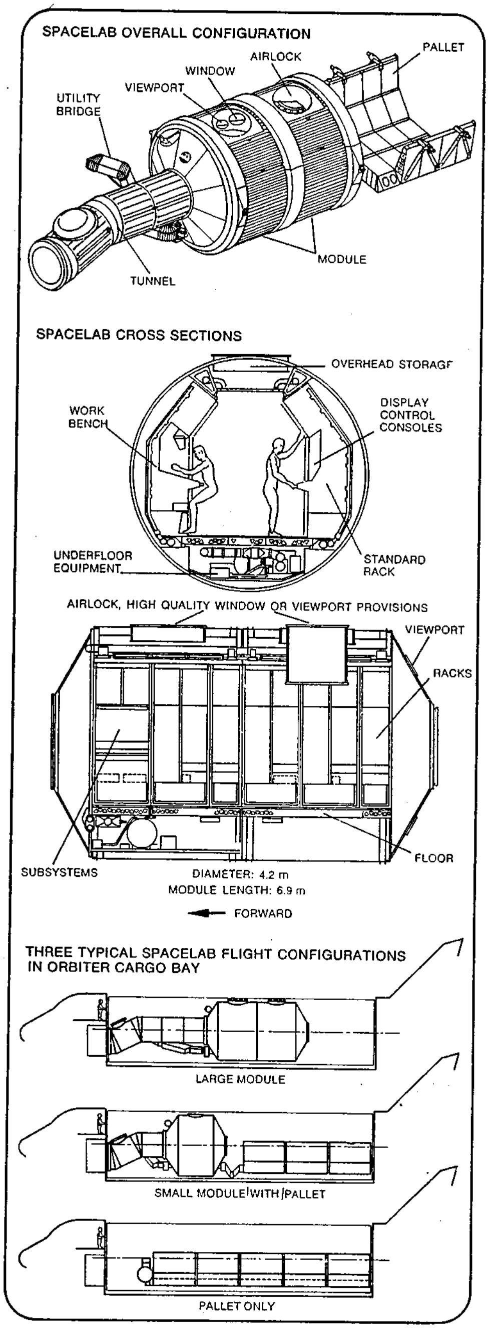
The Space Shuttle is the new manned space transportation system being developed by NASA. The main element of the Shuttle, the Orbiter, is both a rocket (for take-off) and an aircraft (for landing), and it makes repeated journeys out into space and back again. The orbiter, which has a huge payload bay, can carry out a great variety of missions; on 40 percent of all its missions the Space Shuttle is expected to carry Spacelab.

Spacelab comprises either a pressurised laboratory or an instrument-carrying pallet, or both together. Of modular design, the component elements can be combined in various configurations, flexibly meeting the requirements of each successive mission. Crew movement between the Orbiter and the Spacelab is via a tunnel, which is variable in length to ensure that the Orbiter's center of gravity remains in the right place.

A portion of the pressurised laboratory carries equipment common to all the missions for the functioning of Spacelab (computer, tape-recorders, check-out consoles). The other portion of the laboratory and the segments of the pallet carry the experiments themselves (furnaces, microscopes, centrifuges, incubators and photographic apparatus in the laboratory; telescopes, antennas, radars, and sensors on the pallet).

Whereas the crew of the Orbiter is composed of astronauts properly speaking, the crew of the Spacelab—up to four in number, men and women, Europeans and Americans—are scientists and engineers. These experts operate the experiments. They have on board the necessary computing facilities for a first interpretation of the results obtained and, being "on the spot," can modify the experiments while they are in progress and take corrective action in the event of malfunctioning.

Because it is re-usable, Spacelab enables better use to be made of the human and financial resources invested in space. Since it is being developed in Europe, it provides the Europeans with the opportunity of participating in international space activities. Above all, Spacelab satisfies two requirements: it ensures the presence of man in space—the importance of which has been demonstrated by experience—and it places space activities at the service of man, via meteorological missions, earth resources and environmental studies, and studies devoted to telecommunications, biology, bio-chemistry and the development of new materials.


SPACELAB OVERALL CONFIGURATION
PALLET
AIRLOCK
WINDOW
VIEWPORT
UTILITY BRIDGE
MODULE
TUNNEL
SPACELAB CROSS SECTIONS
OVERHEAD STORAGF
WORK BENCH
DISPLAY CONTROL CONSOLES
STANDARD RACK
UNDERFLOOR EQUIPMENT
AIRLOCK, HIGH QUALITY WINDOW OR VIEWPORT PROVISIONS
VIEWPORT
RACKS
FLOOR
SUBSYSTEMS
DIAMETER: 4.2 m
MODULE LENGTH: 6.9 m
FORWARD
THREE TYPICAL SPACELAB FLIGHT CONFIGURATIONS IN ORBITER CARGO BAY
LARGE MODULE
SMALL MODULE WITH PALLET
PALLET ONLY

The discussions of the Committee European Oversight visit to ERNO focused on Spacelab Development and Spacelab Follow-On/Future Projects and a tour of the Spacelab hardware and integration facilities at ERNO.

SPACELAB DEVELOPMENT

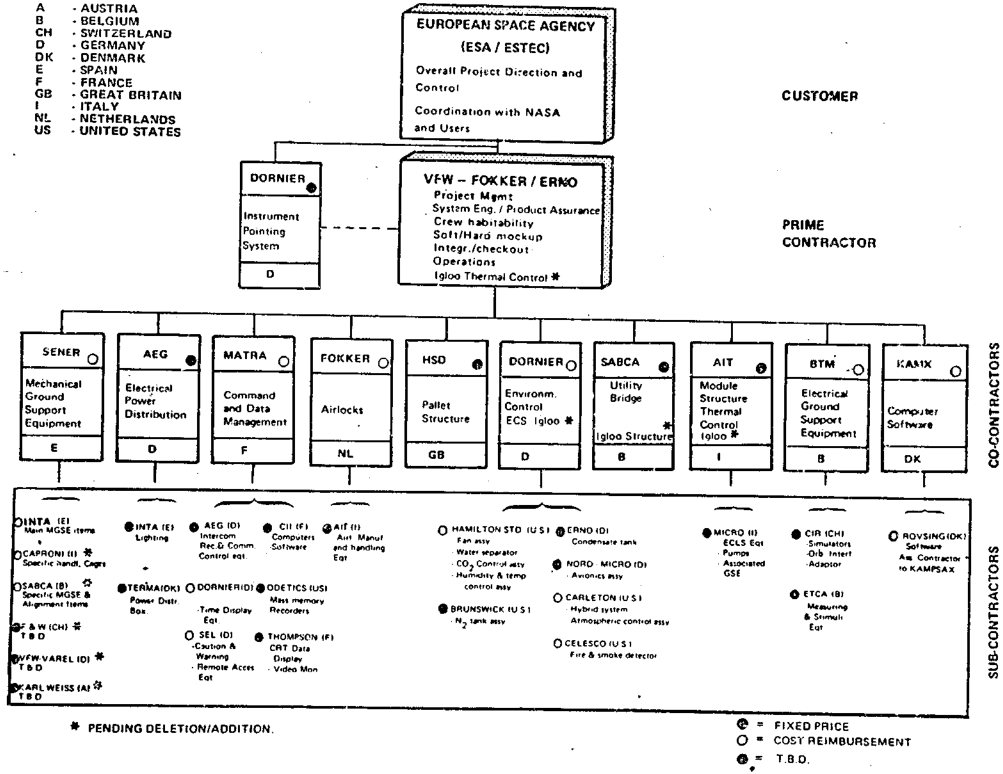
The prime contractor for SPACELAB development is VFW–Fokker/ERNO. The Spacelab tasks which ERNO is responsible for include project management, system development, integration and test, and operations. ERNO has a number of test facilities at Bremen including laboratories and workshops for hydraulic, pneumatic, optical and electronic systems, and for mechanical design work; clean rooms—one of 400 square meters of class 100,000, one of 28 square meters of class 100, and one of 31 square meters of class 10,000; vacuum chambers; and other facilities for determining moments of inertia, centers of gravity, a revolving table, etc. Recently the Spacelab Integration Hall was completed and this will house the hard mock-up of the Spacelab for integration studies and tests.

This year is a very important year for Spacelab. The preliminary design review was completed in December 1976 which showed that the Spacelab consortium could freeze the design and go ahead with manufacture.

As a result of the preliminary design review, it was possible to estimate more precisely the cost-to-completion of the Spacelab program. This program design review, however, showed that the program as structured, and including all the modifications and options which had been agreed, there would be an uncommitted management reserve margin insufficient to guarantee remaining within the agreed 120 percent limit. The financing of the Spacelab programme in Europe is governed by an Arrangement signed between the Agency and the ten participating states and which fixes the ceiling for the programme, but allows for the supplementary expenditure of 20 percent above this ceiling if this proves necessary within the lifetime of the programme. Permission to use the 20 percent requires ⅔ majority in the Board which has responsibility for the programme; if the programme were to require funding in excess of the 120 percent, participating states would be able to withdraw. In order to provide a sufficient uncommitted margin a number of descoping actions have been taken as will be described later.

The management of the Spacelab development is indeed a complex undertaking. The following chart depicts the Spacelab industrial team organization and shows the companies and countries involved for the various systems. Contract negotiations are mostly completed with 40 percent being fixed price and 60 percent being cost plus incentive fee.

SPACELAB INDUSTRIAL TEAM ORGANISATION

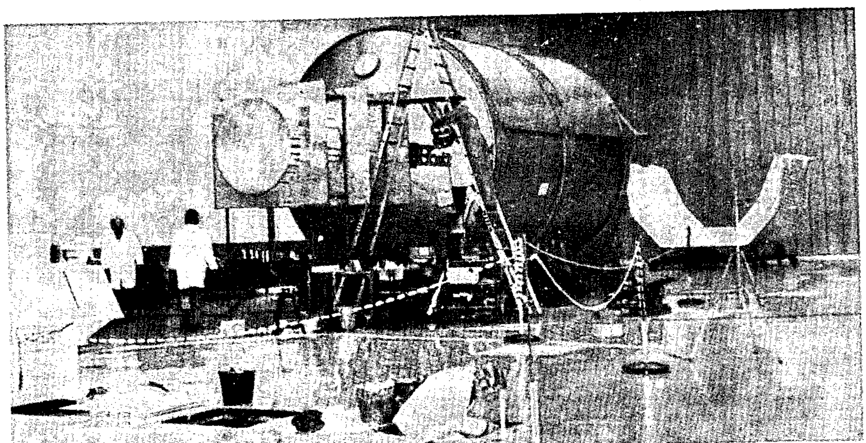


NASA HQ MF77-775 (1'

A further milestone is reached within the Spacelab development program: the integration phase for the first working model is completed with final dimensions. The so-called hard mock up serves as pre-stage to the engineering model which will be delivered to ESA fully operatively equipped by the end of 1978.

In the Spacelab Integration Hall the hard mock up is integrated during different integration phases consisting of two module segments (core and experiment module), equipped with double and single racks as well as the upper airlock. Furthermore two pallets are provided for integration tests.

Eleven months have passed from the delivery of the first hardware—among others module structures from Aeritalia/Turin and pallets from Hawker Siddeley Dynamics/Stevenage—up to the complete integration. For the first time the manufacturing sequence for the integration of the flight unit could be verified with the hard mock up. For carrying out these activities the air conditioning system is switched to visible clean conditions.



VIEW of the SPACELAB Integration Hall. The first working model is readily assembled, a long module consisting of two segments. In the background a pallet model.

Within a seven months interval, starting in April this year, NASA astronauts together with the ERNO team will check the interior equipment in the hard mock up. This includes the selection of the colours and the lighting. Flight-type lighting units have been installed on the ceiling and the rear wall.

Another step is to check the supports which are important for the activities of the future payload specialists as well as the accessibility to the equipment. The results of the assessment through the NASA astronauts that have experience in manned space are evaluated on the spot so that the interior outfit of the working model constantly reflects the latest status.

SPACELAB FOLLOW-ON/FUTURE PROJECTS

ERNO is examining the future potential which Spacelab offers beyond the current NASA/ESA agreements with the objectives of maintenance of the technological basis for the further development of future technology and optimization of the economic yield therefrom, commercialization of space activities, ensuring the continuous preservation and the extension of investments already made, and maintaining and utilization of the recently developed know-how in the area of manned space flight. A large team of approximately 1600 trained engineers and workers has been built up and the Spacelab consortium would like to be able to retain approximately 1100 (⅔) in the future.

To pursue this objective a dedicated organization for Spacelab future/follow-on activities has been established at ERNO and the other major Spacelab consortium members. Under this project organization, ERNO retains the prime contractor/head role for future projects. Presentations have been made on future potential of Spacelab to ESA and the German ministry. ERNO is making significant company investments. As a general guideline ERNO invests approximately 5 percent of its total resources to advanced projects and planning.

Spacelab follow-on/future projects which are being considered include follow-on production for both United States and Europe (ERNO has agreed that ESA will serve the agent for follow-on production sales to the United States. However, ERNO would like to negotiate directly with other countries for the sale of Spacelab hardware); Spacelab follow-on development; European participation in the United States/Spacelab programs including integration contracts, and Spacelab simulators, etc.; European Spacelab utilization programs including integration contracts and payload/equipment development; and space station.

Follow-on production of Spacelab hardware is heavily dependent on NASA plans. To avoid the cost penalties of an extended gap in production, a decision by NASA for any follow-on buys is needed in October 1978. Therefore, any follow-on Spacelab procurement will be an issue for consideration in NASA's fiscal year 1979 budget request.

The ERNO Spacelab consortium will also participate as a subcontractor to McDonnell Douglas in the United States Spacelab integration activities. The European Spacelab consortium will provide support in the areas of system engineering, modification kit design, configuration control, test and checkout, operations planning, and logistics. The European consortium considers this direct contractual relation with the United States prime with importance and views it as having extension potential for participation in other activities including verification flight instruments, tunnel, payload integration, and experiment software.

A number of activities related to this subcontract have been completed including: McDonnell Douglas/ERNO memorandum of understanding (principles of subcontract) signed on May 26, 1977; statement of work for European support to U.S.-integration contractor agreed and submitted to NASA and ESA; ERNO labor rates for U.S. support substantially decreased and agreed with McDonnell Douglas; price for initial '79 MM support negotiated and agreed $499,000.

The European Spacelab consortium is looking at a number of product improvement options including: additional power/cooling capability for space processing; addition of a centrifuge for life sciences; and increased computation capacity and improved load carrying capabilities for astronomy and earth observations. Additionally, during a number of studies performed in Europe and in the United States, on Spacelab experiments and Spacelab missions those areas for improvements and extensions have been identified: Spacelab capabilities for extended mission durations; improvements and extension of Spacelab subsystem performance capabilities; and extension of the common payload support equipment.

SPACELAB PROGRAM DESCOPING

NASA has provided the following information related to descoping of the Spacelab program: Although no formal agreement was signed between NASA and ESA, our present understanding is that the following program changes are being implemented:

(*a*) Deletion of the Engineering Model Igloo which implies: All efforts related to planning, engineering, and procurement of dedicated equipment for the integration and test of the pallet-only configuration of the Engineering Model are stopped.

(*b*) Reduction in the logistics and maintenance documentation and the volume of additional spares.

(*c*) Deletion of the third set of ground support equipment, intended to remain in Europe, from the development project.

(*d*) Reduction of the scope of modification for pallet to meet worst case thermal control subsystems.

(*e*) Change of responsibility of scrubber implementation NASA to assume responsibility for all activities relative to the scrubber.

(*f*) Change of responsibility of installation and qualification of Skylab optical window in adapter plate (to be done by NASA).

(*g*) Deletion of the Core Segment Simulator.

(*h*) Deletion of experiment computer operating software beyond the present baseline.

(*i*) Use of two static converters for 60 Hz capability for the ground support equipment.

(*j*) Cancellation of black box power reduction.

(*k*) Cancellation of design change to combat the magnetic field in payload bay.

(*l*) Cancellation of reduction of the Spacelab water loop flow rate to match Orbiter.

LONG TERM NUCLEAR WASTE DISPOSAL FALCILITY

Date of Visit: June 2, 1977,
Location of Visit: Hanover, Germany.

HIGHLIGHTS

The safety which an undergrownd formation affords for nuclear waste disposal depends critically on the incidence of earthquakes in the region, the age of the formation and its stability.

The roads used to transport the waste to the site must be safe and secure.

The German waste storage facility was not adequately protected from a safety standpoint.

REPORT OF CONGRESSMAN JOHN BREAUX ON HIS TRIP TO THE ASSE SALT MINE DISPOSAL SITE

One of the important issues facing our country in considering the development of nuclear power facilities is the disposal of radioactive waste which is the result of such nuclear facilities. One of the proposals presently being considered is the possibility of utilizing underground salt mines as potential storage facilities. The Energy Research and Development Administration is presently considering as one of their options, underground salt mines located in Southwest Louisiana along the Gulf of Mexico.

The Federal Republic of Germany has concluded that considering their high population density and their relatively rainy climate, the disposal in underground rock salt formations guarantee them the greatest reliability in the storage of such radioactive waste.

I visited one of these undeground salt domes and was accompanied by a representative of the U.S. Embassy and a representative of the Federal Republic of Germany.

The salt formations in this particular part of Northern Germany are more than one hundred million years old and according to the manager of the facility, guarantee an absolute, safe hydrological sealing completely isolating the disposed wastes. In addition, this part of Europe is supposed to be in a zone which is free of earthquakes. And, because of the existence of large caverns in the salt domes, storage can be accomplished at what they consider reasonable costs.

One of the key features stressed to me during my visit is that the salt formations in this part of Germany are extremely old as far as geological structures are concerned and are extremely stable. The stability of the formation is the key to determining the reliability as a potential storage site for radioactive waste. The age of the salt formations should be carefully evaluated when considering U.S. salt dome sites.

The Federal Republic of Germany's disposal program is presently involved with low level and intermediate level wastes. The low level radioactive wastes are packed in a 55 gallon drum which is used as a standard container. The low level wastes are handled by workers using cranes and lifting equipment. They are in direct contact with the drums although never exposed with the waste material itself. Intermediate level wastes are also stored in 55 gallon drums but because of the higher activity can only be transported and manipulated within a shielded environment.

One of my concerns from my inspection is the manner in which wastes are physically transported to the Asse salt dome. It was explained to me that both low level and intermediate wastes are transported by rail car to a site some ten miles from the salt domes and then lifted from the rail cars and placed on a truck van and transported over roads to the salt dome. The roads that I traveled were extremely narrow and winded through an inhabitated village and presented many potential problems.

In considering potential sites in the United States, transportation to and from the salt domes will have to be carefully planned and the maximum number of safety requirements should be mandated.

The physical location of the salt dome and the manner in which it was guarded, in my opinion, did not seem adequate from a safety standpoint. While the facility was surrounded by a small fence, it did not seem to be sufficiently protected from possible violators who would wish to do damage to the facility. In addition, the manager of the salt dome was not aware of any restrictions on overflying aircraft. I would certainly feel that precautions in these areas are absolutely essential.

Although no high level radioactive wastes are presently being stored at the Asse salt mines, there are plans to do so. The present plan is to solidify the radioactive waste into a form of glass or ceramic. In addition, these high level wastes could not be stored in the 55 gallon drums but only in much smaller containers because of their production of heat. The Asse salt mines are presently undergoing tests to determine the best method for disposal of these high level wastes and to carefully plot the reaction of the salt formations to the higher temperatures. Temperature tests are presently being conducted and the results will be forthcoming in the near future.

The final point I would like to make is that there seems to be a great deal of cooperation between the Federal Republic of Germany and the United States with regard to the exchange of information on these disposal programs. Mr. Egon Albrecht who is the manager of the Asse facility was very familiar with our ERDA programs and has visited the United States on a number of occasions to discuss with our scientists the progress which they are making. I think it is absolutely essential that ERDA be encouraged to continue the exchange of information with the Republic of Germany in order that we might benefit from their work experience.

32D SALON INTERNATIONAL DE L'AERONAUTIQUE ET DE L'ESPACE, LE BOURGET AIRPORT, PARIS, FRANCE—JUNE 3, 1977

HIGHLIGHTS OF VISIT

The theme of the 32nd Paris Air Show was commemoration of the 50th Anniversary of Charles Lindbergh's historic solo flight from New York to Paris.

This year's show illustrated the recent trend toward greater participation in the world aviation market by ever larger numbers of countries.

U.S. military fighters including the F–15, F–16, F–18, A–10, YC–14, YC–15, along with several entries from foreign countries performed daily flight demonstrations.

Commercial transports from Europe and the Soviet Union emphasized the foreign challenge to U.S. leadership in this field.

General aviation aircraft including small commuter-types helicopters and special purpose aircraft such as agricultural airplanes were displayed on the ramp at Le Bourget.

REPORT

Nearly fifty years to the day after Charles Lindbergh's historic solo flight across the Atlantic, the 32nd Paris Air Show opened with that intrepid event as its centerpiece. Many people feel that Lindbergh provided commercial aviation with the bellwether it needed to become viable as a mode of transportation. So it was appropriate that his achievement was honored at the world's premier exhibition of both civil and military aerospace technology and hardware.

Although missing the past excitement of head-to-head competition, between U.S. and French light-weight fighters, this year's show nevertheless emphasized the continued shift toward ever greater participation in the growing world aerospace market by a variety of countries. As recently as 1970 the U.S. held a dominate 80 percent share of the $28 billion global market. By 1985 the sales total is projected to grow to over $50 billion, but the U.S. share is expected to decline to 60 percent.

Against these projections must be weighted the effect of a number of uncertainties. President Carter's policies on sales of military equipment could further reduce the role of the American aerospace industry in markets outside NATO. Standardization of NATO weapons, urged by the U.S., could invite Western European participation in the U.S. domestic market. Demands for collaboration in the form of joint ventures and offsets as the price for export sales may increase.

Because the total size of the market will grow, U.S. industry will still benefit from real growth. But the steadily increasing European share of world sales and the rising demands of nations outside Europe for a bigger piece of high-technology industrialization will have profound affects on the shape of the export business. This year's Paris Air Show was a vivid illustration of the results of these trends.

The 32nd Salon Internationale de l'Aeronautique et de l'Espace, as the 1977 Paris Air Show is officially known drew a total of 628 exhibitors and 233 aircraft from 20 countries, an increase of 10 percent over the previous show in 1975. Cost increases for everything from exhibit space to meals apparently had little affect on exhibitors and spectators.

MILITARY AIRCRAFT

One of the highlights of the show was the daily flight demonstrations by various military aircraft. The USAF/McDonnell Douglas F–15 air superiority fighter made its second show appearance. The USAF/General Dynamics F–16, French Mirage F–1 and the Swedish Viggen, center of attention during the 1975 show, all returned for encores. The Northrop YF–17 prototype of the Navy/McDonnell Douglas/Northrop F–18 provided impressive displays.

Of particular interest was the competition between the two candidates for the USAF Advanced Medium STOL Transport. The Boeing YC–14 and the McDonnell Douglas YC–15 demonstrated alternate new-technology concepts for achieving short-field operations. These aircraft have potential for adaptation to commercial passenger and cargo applications, particularly in U.S. and developing countries. The Air Force is expected to pick a winner by the end of the year.

The jointly developed British/German/Italian multi-role combat aircraft, the Tornado was flown daily at the show. Total orders for this fighter are projected at 810 with deliveries scheduled to begin in 1979.

Israel is making a massive push to expand its aerospace export sales. The key to this is the Kfir fighter, manufactured by Israel Aircraft Industries and powered by G.E. engines. Two Kfirs were on static display in conjunction with the Israeli pavilion at Le Bourget.

Another sales contest at Paris involved the market for European early warning aircraft. The USAF/Boeing Airborne Warning and Control System (AWACS) aircraft appeared but made no flight demonstrations. Grumman demonstrated two E–2*c*'s, costing about one-fourth the price of AWACS, as an alternative for the NATO order.

The USAF/Fairchild A–10 interdiction aircraft made several impressive flight demonstrations, but became involved in a very unfortunate accident early in the show.

COMMERCIAL TRANSPORTS

Nowhere does the threat to U.S. leadership in aviation have greater potential consequences than in the area of large commercial transport aircraft. Today, 85 percent of the commercial aircraft flying in the free world are of U.S. manufacture. The economic importance of this can be illustrated by the fact that the sale of a single Boeing 747 is sufficient to offset the cost of about 4 million barrels of imported oil. In recent years, however, foreign countries, especially those in Western Europe, have stepped up their efforts to compete with U.S. firms.

A decade ago, the European aerospace industries were one-tenth the size of the U.S. aircraft industry. Today, however, they are approximately one-quarter the size of their U.S. counterpart. Aerospace employment in Europe, including military and commercial production aircraft, engines and parts, is about 425,000 (half of whom are British) as compared to some 925,000 in the United States. As for sales, Europe's output increased 24 percent between 1965 and 1973. The evidence of this was prominently on display at Paris. Particularly significant are their efforts to pool their resources and talents in consortia to challenge U.S. preeminence.

One of the most successful examples of such collaboration is the Airbus Industrie A–300, a two-engine, wide body, seating about 250 passengers. The first foot-in-the-door to the U.S. market came recently when Eastern Airlines agreed to lease four of these aircraft for a trial six-month period.

Other jointly produced transports at Paris were the VFW-Fokker F–28, an 85 passenger conventional take-off and landing aircraft and the VFW-Fokker 614, a very low noise short take-off and landing aircraft. Also on display was the most famous European aircraft, the Anglo-French Concorde.

The Russians made a big showing at Le Bourget of their latest civil aircraft, all of which looked like copies of western models. Their new four-engine wide-body the Ilyushin IL–86 made its debut outside the Soviet Union. Of course the Tupolev Tu–144 supersonic transport was on display again. And the new Yakovlev Yak–42 short-haul transport flew in during the show. The Soviets hope to sell this airplane in the west.

Another international joint venture that has received much attention in recent years, partly because of concern over technology transfer, is the G.E./SNECMA effort to produce a new turbo-fan engine. At this year's show this new engine, called the CFM56, could be seen installed in the left outboard pod of the YC–15. The engine, which is in the ten-ton thrust category, is considerably more quiet and fuel-efficient than current technology. It is under consideration as the power plant for a host of proposed new aircraft designs.

G.E. and SNECMA announced at Paris that they would continue their collaboration with another joint venture to produce a clipped fan version of the CF6, to be designated the CF6–32. The new engine with a thrust of 30,000 pounds is aimed at Boeings' proposed 7x7.

GENERAL AVIATION

The area of general aviation saw the greatest participation by the largest number of countries. The big push for a share of the international market has brought aviation products from an ever expanding circle of producing nations.

Eastern bloc countries including Russia, Poland and Czechoslovakia are represented by a line of transports, military trainers, agricultural aircraft and helicopters. The Polish industry was represented by the WSK–Mielec M–15 agricultural biplane, powered by a Soviet-built Ivchenko A1–25 turbofan engine. The Czechoslovakians exhibited a two-seat basic trainer, the Aero L–39 Albatross, which is being considered by both East and West Europe as a military trainer.

The Canadian presence was strong with both the DeHavilland DHC–5 and DHC–7 STOL transports making daily flight demonstrations. South American industry is making a concerted bid in the international marketplace. Embraer of Brazil flew the Xingu, a new 9 passenger, pressurized commuter. Also on display was the Bandeirante of which 150 have been sold throughout South America.

U.S. firms were also well represented with aircraft from Rockwell, Gates Learjet and Cessna among those on static display at Paris.

SPACE

In recent years the Paris Air Show has been expanded to include space. This year the Soviets had a pavilion dedicated to their space efforts. For the first time they displayed their Venus soft-lander, Venera 10. The U.S. pavilion included displays of the Space Shuttle and a mock-up of the proposed Mars Crawler. The French National Space agency, Centre National d'Etudes Spatiales (CNES) had a large display featuring hardware from the European Ariane launcher for which it is the program manager.

ADDITIONAL MATERIAL

Background Information on the U.S. Mission to the International Atomic Energy Agency, Vienna

TABLE OF CONTENTS

1. Introduction—U.S. interests and the IAEA.
2. How the U.S. Mission operates.
3. The organization of the IAEA:
   a. Governing bodies.
   b. The Secretariat.

Annex A—Officers of the U.S. Mission.
Annex B—Principal officers of the IAEA Secretariat.
Annex C—The Agency's budget and finance.
Annex D—IAEA Board of Governors.
Annex E—Staff of the IAEA.

INTRODUCTION—U.S. INTERESTS AND THE IAEA

In his historic "Atoms for Peace" address to the United Nations General Assembly in 1953, President Dwight D. Eisenhower urged the establishment of an international organization to:

". . . devise methods whereby . . . fissionable material would be allocated to use in the peaceful pursuits of mankind." Three years later, in 1956, the Statute of the International Atomic Energy Agency (the IAEA) came into force and the organization itself came into existence the following year on July 29, 1957.

In Article II of its Statute the basic objectives of the organization are set forth:

> The Agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world. It shall ensure so far as it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose.

The United States shares and strongly supports the basic objectives of the Agency. The principal U.S. interests in the IAEA relates to the Agency's responsibility to assure that nuclear materials and facilities are not used to further any military purpose. These are carried out under its program called "Safeguards."

IAEA Safeguards have the principal objective of timely detection of the diversion of significant quantities of sensitive nuclear material of importance to the manufacture of nuclear weapons or other nuclear explosive devices (principally plutonium or enriched uranium) and the deterrence of such diversion by the risk of early detection and the consequent threat of international exposure. To accomplish that objective, IAEA safeguards include review of the design of facilities, examination of records and reports, surveillance and containment devices and, most importantly, on-site inspection by IAEA inspectors for the purpose of independent verification of nuclear material flows and inventories by means of analysis of samples, measurements, etc.

Since the founding of the Agency, the United States has taken a leading role in creating an effective IAEA safeguards system, and, to a great extent, we have transferred to the Agency the responsibility for applying safeguards on the nuclear materials and facilities which the U.S. provides bilaterally to other countries. In this important function, therefore, the IAEA has become a primary vehicle for implementing relevant U.S. interests. In recent years, particularly with the coming into force of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), the Agency's safeguards functions have assumed increasing importance. Under the NPT, non-nuclear weapons states party to the Treaty (there were 97 as of June 30, 1976) are required to accept safeguards on all of their peaceful nuclear activities under agreements with the Agency to insure that nuclear materials are not diverted from peaceful uses. All the non-nuclear weapons states of Western Europe, except Switzerland and Spain, and all East Europeans states, except for Albania, are parties to the NPT, as are Japan and Canada.

Although not required to do so under the NPT, the United States and the United Kingdom (two of the three nuclear-weapons states party to the Treaty; the USSR being the third) have each offered to permit the IAEA to apply its safeguards to their respective peaceful nuclear activities, excluding only those having direct national security significance, when such safeguards are applied generally in non-nuclear weapons states party to the Treaty.

A second important U.S. interest in the IAEA arises from our commercial position as the predominant supplier of nuclear materials and equipment to the rapidly growing world market for nuclear electric power generating facilities and materials—such as power reactors, fuel, and related equipment and services. Particularly in view of the recent energy crisis, our commercial interest is an important and expanding one, and necessitates our active participation in the work of the Agency in this field.

Active U.S. involvement in the Agency's programs, for example, serves to preserve and advance this commercial interest. The Agency's activities, which include defining the market for certain items, and helping to coordinate legal and regulatory standards relating to nuclear programs in member states are of direct interest to our nuclear equipment vendors. In addition, Agency functions in other areas help insure that U.S. products may be sold under our own laws relating to conditions of export, and that the equipment will be received and used by customers who are well-trained and capable of using them safely, reliably and effectively.

The U.S. Government seeks to realize its other objectives in the IAEA by full financial backing through (1) its annual assessed contribution to the Agency's regular budget, which is the largest contribution of any member state (the Agency's budget and finance is described in greater depth in Appendix C), (2) the provision of cost free experts to advise on numerous regular program activities, (3) a pattern of participation in the many technical meetings and symposia scheduled by the Agency each year, and (4) through vigorous support for the Agency's technical assistance program. This last item includes:

An annual voluntary cash contribution to the Agency for technical assistance to developing countries which are members of the Agency:

Gifts of U.S.-made equipment to the Agency and to certain developing countries;

Providing to the Agency, on a cost free basis, fellowships for study in the United States and the services of U.S. experts to advise on technical assistance activities in Member States; and

Support for organization of specialized training courses for nationals of IAEA developing Member States.

The United States also maintains continuing active cooperation with the Agency's numerous other programs, particularly the International Nuclear Information System.

Finally, the strong and active role of the United States Mission to the IAEA, located in Vienna, enables the U.S. Government to encourage the Agency to act in areas of scientific or technical interest to the United States or in areas where the U.S. has determined that there is a requirement for concerted international action relating to nuclear energy.

HOW THE U.S. MISSION OPERATES

The U.S. Governor and the Deputy U.S. Representative

The U.S. Mission to the IAEA is headed by the U.S. Representative (also the U.S. Governor on the Board of Governors of the IAEA) who has the rank of Ambassador. The current U.S. Representative is the Honorable Gerald F. Tape. He is resident in Washington and comes to Vienna three or four times a year for meetings of the Board of Governors, the General Conference, and such other special meetings as require his presence. When the U.S. Representative is not present in Vienna, the Mission is headed by the Deputy U.S. Representative (also referred to as the Resident Representative). Both the positions of U.S. Representative and Deputy U.S. Representative are established by law and require Presidential appointment and confirmation by the Senate.

The staff of the Mission

The staff of the U.S. Mission to the IAEA (listed in Annex A) includes three advisers who handle most of the scientific, technical, and legal affairs, and two Foreign Service officers who act as political advisers. A sixth adviser has been on loan to the Mission from the U.S. Arms Control and Disarmament Agency since August 1975. The Mission also has four secretaries, a communications and records officer, an administrative assistant (an Austrian), and two drivers.

The Counselor for Atomic Energy Affairs is the Representatives' chief technical and political adviser on a wide spectrum of Agency activities, and is the acting chief of mission when the Resident Representative is out of the city. The senior technical adviser has primary responsibility for safeguards matters. The Attaché works on personnel matters regarding staffing the Agency Secretariat with qualified Americans. The Attaché also follows the Agency's schedule of meetings and assists the second political officer in analysis of the Agency's technical assistance program and its budget.

The senior political adviser is responsible for traditional multilateral diplomatic contacts with other missions and is the Representatives' chief adviser on political strategy in the organization. The second political adviser interacts more with the staff of the Secretariat and is responsible for following the Agency's technical assistance activities. He also handles matters concerning the Agency's budget and administration and its relations with the remainder of the U.N. family. The officer on secondment from ACDA has responsibilities primarily in the Agency's safeguards field and regarding any responsibilities the Agency may acquire in the field of peaceful nuclear explosions.

The entire staff of the Mission assists the U.S. Representative in conducting relations with the Agency and in keeping the Department of State and other interested U.S. Government agencies informed of developments within and concerning the Agency, particularly on matters to be discussed at meetings of the Board of Governors and at the General Conference. The Mission makes recommendations as to positions that the U.S. Government should take, and provides the U.S. representation at most meetings which are not of a strictly technical nature. It is also responsible for analyzing the results of these meetings and following up subsequent developments with other Missions in

Vienna and with the Secretariat. During meetings of the Agency's Board of Governors the members of the Mission staff (along with such persons as are sent from Washington for individual meetings) serve as advisers to the U.S. Governor.

The Mission is a U.S. diplomatic post separate from the U.S. Embassy in Vienna. It looks to the Embassy, however, for administrative support and cooperates closely with the U.S. Ambassador to Austria and his staff.

Relationships with other missions

The bulk of the ongoing work of the Agency, and especially of the Board of Governors, is presently conducted in Vienna through normal diplomatic interchange and informal consultations among the resident representatives or permanent missions and between these representatives and the Agency's Secretariat. Maintenance of continuous liaison with these resident representatives and missions is one of the principle duties of the U.S. Resident Representative and of the U.S. Mission's political adviser.

Many of the thirty-four Governors who are members of the Board are officials of their governments' atomic energy establishments and are residents in their countries' capitals; some of these Governors have resident representatives in Vienna who are usually career members of their diplomatic services (as is the case with the U.S.). Others are concurrently their country's Ambassador to Austria or Representative to the United Nations Industrial Development Organization.

THE ORGANIZATION OF THE IAEA

Governing bodies

(*a*) The Board of Governors:

The IAEA Board of Governors is unique in the UN family by virtue of the unprecedented scope of its authority. The Statute gives the Board "authority to carry out the functions of the Agency." The Board appoints the Director General (subject to the approval of the General Conference), and submits the annual budget of the Agency to the General Conference, which can accept or reject it, but not amend it.

The Board has important responsibilities under the Statute in the field of safeguards. It approves each Safeguards Agreement to which the Agency is a party, and the designation of inspectors to conduct safeguards inspections. In the event of any non-compliance with the provisions of a Safeguards Agreement, the Board is called upon to report such non-compliance to Member States and to the Security Council and General Assembly of the United Nations. If the State fails to take corrective steps within a reasonable time, the Board may withdraw or terminate any assistance given to that State by the Agency. (However, there has never yet in the Agency's existence been a case where the Board was required to invoke these procedures.)

The Board currently consists of 34 members (enlarged from 25 by an amendment to the Agency's Statute which came into force in 1973). Nine of these seats are filled by members designated each year, for one-year terms, by the outgoing Board from those members "most advanced in the technology of atomic energy including the production of source materials." In addition, the outgoing Board designates the member most advanced in each of the Agency's geographic regions which do not include one of the above nine; accordingly, at its June 1976 session the Board designated 12 states to serve during the period 1976–77. These "designated" seats on the Board are normally filled by the largest and most advanced members, including the U.S., the UK, France, the USSR and Japan.

The remaining 22 seats on the Board are filled by election by the General Conference for two-year terms, with specific provision for distribution of these seats among the eight geographic regions named in the Statute. Counting both elected and designated seats, the Board representation for North America now stands at 2 (the U.S. and Canada). for Western Europe at 8, for Eastern Europe at 4 (including the USSR), for Latin America at 6 and for Asia and Africa at 14. A listing of the 34 members of the Board as of June 30, 1976, is attached at Annex D.

(*b*) The General Conference:

All members of the Agency are entitled to attend the annual General Conference of the Agency, which ordinarily is held in Vienna during the latter part of September. This gathering of high-level officials concerned with atomic energy from all over the world provides many of them with a unique opportunity to transact bilateral business with many of their counterparts from other nations, with whom they might not otherwise have a chance to conveniently meet. The General Conference also serves as an opportunity for non-members of the Board to voice their desires and opinions of the Agency's activities, and for contact between the Agency's Secretariat and those members not regularly represented in Vienna.

Although empowered to discuss and make recommendations upon any issue within the scope of the Statute, the specific functions of the General Conference are limited and include:

Election of 22 (11 each year) of the 34 members of the Board of Governors;

Approval of states for membership (upon recommendation of the Board);

Suspension of members (upon recommendation of the Board);

Approval of the budget submitted by the Board (although the Conference may not amend it);

Approval of relationship agreements with the UN and other international organizations;

Approval of amendments to the Statute; and

Approval of the appointment of the Director General (upon recommendation of the Board).

The U.S. Delegation to the General Conference would normally include high-ranking officials of the ERDA, of the NRC and of the Department of State. The Delegation also normally includes members of Congress (usually drawn from the Joint Committee on Atomic Energy). The U.S. Representative and Deputy Representative serve as alternates to the Head of Delegation and the remainder of the Mission staff serve as advisers to the Delegation.

The Secretariat

(*a*) The Director General:

The Secretariat is headed by the Director General, who is appointed by the Board with the approval of the General Conference for a term of four years. The current Director General, Dr. Sigvard Eklund of Sweden, was reappointed by the Board and the General Conference for his fourth four-year term in the fall of 1973. The Director General is responsible for the appointment, organization and functioning of the staff of the Secretariat, under the authority of and subject to the control of the Board, and performs his duties in accordance with recommendations adopted by the Board.

(*b*) The Deputy Directors General and the Inspector General:

The Secretariat of the IAEA is divided into five Departments, four of which (Technical Assistance and Publications, Technical Operations, Administration, and Research and Isotopes) are headed by Deputy Directors General (DDG's). The Department of Safeguards and Inspection is headed by the Inspector General (IG) who has a rank and status equivalent to that of a DDG. When the Director General is absent from his office, he appoints one of the DDG's to act for him; in view of his special position, the IG ordinarily is not asked to serve as Acting Director General. In addition, a new post has been created (in 1976) that of Assistant Director General, which is currently held by a South African national, D.A.V. Fischer, who also handles the Agency's external relations (e.g., relationships with other international organizations).

(*c*) Division Directors:

The next level is that of Division Directors within the five Departments. Two of these Director level posts are currently held by Americans (Directors of the Divisions of Budget and Finance and Scientific and Technical Information). In addition, an American employee of the Food and Agriculture Organization heads the Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture, which is located in the Agency's headquarters in Vienna. (The names and nationalities of the Deputy Directors General, the Inspector General, and Director-level officials of the Secretariat are contained in Annex B.)

(*d*) The Staff:

The Agency's total regular staff numbers just over 1,240, and is located almost entirely at the Agency's headquarters in Vienna. (The Agency also has employees at the International Center for Theoretical Physics at Trieste, the International Laboratory of Marine Radioactivity at Monaco, its Seibersdorf Laboratory just outside Vienna, and at its small liaison offices in New York and Geneva.) About 830 of these employees are General Service and Maintenance and Operational category employees, who are largely Austrian. The professional staff as of June 30, 1976 (as reflected in the table in Annex E) included nations of 60 Member States of the Agency among its 349 posts, subject to geographical distribution. About 18.6 percent of these professionals were Americans.

An additional 63 posts are not subject to geographical distribution. There are also 19 staff members in the Joint Food and Agriculture Division and some 79 temporary employees (assistance contracts, consultants, and secondments).

Most of the Agency's scientific professionals serve for fixed terms of two to four years. This is based upon the provision of the Statute which requires that the Agency's permanent staff be kept to a minimum, (a provision which is unique in the UN family of organizations), and reflects a deliberate policy of avoiding the creation of a large group of long-service scientific professionals. This serves to promote a constant infusion of scientists with up-to-date knowledge and new ideas, enabling the Agency to keep abreast of new developments in the constantly-changing nuclear field.

The Secretariat is responsible for the year-round implementation of the Agency's program in accordance with the direction given to it by the Board and General Conference in their consideration of the Agency's program and budget documents. In addition, as the member of the UN family competent in the field of nuclear energy, the Agency is frequently called upon to provide advice and assistance to other UN agencies whose activities enter the nuclear field, and to implement technical assistance projects in the field of nuclear energy and techniques within the United Nations Development Program (UNDP).

In addition to the permanent regular staff at headquarters, the Agency normally employs a number (which varies according to the demands of its program) of short-term consultants to assist the Agency's regular staff on specific projects which require special expertise, and experts who render technical assistance to developing countries. The Agency normally employs about 200–300 individuals annually to implement assignments as technical assistance experts in field locations around the world, with these assignments ranging in duration from two weeks to one year or longer. The number of Agency experts in the field at any one time varies greatly, but normally averages around 30–50 during any month in a given year.

Additional sources of income for technical assistance activities are members' contributions in kind and certain "special" cash contributions for specific programs or purposes. Contributions in kind are usually equipment or expert services provided cost-free to the Agency, or cost-free fellowships in the donating country whose recipients are nominated by the Agency. In 1975, these amounted to over 4 million dollars (compared to about $2.7 million in 1974) of which the United States provided almost $1,650,000. In accordance with a policy announced in 1974, the United States gives preference to NPT parties in allocating its contributions in kind.

Other sources of income for the Agency include receipts from the UNDP for overhead costs resulting from use of United Nations technical assistance funds, income from short-term deposits, sales of Agency publications, reimbursement from the United Nations Industrial Development Organization (UNIDO) for the costs of Agency administrative services used jointly by the two agencies in Vienna, and other miscellaneous income.

The IAEA budget is among the smaller of those of the major agencies of the UN family. The Agency has a history of maintaining a sound and well-managed program on its relatively modest budget. The budget will, however, have to keep pace with the increased level of activity and responsibility placed on the Agency by its members, including the United States, in its safeguards, technical assistance and other activities in response to the rapid increase in nuclear power plants throughout the world.

Further details of the Agency's budget for 1977, and of its detailed program of work for the period 1977–82, can be found in the published budget documents (most recently, document GC(XX)567) which is available from the Mission on request.

Annex A

U.S. Mission to the International Atomic Energy Agency

1080 Vienna, 14 Schmidgasse

U.S. Representative: Ambassador Hon. Gerald F. Tape (nonresident).

Deputy U.S. Representative: Ambassador Hon. Galen L. Stone (resident).

Secretary: Mrs. Georgia H. Alexander.

Counselor: Allan M. Labowitz.

Attaché: Thomas G. Gabbert. Secretary, Mrs. Chris Ashley.

Scientific advisers: John F. Mahy, Eric E. Anschutz. Secretary, Miss Ruth Sweeney.

Political adviser: Joseph P. Leahy.

Political/administrative adviser: James H. Williamson. Secretary, Mrs. Gladys Oakley. Central files, Miss Irene Norman. Administrative assistant Mrs. Susanna H. Kun.

Annex B

Principal Officers of the International Atomic Energy Agency

Director General: Dr. Sigvard Eklund (Sweden).

Deputy Director for Administration: Dr. John A. Hall (U.S.).

Director, Division of Budget and Finance: John P. Abbadessa (U.S.).

Director, Office of Internal Audit and Management Services: Dov Broshy (Israel).

Assistant Director General and Director, Division of External Relations: David Fischer (South Africa).

Director, Division of General Services: Muneer-Uddin Khan (Pakistan).

Director, Legal Division: Ian MacGibbon (U.K.).

Director, Division of Personnel: Wilfrid Lynch (Australia).

Secretary, Secretariat of the Policymaking Organs: Terence Garrett (U.K.).

Deputy Director General for Research and Isotopes: Hellmut Glubrecht (F.R.G.).

Director, Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture: Maurice Fried (U.S.) (FAO Staff Member).

Director, Division of Life Sciences: Masamichi Saiki (Japan).

Director, Division of Research and Laboratories: Alexander V. Shalnov (U.S.S.R.).

Director, International Centre for Theoretical Physics (Trieste): Abdus Salam (Pakistan).

Director, International Laboratory of Marine Radioactivity (Monaco): Charles Osterberg (U.S.).

Inspector General: Rudolf Rometsch (Switzerland).

Director, Division of Development: Adolf Von Baeckmann (F.R.G.).

Director, Division of Operations: Slobodan Nakicenovic (Yugoslavia).

Director, Information Treatment Unit: Vladimir Shmelev (U.S.S.R.).

Deputy Director General for Technical Assistance and Publications: Helio F. S. Bittencourt (Brazil).

Director, Division of Technical Assistance: Svasti Srisukh (Thailand).

Director, Division of Publications: Norbert Brell (Austria).

Deputy Director General for Technical Operations: Ivan S. Zheludev (U.S.S.R.).

Director, Division of Scientific and Technical Information: Edward J. Brunenkant (U.S.).

Director, Division of Nuclear Power and Reactors: Andre-Jacques Polliart (France).

Director, Division of Nuclear Safety and Environmental Protection: Charles H. Millar (Canada).

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ANNEX C

THE AGENCY'S BUDGET AND FINANCE

The Agency's Budget for 1977 is broken down into the following main sections:

Regular budget	**$43,501,000**
Operational budget:	
Operating Fund I	**1,155,000**
Operating Fund II	6,350,000
Total budget for 1977	51,006,000

The Regular Budget provides funds for the regular activities of the Agency, including its safeguards program. The Operational Budget includes support for certain activities of the International Center for Theoretical Physics at Trieste, Italy and the International Laboratory of Marine Radioactivity at Monaco (Operating Fund I), and for the provision of Technical Assistance by the Agency (Operating Fund II).

ASSESSED CONTRIBUTIONS

About 85 percent of the funds for the 1977 Regular Budget will come from assessed payments by the members, based on a scale fixed annually by the General Conference. Of this amount, the United States will pay just short of 28 percent. The percentage paid by each member, including the U.S., is made up of two components. Each member has a "base rate of assessment", which is computed based on the principles adopted by the United Nations General Assembly in fixing the UN scale. This base rate is then adjusted, according to a complex "safeguards financing formula" adopted by the 1971 General Conference, to calculate the "scale of assessment" percentage actually paid by the member state.

The United Nations scale of assessments for 1974–1976, on whose principles the base rates of assessment for IAEA members will be based in 1977, includes a maximum rate for the U.S. of 25 percent. When the Congress of the United States imposed a limit of 25 percent on U.S. assessed payments to international organizations, however, it exempted the IAEA from this limitation. Therefore, the U.S. "base rate of assessment" for 1977 will be 27.51 percent, and will continue to be somewhat above 25 percent (to prevent an increase in other member's "base rates of assessment") until the addition of new members and their contributions can reduce the U.S. base rate to the 25 percent level.

The safeguards financing formula was devised in order to insulate developing members of the Agency from the effects of rapid increases in the costs of implementation of safeguards pursuant to the Non-Proliferation Treaty (NPT). As a result of this formula, developing countries actually pay at rates which are somewhat below their base rates of assessments, while advanced countries have scale of assessment percentage rates somewhat above their base rates. For example, 1977, with a base rate of 27.51 percent, the United States will actually pay at a scale of assessment of 27.88852 percent. In fact, even after the United States' base rate of assessment reaches 25 percent, we will pay our assessed contributions to the Agency at a scale of assessment somewhat above 25 percent. This additional amount represents costs which the U.S. has accepted, pursuant to its policy of commitment to the NPT and to Agency safeguards. It also expresses, in one small way, our recognition of the additional costs necessary to further U.S. interests in the maintenance and advancement of this aspect of international peace and security. Thus, in 1977, the U.S. will pay 29.27478 percent of total Agency safeguards costs of $7,936,000 (or $2,323,247).

OTHER SOURCES OF INCOME

Voluntary contributions constitute the principal source of income for the Operational Budget. Income to Operating Fund I is largely from special contributions made by some members and some other organizations for the support of the two facilities financed from this Fund. The provision of technical assistance from Operating Fund II is financed solely by voluntary cash contributions made by member states toward a target set annually by the General Conference. The Target for 1977 is $6.0 million. Voluntary cash contributions pledged by members for 1976 should amount to about $5.0 million of a $5.5 million Target. The United States has pledged $1,516,350 toward this 1976 total.

The Agency also serves as an executing agency for the United Nations Development Program (UNDP) each year, implementing a large number of projects in the field of nuclear energy in developing countries. In 1975 it received and expended $4,493,301 to execute such projects, compared to $3,556,720 for the same purpose in 1974.

Annex D

IAEA Board of Governors

1975–76	1976–77
Most Advanced (Appointed by the Board)	
1. Canada	1. Canada
2. France	2. France
3. Germany (Federal Republic)	3. Germany (Federal Republic)
4. India	4. India
5. Italy	5. Italy
6. Japan	6. Japan
7. USSR	7. USSR
8. USA	8. USA
9. United Kingdom	9. United Kingdom
Regionally Most Advanced (Appointed by the Board)	
10. Argentina (Latin America)	10. Australia (Far East)
11. Australia (Far East)	11. Brazil (Latin America)
12. South Africa (Africa)	12. South Africa (Africa)
Elected by General Conference (region in parentheses)	
13. Bangladesh (MESA)	13. Bangladesh
14. Brazil (LA)	14. Argentina (LA)[1]
15. Chile (LA)	15. Chile
16. Colombia (LA)	16. Colombia
17. Denmark (WE)	17. Denmark
18. German Democratic Rep. (EE)	18. (Not yet announced) (EE)[1]
19. Indonesia (SEAP)	19. Indonesia
20. Iran (MESA)	20. Pakistan (MESA)[1] or Iraq (MESA)[1]
21. Iraq (Floating seat)	21. Egypt (Floating seat)[1]
22. Libyan Arab Republic (AF)	22. Libyan Arab Republic
23. Netherlands (WE)	23. Netherlands
24. Philippines (Floating seat)	24. Philippines
25. Poland (EE)	25. Poland
26. Senegal (AF)	26. Senegal
27. Spain (WE)	27. Belgium (WE)[1]
28. Thailand (SEAP)	28. Malaysia (SEAP)[1]
29. Turkey (WE)	29. Portugal (WE)[1]
30. Uruguay (LA)	30. Mexico (LA)[1]
31. Venezuela (LA)	31. Panama (LA)[1]
32. Yugoslavia (EE)	32. Yugoslavia
33. Zaire (AF)	33. Nigeria (AF)[1]
34. Zambia (AF)	34. Ghana (AF)[1]

[1] Newly elected in 1976 for 2-year term.

Annex E

Staff of IAEA

TABLE 1.—TOTAL STAFF BY NATIONALITY AND GRADE WHO ARE IN POSTS SUBJECT TO GEOGRAPHICAL DISTRIBUTION

Nationality	DDG	D-2	D-1	P-5	P-4	P-3	P-2	P-1	Total
Algeria					1				1
Argentina				2	1	1			4
Australia		1			1	2			4
Austria			1	3	3	6	4	2	19
Bangladesh					1	1	1		3
Belgium				1	2	1			4
Brazil	1					1	1		3
Bulgaria				1	2	1	1		5
Byelorussian SSR					1				1
Canada			1	1	3	2	1	1	9
Chile					1	1			2
China					2				2
Colombia						1			1
CSSR				1	2	1			4
Denmark			1	3			1		5
Egypt				2	2				4
Finland				1			1		2
France			1	3	5	2	2	2	15
German Democratic Republic				1					1
German Federal Republic	1		1	5	6	10	1	1	25
Greece				1	1	1			3
Guatemala					1				1
Hungary				4	1				5
India					6	1	1		8
Indonesia					3				3
Iran						1		1	2
Iraq						1			1
Ireland				1			1		2
Israel			1			1			2
Italy			1	2	4	5	1	1	14
Japan			1	2	6	1			10
Korea, Republic of						2			2
Lebanon				1		1			2
Mexico							1		1
Morocco					1				1
Netherlands				2	1	2			5
New Zealand					1				1
Nigeria					1				1
Norway				2	1				3
Pakistan		1							1
Peru					1				1
Philippines							1		1
Poland		1		2	2	1			6
Portugal					1		1		2
Romania					3				3
South Africa		[1] 1				1			2
Spain						1			1
Sri Lanka					1				1
Sudan					1	1			2
Sweden				1	4	2		1	8
Switzerland	1			1	1	1	2		6
Thailand			1			1			2
Turkey					1	1	1		3
United Kingdom			3	10	7	3	3		26
Ukrainian S.S.R.					1				1
Uruguay					1				1
United States	1	2	1	22	21	12	6		65
U.S.S.R.	1		3	10	11	5	2		32
Vietnam Republic, South					1				1
Yugoslavia		1		1	1				3
Total	5	7	16	86	118	75	33	9	349

[1] Has the rank of Assistant Director General.

Note: in addition to the above, there are 63 staff members for whom consideration of geographical distribution does not apply.

TABLE 2.—STAFF HOLDING PERMANENT APPOINTMENTS

Nationality	D–2	D–1	P–5	P–4	P–3	P–2	P–1	Total
Argentina			2					2
Austria		1	2	3	3	4	1	14
Belgium			1					1
Brazil						1		1
Denmark		1	1					2
Egypt				1				1
France			2	1		1		4
Germany, Federal Republic of			1	1			1	3
India				1				1
Ireland			1					1
Italy			1					1
Morocco				1				1
Netherlands			1					1
Pakistan			[1] 1					1
South Africa	[2] 1							1
Switzerland						2		2
United Kingdom		1	2			1		4
United States			2	1	2	1		6
U.S.S.R.						1		1
Total	1	3	17	9	5	11	2	48

[1] Serving at the D-level under a fixed-term appointment.
[2] Has the rank of Assistant Director General.

TABLE 3.—STAFF HOLDING FIXED-TERM APPOINTMENTS OR EXTENDED APPOINTMENTS WHICH WILL COVER A TOTAL PERIOD OF NOT LESS THAN 5 YR

Nationality	DDG	D–2	D–1	P–5	P–4	P–3	P–2	P–1	Total
Algeria					1				1
Argentina						1			1
Austria				1		3		1	5
Bangladesh					1				1
Belgium					2				2
Bulgaria				1	1				2
Byelorussian SSR					1				1
Canada				1		1		1	3
China					2				2
CSSR				1	1				2
Denmark				1					1
Egypt				2	1				3
France					3	1		1	5
Germany, Federal Republic of				4	3	3			10
Greece					1	1			2
Guatemala					1				1
Hungary				4					4
India					3	1			4
Indonesia					2				2
Ireland							1		1
Israel			1						1
Italy					3	2	1		6
Japan				2					2
Lebanon				1		1			2
Netherlands				1	1	2			4
Nigeria					1				1
Norway				2					2
Poland		1			1				2
Romania					1				1
Spain						1			1
Sri Lanka					1				1
Sudan					1	1			2
Sweden				1					1
Switzerland	1			1	1	1			4
Turkey					1	1			2
United Kingdom				5	5	1	1		12
Ukrainian SSR					1				1
United States	1	1		9	2	5	2		20
USSR				3		1			4
Vietnam, Republic of South					1				1
Yugoslavia		1			1				2
Total	2	3	1	40	44	27	5	3	125

TRANSCRIPT OF INTERNATIONAL ATOMIC ENERGY AGENCY MEETING, VIENNA, AUSTRIA—MAY 29, 1977

INTERNATIONAL ATOMIC ENERGY (IAEA)

Mr. TEAGUE. Dr. Hall, let me say we are pleased to be here and let me introduce my colleagues. On my left is Congressman Dale Milford of Texas, Jim Scheuer of New York, Gary Myers from Pennsylvania, across the table is John Paul Hammerschmidt from Arkansas, a Louisiana Cajun Mr. John Breaux, and I'm not going to tell you what they remember the next man for, but he's from California—Mr. Norman Mineta. The other members I'm not going to call are staff members on our Committee on Science and Technology. I think they are all from that; maybe, is Ed Bowser here? Mr. Ed Bowser was the Staff Director of formerly the Joint Committee on Atomic Energy. He's been here many times.

Now before you came in, Dr. Hall introduced all the members here and I wish he'd go through that again—I'd think you'd know who's here.

Dr. HALL. Before I do that, before you, there is a listing of all the personnel in the room—one of your yellow sheets. There's a listing of the staff, the country and a little bit of our background. Bob, why don't you start; just stand up, announce yourself, and then you can identify the person by looking at the list, too.

I'm Bob Catlin from the United States.

I'm Leonard Bennett also from the United States.

Wojciech Morawiecki from Poland.

Reinhard Rainer from Austria.

George Delcoigne from Belgium.

——— ——— from Norway.

Art Waligura from the United States.

Norm Beyer from the United States.

Jim Cameron from the United Kingdom.

Vladimir Shmelev from the U.S.S.R.

Tohru Haginoya from Japan.

James Lane from the United States.

Robert Skjoldebrand from Sweden.

Rurik Krymm from France.

Dr. HALL. There we are, Mr. Chairman. I would like to draw your attention to a short agenda which should be before you and if you agree, Mr. Chairman, I would like to give a very short presentation so we can devote most of our time to the asking of questions and perhaps we could ask you a few questions. Item number three, the Instrumentation Demonstration is in the next room and I thought that perhaps we could have a cup of coffee or tea in about an hour and take a look at the instruments. I consider this very important because on the safeguard inspection activity, the use of instruments has not only facilitated, but enhanced our ability to do our job. To avoid returning with simply an impression of human beings pumping things, we do have some very sophisticated equipment which helps us, as I say, do the job.

Mr. TEAGUE. Doctor, will you comment on what I asked the Ambassador last night; do you think you can be objective to us or not?

Dr. HALL. Objective?

Mr. TEAGUE. Yes.

Dr. HALL. Sir, I will be objective and balanced . . .

Mr. TEAGUE. I didn't say "you"; I said the rest of you.

Dr. HALL. If they are not, I'll be the first man to curb the passion, as it were. The Director General should be arriving in the next half hour at the airport and I know that he would like to be here himself, but he's been on an African trip.

Mr. Chairman, very briefly, I think most of you know this, we are an agency—20 years old this year. And as you pointed out yourself, you were one of the participants 20 years ago at our first conference. We have grown to an organization of 110 members. We have a budget of about $45 million and the staff at the moment is scattered in three buildings. This is the temporary headquarters and has been for 20 years. This was turned over to us by the Austrian authorities as an old hotel. You may see clues as to its earlier purpose. The nationality on the staff is rather interesting; we have over 65 nationalities on the staff and for those of you who might be concerned about U.S. and American participation, I think we have the highest percentage of Americans in our mission than in any other international organization. It's running pretty close to 20%. So American participation is good and we have been fortunate over the years to have been able to draw the calibre of people who are prepared to spend two or three or four years with us and longer. Many of us have come from the national laboratories. Jimmy Lane has been in Oak Ridge for 35 years, so you have a great deal of competence here from the U.S. as well as the rest of my colleagues from other countries.

How are we run? We have a Director General who is Swedish and we have the four Deputies. I'm one of those deputies. We have a Soviet deputy, a deputy from the Federal Republic and Brazil and Switzerland. My responsibility is the administration, budget, the legal side, public information and all the housekeeping responsibilities as well as external relations. The Board of Governors consists of 34 governors. The Board meets about four times a year, two important meetings—one in June.

And you probably know some of the previous governors. Professor Smythe from Princeton was here for about seven years. Dr. Keith Glennon who I think was a friend of yours was a governor for several years. And Dr. Tape who is still a governor and earlier was the commissioner of the old AEC and is now responsible for the Brookhaven National Laboratory. I make this point because of being American, you have to ask yourself who represents us? Who is the person who really is talking around the table? Well, we've had some very able men here. So that's the Board of Governors—34 governors—and it's the group who approves the budget and policy.

We have once a year a meeting of the full membership which we call the General Conference and is comparable to the General Assembly in New York. This takes place in September and that's the first meeting that you attended in 1957. We have two Directors General; one an American, Mr. Cole, who was for years here in the beginning and presently we have here, as I said earlier, Dr. Ecklund from Sweden. He's a physicist and came from the Swedish nuclear energy program.

What are the issues? The interesting and I think important issue, if I can make this clear, is that in the past four or five years you've had an extraordinary political consensus between, let's call it, the East and West, and the South and the North, on certain issues which makes this agency somewhat unique. What are these issues? The safeguard issue is one. And after 1963, we've had the strongest support from the East and the West on safeguard. We've never really had a problem on the budget side on getting money for safeguard. Some of our developing country friends are on the board.

I might point out that they want to maintain a balance because they are interested in technical assistance in which we have a small program, but they too, now are supporters of the safeguard program.

What does this mean realistically? It means that if we have, and I think we do have, a sensible safeguard program that we have no problem in having the political and economic support necessary to implement that program. Twenty years ago I couldn't say the same thing, because in the early days the purposes and the objectives of this agency were rather misty. But now we enjoy I would say nearly complete support from our Board of Governors, which is a bit unique.

I have to make two or three points because while the political issues are not as dramatic here as they in New York or the United Nations, they do emerge. For example, we will have in June a question on South Africa. So we are not devoid of the realities of 1977. What is the question on South Africa? South Africa has been a member of our Board of Governors for 20 years and there is some thought that perhaps South Africa should not be a member of the Board. This is not a question of throwing South Africa out of the agency. It's simply a question on how certain that the Africans—they feel—from their standpoint that it would be better for South Africa if they were not on the board. Mr. Chairman, I'm trying to be balanced and objective.

Mr. Teague. Doctor, what does a member nation do when it is a member of this organization?

Dr. Hall. There are four or five answers to that.

In the early days I would find it difficult to answer that question other than the easy answers of status and prestige and being on the Governors' board. Now, and in the case of South Africa, there are so many policy discussions that affect all member states that it is becoming increasingly difficult to keep people off the board. Each state feels that he wants to participate and this has a political impact too, because right now we're being confronted with a small but aggressive group who feel that the board membership should be enlarged. And it's always that worrisome thing because the larger the board the more difficult it is to do business. We had a Board of Governors for many years of 23 and it jumped to 25 and from 25 to 34. This is manageable and still one of the smallest governing councils in the United Nations family. If you're on the board you participate on the national side you support, you participate on all the political decisions, the scope and intensity of the agency policy. You are there. You're a member of that committee; you're a member of the Committee on Science and Technology, if I can put it that way. As to why there is such a great interest in Congress of being a member of your Committee. As I said earlier, there are elements of prestige in consideration.

Now, who runs the board? We have a chairman, a new chairman every year. We've never had a problem in selecting a chairman because very early in the selection process, it was decided that there would be a rotation among the areas of the world. And so there never has been a problem. The present chairman is Dr. Sece, from Senegal, who is a very intelligent, tri-lingual person.

One exception to the chairmanship is that early is was agreed outside the board that the big powers would never be chairman. So the United States, Soviet Union and England have never chaired.

Now let me quickly see if I covered in a very general sense the budget, the membership, the chairmanship of the board, the function of the general conference and the makeup of the staff. Now before we go on to item number two, I wonder if there are any questions, Mr. Chairman, about what I have said?

Mr. TEAGUE. Doctor, why don't we go on to your schedule, then get questions and answers at the end.

Dr. HALL. Very good. Mr. Chairman, I promised that the presentation be short so we could have more time to talk among ourselves, so if we could move to item two—which is Immediate and Long-Term Prospects for Nuclear Power, Light Water Reactors, Heavy Water Reactors, Advanced Reactor Types and the Breeder. All of this is very contemporary as you know and we put this item on deliberately because we are interested in this and we are acutely aware that throughout the world there are some controversies dealing with this subject. So we wanted to in a balanced fashion, Mr. Chairman, to give you our thinking. Could I call on Mr. Krymm first to give us a little feeling on nuclear energy and the general energy picture and then after that program, we will talk about some of the specific reactor types. Mr. Krymm.

Mr. KRYMM. Mr. Chairman and gentlemen. I feel that Dr. Hall it was your original intention by considering the agenda to put economics last.

And I am sorry that he didn't yield to that first impulse because that's where it would belong since of all the reasons which can at present account for the status and immediate prospect of nuclear power, economic reasons are certainly the last ones to be taken into account. The reasons may be social, environmental, domestically political, internationally political, economics comes at the bottom. So you will forgive me if I am not going to discuss costs—cost of capital investments of the fuels in detail. It will only leave us all confused including myself and rather proceed to very broad-brush presentation of the framework within which nuclear power is likely to take its place. Now today we are dealing with a world of about 4 billion people. Total energy consumption of that world is on the order of 6 billion tons of oil—equivalent, that is if you convert everything to oil, there may be argument about that 5 or 10 percent plus or minus because this conversion process is always to some extent arbitrary. Out of those 6 billion, a little less than 3 billion actual oil and two-thirds of the total—more than two-thirds—is accounted by gas. Again, it is worth thinking that about two-thirds of the 6 billion—4 billion—are consumed in countries with developed market economies and about a little less than 2 billion in the other countries. Also worth remembering is that the United States accounts for about 30 percent—a little more—of the total. That is about one billion eight hundred fifty million (1,850,000,000) tons of oil equivalent and about a little less than half of the total of the countries with developed market economies. No less important is the developing countries taken as a whole including the oil producing and exporting countries for the time being account for a little less than 10 percent of the total consumption.

It accounts for about a little more than 2 percent of primary energy in 1977. A little more than 8 percent of total electricity.

If we turn to the year 2000 of course the bets are wide open, but looking at the most modest projections, taking for instance President Carter's projection up to 1985 and less precise projections beyond the year 2000, you see that even the United States which is by far the greatest energy consumer, expects to consume more whether it grows at 2.25 percent a year or 3.85 percent or even 2 percent with extreme conservation measures. Still, it will increase. The room for conservation is small in countries like my own France which per GNP dollar or franc consumes about half of the energy consumed in the U.S. for one unit of GNP. And the countries of the centrally planned economy have development plans which involve a rapid energy consumption growth. As for the developing country any attempt is made to narrow even slightly the gap between theirs and our standard of living there will be a rapid increase in energy consumption there. So we are dealing with the world in the year 2000 which will consume between 12 billion which is twice the present total and 18 billion tons of oil equivalent. Now without speculating as to the composition of that consumption as between coal, oil, natural gas, we can estimate roughly the share of nuclear power by taking the rock bottom minimum targets which have been established recently and somewhat more optimistic programs which have been considered only for several years, or even a year ago. The share of nuclear power will be about 10 to 20 percent of the total. Ten if the rock bottom targets are actually implemented; 20 if somewhat more optimistic objectives are achieved. So that by the year 2000 nobody actually expects nuclear energy to be the predominant fuel.

It could be hydocarbons, coal will no doubt increase substantially, but nuclear will not be the decisive fuel. Does it mean that nuclear is not significant over even the short term? Of course not, because you remember as a benchmark that roughly speaking, each 1000 megawatts of nuclear—that is each large station of the type which is being built in Europe or the United States and France—the larger types. . . . Well, a 1000 megawatts saves about 1½ million tons of oil a year. So that for countries which are heavily dependent on oil this is of tremendous significance. So that this relative share of 10 to 20 percent should not blind people to the significance of nuclear energy for oil importing countries.

You may wonder why after oil has risen by a factor of about 5, let's say, since the middle of 1973, I'm talking of OPEC oil which sooner or later all oil prices will pretty well be determined just what-ever the production place. Nuclear programs today are substantially lower for the years to come and especially for the year 2000 than they were, let's say, in the middle of 1973 before the price of competitive fuel jumped by a factor of first 4 and then 5 or even more. Much has been said about economic reasons, but as I tried to point it out from the beginning, they are not really of relevence here. There is a total divorce of prices and cost of production—you may say at any rate the representatives coming from oil states—what else is new? Because that has always been the case in the case of oil and to some extent of gas. But it has now extended to coal and even uranium which has increased by a factor 7. But for spot delivery prices.

But it is not in economics that you will find an answer because even with all those increases in uranium prices, and in the increases of the investment costs of nuclear power plants, nuclear is clearly economic in all cases where it is competing with imported oil, or fuel—to be more precise—derived from imported crude. That is in all Western European countries which are not coal producers or exporters. The reasons therefore are social, rooted in domestic politics, in international politics and it's not for me to enter into their discussions here. But what we may ask is how long will those reasons continue to prevail over certain underlying factors which push a whole category of countries towards nuclear power—regardless of the economics which are favorable.

I have in mind countries like my own, France, or even the most extreme case of Italy, which total fossil fuel resources are worth three years of national consumption and two months of United States consumption of energy. Obviously, countries of Western Europe devoid of fuel resources will take the stand that if they are not to become totally dependent upon oil imports from OPEC countries, and they are already for the majority of their energy needs, they have to develop nuclear power and if they are not to become totally dependent on uranium supplies from the outside world, they have to develop particularly economic types of nuclear power plants—in particular for the first step they have to consider squeezing out the energy still contained in the irradiated fuels for reprocessing—that's gaining about 30 to 40 percent from a given amount of uranium, but much more important than that, they have to consider the necessity for breeding which would permit them to become totally independent—almost totally—since you can use depleted uranium as fertile material for the breeder from outside uranium sources.

So that the positions of countries looking at the short term will be radically different depending on their wealth of natural resources. It is one thing for the United States to look at the immediate future on the basis of the largest coal reserve in the world, a very substantial oil and gas reserves which perhaps may be more extended in pricing policies are changed, a very substantial uranium reserves. It's another thing to look at it from the standpoint of France or Italy which have no fuel reserves and in the case of Italy no uranium reserves: in the case of France, very limited uranium reserves. Intermediately, you could have countries like the United Kingdom who can have a breathing spell because they have the North Sea oil and they have substantial coal resources which were perhaps underestimated in the past. But my major point is that those countries will look at the short term policies in the nuclear field from entirely different points of view. And you will understand the urgency which presses on countries who want to become somewhat less dependent—not fully independent, far from it—but somewhat less dependent on imports of coal and oil

Now regarding the longer term, these countries of course continue to press with the development of reactor types which will permit greater and greater independence even from imports of uranium. But even if we look at the resources of rich countries like the United States, like the Soviet Union, and to a lesser extent the United Kingdom, much lesser extent, when the long term is taken into account, you realize that some kind of breeding appears essential. It is true that the figures which are at present bandied about about uranium resources—Mr. Cameron will no doubt point out—are very tentative figures.

The fact that uranium seems to be consentrated in the United States, Canada, South Africa and Australia plus a couple of African countries is not the geological enormity; it's probably due to the amount of prospective money which was sunk in those areas to find the uranium and since there was a long period of market glut, no prospecting worth speaking of has occurred in other areas which may turn out to be promising. So that the 4 million tons of proven and additional reserves which are advanced as a figure for the Western World are probably going to be pre ——— ——— maybe by a factor of 2, maybe by a factor of 3—who knows?.Nevertheless, if you take the 4 million tons in terms of energy producible in present light water reactor types—this corresponds to about 40 billion tons of oil. This is less than half of the proven oil reserves. So that it's not really significant for the long term, however important it may be for transitional gap bridging. Even if you multiply it by a factor of 10 instead of 4 million tons of uranium, 40 million tons were to be discovered, if it were to be used in present-day's light water or even heavy water reactors of the present fuel cycle, you would still be meeting with an energy equivalent much smaller than that producible from economically recoverable coal reserves; so again it would be no more than the stop-gap solution over the longer term. However, if you engage in breeding, you multiply all those figures by a factor of 50 to 60 which places you in an entirely different ballgame. Also you are then free to turn to very low grade uranium deposits because the cost of the uranium fertile material in the breeding cycle is insignificant and in fact, for a very long period this fertile material will be depleted uranium from the enrichment cascade tails which is practically worth nothing except under these conditions.

Now again, the degree of urgency to prepare for this long term future will be judged differently by different countries depending on their resources both in the field of fossil fuel and in the field of uranium, but one thing which should certainly be remembered in that respect are the lead times required for a capital intensive complex, difficult technology to make a real dent on the energy market. Now the first reactor has operated in 1941 in Chicago. The first power reactor has operated in 1954–55 and we are now in 1977, so it took 22 years for certain reactor lines to prove themselves and today the account for only 2 percent of the world primary energy and about 8 percent of world electricity.

Now if demonstration efforts or pilot plants or first industrial plants of a given line are abandoned, if skilled teams of engineers and scientists are disbanded, it may take a long time to put them together again. And this might be not only time, but also a money-consuming business. But I feel I am already getting into deep waters in which my friend, Bob Skjoldebrand, is a better swimmer than I am, and . . .

Mr. TEAGUE. May I ask Mr. Krymm a couple of questions. I understand you said that the area of conservation is small. Now is my attitude right that in our country we estimate that we use about the same amount of energy that we waste? Is that a fair statement?

Mr. KRYMM. I think that it's an understatement, probably.

Mr. TEAGUE. Let me ask another question. In the field of international cooperation, it seems to me that France should be a good nation to comment on what more can our country do in the field of waste storage and in the field of uranium enrichment. What would you like to see us do?

Mr. KRYMM. Well, Sir, I'm not speaking for the government of France, but I am sure that France intends to continue with an effort on the one hand that national energy—not independence—because it would take an awfully long time for any of the Western European countries to become really energy independent, except in the special case of the United Kingdom with the North Sea oil; but to lessen its dependence on imported oil in particular and unstable areas of supply. It will certainly continue therefore in all areas of nuclear power development in which it has been fairly active and in some cases a leader that is, in reprocessing and in breeder reactors, with special emphasis on the breeder because the French feel, not without reason, that nuclear technology is not breeder resources based—it's human based—it's based on human resources. By the time you have a breeder you are practically independent from geological vagaries and you depend on your own technological, engineering, scientific organizational brain power. It seems to me the only technology of that kind because that even solar depends on geographical conditions, and availability of cheap lime. Let alone, hydrocarbons or coal . . . so that certainly France would like to see full steam ahead the development of advanced reactor systems which of course require development and research in the breeding field. Now as between different breeding cycles, France is developing, as you know, the plutonium fuel fast breeder sodium cooled. There is ——— ——— research, but France is not that large and that rich a country to engage in the investigation of a variety of possible breeding cycles and has concentrated her efforts on the prototype which has given quite a bit of successful results up to now.

Dr. HALL. I think that answered your question. Bob, could you talk briefly about reactor types and touch on the breeder also?

Mr. SKJOLDEBRAND. I'll try to be very brief. I'll try to summarize the situation. Where we are, where we are going based on the Saltzburg conference on nuclear power and its fuel cycles. We finished just two weeks ago in Saltzburg. It was a major conference and it followed the traditional engineer conference. There was one major lesson we got from Saltzburg—that was if anyone who had doubts about the future of nuclear power going there, we came back reaffirmed. Nuclear power programs are definitely here to stay; they're expanding. The programs have been reaffirmed, they've been stabilized and they are going ahead full speed.

QUESTION. All programs?

Mr. SKJOLDEBRAND. Not all programs. But in general. Let me come back to that later.

In discussing the programs of the United States and ——— ——— refer to all capital major industrial nations which outside the United States are certainly likely to shape the future of nuclear power programs. These are Germany, France, Japan, United Kingdom, Soviet Union and perhaps also Italy, Canada, and Sweden. These are the countries also which have their own domestic industrial capability to produce their plants—their power plants—and also to go into, if they want to, the fuel cycles. All these countries have strong nuclear power programs. It's notable that present in the United Kingdom there is a—at the present time—pause or reevaluation. Let us not forget that 6000 megawatts are going to go on the line in 1982, 6000 megawatts nuclear in the United Kingdom. Sweden is perhaps the most notable example of a country which has now reevaluated its programs.

Where that is going to stop is not to say at the present time, but again, Sweden has at the present time the highest nuclear capacity per capita in the world. It is a small country . . . [there was some discussion here as to what Mr. Skjoldebrand said; the other members did not understand what he was saying either].

In most of these countries with the exception of the United Kingdom and Sweden and Canada the programs of the present time are based on the light water reactors, where the pressurized water reactors seem to be getting the edge at the present time over the boiling water reactors. If that is a long term plan it is difficult to say right now, but it appears that the pressurized water reactors are the fundamental basis for the programs in most of these countries. There are some interesting variations. The pressurized water plants and also boiling water plants have a technological limitation in size to about 1300 megawatts electrical. Mainly based on the pressure vessel technology. We don't want to build bigger pressure vessels than that. In the Soviet Union there is some development now toward a pressured tube-type reactor which can be designed and constructed in a modular fashion. They at the present time have on the drawing board units of 2400 megawatts—very big units.

Canada is of course going ahead with the heavy water reactor plants of the candu type. They are also giving paramount of interest in other countries outside these major industrial countries. Also there, there are some variations in ——— ———; they are talking about cooling heavy water reactors with light water reactors. But these are ripples on the surface. What we are really seeing at the present time in the thermal reactor field is a focusing on the light water reactors and on these candu type heavy water reactors. All others are more or less falling by the wayside.

Now in the five countries which are mentioned first—that is, Germany, France, Japan, the United Kingdom, the Soviet Union, there were definite statements in the Saltzburg conference that it is a national objective to close the fuel cycle and to head towards the breeder.

It is notable as Mr. Krymm pointed out here also that these countries have a lack of indiginous uranium resources or very small resources of any country.

QUESTION. Which countries?

Mr. SKJOLDEBRAND. That is German, France, Japan, the United Kingdom, the Soviet Union. They are definitely going—and is a national stated objective—to close the fuel cycle and move towards a fast breeder development . . . and a domestic fast breeder development. In this context, we have pointed out that we have at the present time a status where demonstration plants are in operation—the demonstration plants, I talk about plants of the size range 250 to 350 megawatts electrical. They are in operation in the Soviet Union since 1973, in France since 1974, in the United Kingdom since 1975. They are under construction and plan in German for operation in 1981, in Japan in 1983 to 1984. It should be remembered here also that Italy and Germany are working together with France in the development of the fast breeder program. They are heading you could say that in the mid 70's to the early 80's is a demonstration plant stage of the fast breeder. In the mid 80's we are aiming at the first commercial prototype plant in the 1200 to 1600 megawatt range. In France the Superphenix should go on line in 1982: in the United Kingdom the prototype commercial reactor should go on line in 1986; and the Soviet Union has on the drawing board now a project for a 1600 megawatt breeder without even ——— ———. And here Italy and France are participating with about 30% involvement in Superphenix projects.

Canada has of course always had a special situation with its heavy water reactors. The economics in that part of the fuel cycles—they have had a stated objective not to close the fuel cycle. It is interesting to note that in the Saltzburg they came back to the situation where they've always kept their options open for the future And I hear they stated that they are launching an orderly 20 to 25 years program to develop and demonstrate technology of recycling of this size material in the candu reactors. And they are here going to study both the plutonium recycling but undoubtedly going to concentrate on the plutonium and thorium fuel cycle.

In other countries, industrialized or developing countries, you see a definite focusing on the thermal reactors of the light water type or the candu type. The basis is always the pressurized water reactors with a sprinkling of interest in the candu type of breeder reactor. In none of these countries is there a real interest in the fast breeder cycling. They would like to see the fuel cycle closed outside thir own countries. The exception here of course is India that has a closed fuel cycle and has a possibility of closing it for the power plants and which also has a small fast breeder reactor program. At the present time it is very early—in the early stages.

I could have just mentioned some points that were made on the more exclusive concepts, the more exotic concepts of power plants. Notably the high temperature reactor where we at the present time stand with 20 years of research and development behind us and in the program which is now in the next couple of years going to have two demonstration plants in the 300 megawatt range, with no certain plans for the future. There is an effort in the Federal Republic of Germany to commit an international cooperation on the high temperature reactor program. It's attractive because the high temperature reactor again uses thorium ——— ———; it has a higher fuel use efficiency; it has a higher thermal efficiency; it has several advantages, but in the German statements here it was pointed out and expressed the great capital investments that have prevented this development effort. That it needs international cooperation. At the present time there is no closed fuel cycle for it and they look forward to performing formal discussions to something like 20 years additional work that the breeder concept can be applied.

And the same came out for the major part of the other exotic concepts like the gas cooled breeder, for instance. There was one possible notable exception which astonished me very much indeed. That was a statement by a U.S. industrial concern that the molten salt breeder could be brought on line very quickly. I was taken aback by that because that—it would be an outstanding example—so here here again Mr. Lane is the specialist in that area.

I think that's a quick rundown of what we have.

Mr. TEAGUE. Doctor, am I correct in my understanding that Canada and Australia are two nations that agree on the announced policy by President Carter?

Dr. HALL. Mr. Chairman, part of our problem in Vienna is that, frankly speaking, to understand what the policy is. I'm not making a joke here—being frivolous—I'm saying we had a Presidential speech; we had a Presdiential press conference; if you take the small shifts between the speech and the press conference, the most straightforward understanding on my side of what the U.S. policy is related to the transmittal of the proposed legislation on the export questions. And I think here the Australian policy and the Canadian policy is the same as the U.S. on the export control. . . .

Mr. TEAGUE. Doctor, it is not. The President's announced policy restricts reprocessed energy, restricts the breeder.

Dr. HALL. The reason that I have to be balanced here is that when we were in Saltzburg we had the Deputy Under Secretary, Mr. Nye, and I discussed this thoroughly. This particular point that you've made, and he said that we and the U.S. are not against stopping the breeder or stopping chemical reprocessing because we feel that that is a national decision, but on our side, the U.S. for reasons that the President has stated. Now, I have to choose my words carefully because this was a luncheon discussion, and I had to tell him that many of us were from Western Europe and had a more limited access to what the U.S. policy is than let's say you in Congress ——— ——— and in Washington and New York, but that's one reason earlier, Mr. Chairman, I said that I would be most grateful that if some point I could ask a few questions so that we could be informed on what the U.S. policy is.

Mr. TEAGUE. Why don't you ask the question; I think we'd get a bunch of different answers.

Dr. HALL. Well, as I say, I am not being frivolous here; I am trying to be honest because our—we do have some concern on certain aspects of the announced policy. We do find that there has been a little adjustment as they go along. And like you say, what is that adjustment? Well, I'm just speaking of one example ——— ——— in our luncheon conversation, I don't think that I heard that type of comment as explicit in the press or in the press conference. Maybe you can help us here understand. We understand the objectives of the President. In fact, this is our job here in Vienna. We are as I said earlier, you are in the heart of the group that is opposed to the proliferation of atomic weapons; this is our job. Everyone in this room on the staff side is related in some way to achieving that objective. And so we support President Carter's objective; where we're really concerned is to make sure that we understand the policy points that have been made by a series of individuals other than the President which seem to suggest that there are shades of difference. But on the export presentation, this proposed legislation to Congress here I think that I understand completely and I think I agree with it. If I understand it, and I think I do.

Mr. MYERS. Mr. Chairman, I think that our Committee is particularly interested in one aspect of what the President has said and that is that we should delay our breeder development program until the answers can be gained about the proliferation problem. Now is that a realistic approach? Number one, will a unilateral policy on our side stop the commitment that has been indicated here by other countries? Number two, can we gain any knowldege while we are not proceeding with our program?

In other words, are we going to know more about how to control proliferation if we delay the program or are we going to gain more knowledge about what to do if we continue with the program? I think with our Committee that is the crux of it. What to do with the demonstration project of 300 megawatts? Do we scuttle it and then try to bring back the nuclear scientists together later on? Will we have known more that way? Will we have solved the proliferation problem that way, are we in better position internationally and domestically? I guess that's the question we have to answer for ourselves. I think our Committee is most concerned about that today. We will be looking at the funding of the program.

Dr. HALL. This is a very important question you've raised and before I make a few comments I wonder if Mr. Lane could comment on this point.

Mr. TEAGUE. Mr. Lane, be objective . . .

Mr. LANE. After 35 years in the nuclear business, I don't believe I can. I tend to agree with the attitude of your Committee, as I understand it from what the Chairman has said, that there is a question of timing on the breeder and as Mr. Krymm pointed out it will take at least 20 years to be able to introduce any new type of breeder in large enough quantities to make a serious impression on the uranium resources. Now, that means that if you delay the introduction of the breeder until after the year 2000 which is what some people have said, I think it brings up a tremendous amount of uncertainty as to where you go from there because if you build a lot larger amounts of light water reactors in the 1990's, you're committing 5000 tons for each one of them—natural uranium—you're going to run into the tens of millions of tons requirement not only, if not before then.

So I think you have to keep the program going. You have to keep an echelon of engineers intact whether the program goes slowly or fast, that's something else, but I think you have to keep it going. Otherwise, you will never be in a position to meet the resource problem in time to make any appreciable dent.

Now I would like to make one point about the molten salt breeder. In Saltzburg the question was asked Mr. Lightly—"Well, if this is such a good reactor that can avoid proliferation and plutonium conversion, why did it fall by the wayside after 25 years of development? Well, I think the answer is quite clear to me anyway, in my opinion, that you don't need two successful breeder programs. If you have a successful fast breeder, that will solve the job and so with the successful fast breeder, it is very difficult to have a lot of incentive to develop a parallel breeder. The same thing is true of fusion. If you have a successful fast breeder, you don't need fusion either. That's something else you gentlemen might think about. But, if the plutonium breeder has problems, then there is a great deal of desire to look at alternatives.

Mr. TEAGUE. In you people, this group here, in your discussions, do you considerably agree among yourselves or are the peculiarities of each nation's ——— ——— supply of energy, of coal, gas, all the other—or do you have a considerable difference. Your big mission is the peaceful use of atomic energy. And you would like to restrict weapons. Is that a fair statement?

Dr. HALL. We have a statutory responsibility and also we have a responsibility given to us by how many states?—95?—How many have ratified the NPT 95 non-nuclear states.

Mr. TEAGUE. Is there a fairly good consensus among you people?

Dr. HALL. I will make a statement and I will ask my colleagues if they disagree. We feel that plutonium is important in the energy field servants. I've——

Mr. TEAGUE [continuing] and can you produce plutonium and not bring in the fear of weapons?

Dr. HALL. We have lived with a situation until the past four or five months ago where one of our important objectives was to control reprocessing plants; we have developed with the support of the United States some interesting proposals dealing with the regional fuel cycle centers which would avoid the proliferation of small reprocessing plants; and so to answer your question, yes, I mean we—this has been our responsibility, exactly, to avoid the problem which I think is—I'm talking about plutonium—I'm talking about the problem of the reprocessing plant control, and the natural, nearly a natural objective which Mr. Krymm has pointed out, that the breeder simply must come into the picture of energy in the next 40 or 50 years. It's been so natural to us and I think, Mr. Chairman, that my colleagues are men of integrity; I don't think that there's any—there's no commercial interest involved in this room at all and we are international civil servants. I've——

QUESTION: Are there national interests that divide you?

Dr. HALL. No, not on this subject; not on this subject at all.

Now, may I ask my colleagues whether I have stated the case too strongly or do we agree. The question is, are we in general agreement on the future of plutonium, the breeder and the—as a necessary part of the energy requirements? Mr. Krymm had pointed out the states that are completely without certain resources—that Japan should be included—and the breeder is a part of the future and it's international decision.

And now I call on my American colleague, Mr. Lane, first.

Mr. LANE. I think it's a wholehearted agreement with what you say.

And not only among the staff here, but there was almost wholehearted agreement at the Saltzburg conference with that position. Every person I talked to was completely in agreement with the fact that, one, the breeders, until we have to close the fuel cycles. So, it is 100 percent unanimous as far as I'm concerned.

Mr. TEAGUE. If you were a member of the Science and Technology Committee of the United States Congress, and you had to vote on whether to go ahead with the breeder, what would you do?

Dr. HALL. I think we have answered that question.

Mr. MILFORD. You didn't really answer Mr. Myer's question. As to whether or not the unilateral action of the United States is stopping breeder reactions . . . will that have any effect on the work being conducted by Great Britain, by France, by Germany, by others? Will they continue?

Dr. HALL. I think we can answer that by saying "no". Now let me make——

Mr. MILFORD. They will continue?

Dr. HALL. Yes.

What has happened is this: this is one of the important elements of attending this Saltzburg conference. The United States for many years has had a strong leadership in the nuclear energy field. The United States with its scientific ability is highly respected. So when the President of the United States makes a statement, it is listened to by the rest of the world. There's no doubt about that. So I felt that many of our friends, while they were puzzled, became a little cautious on their own statements. But the serious problem of developing a sensible, logical energy plan in Japan, the Federal Republic, France, the United Kingdom, the Soviet Union, is so crucial to the people of these countries that I think the unilateral action by itself will not change the burden on technology.

Mr. MILFORD. Let me pick one short problem, if I may. If the United States proceeds to take such unilateral actions as the President has indicated, will that have any significant effect on controlling proliferation?

Dr. HALL. Well, I will answer as a person on this rather than as an official of the agency. My answer would be "no". Would any of the other members care as a person to answer the question?

General mumbling . . . (. . . criticizing another country . . .)

Dr. HALL. We have had in this room certain safeguard people—see part of the problem here as I stated earlier is "what is U.S. policy?" I thtink we've all heard what you have had to say, I will take the legal side first. If anyone does not wish to comment, I'll answer for them. Mr. Rainer.

Mr. RAINER. Well, I think I'm sure as I look at the U.S. as an Austrian and substantially say . . .

* * * * * * *

. . . now whether this of course has a political effect on nonproliferation is a different thing. But certainly it will inhibit many other states that will repossess or to gain access to plutonium.

Mr. MILFORD. Mr. Chairman, I understood the statement earlier though that you seem to have a fairly common belief that uranium can be found in other areas and it's simply a matter of looking for it. Would it also simply encourage others to look for it someplace else?

Dr. HALL. I think that's possible . . . you also have to talk about the enrichment question here, because you may find uranium resources in many new places in the world, but you still have a reactor technology now that requires first a slightly enriched uranium that requires a plant. And then also the Canadian reactors that refine natural uranium. But could I come back to the unilateral question. And this is where it hurts. The United States, and I think everyone in this room would agree with me, proposed many years ago that the international community itself could do something about the control of proliferation. Now I'm talking about the founding fathers of this organization. This is all based on not unilateral action, but the idea that there is a common goal and so we have the agency. And that's the reason that I think basically that I would hesitate to suggest that any country by unilateral action could develop a policy of avoiding proliferation which would be more effective than the international community working together—and we have been pretty successful on this.

Mr. TEAGUE. You said that the United States *could* do something . . . are you implying that it didn't do anything?

Dr. HALL. No, I'm implying that to me the great hope objective on proliferation can be achieved through this organization. That's what I am saying and this was the original U.S. idea.

Mr. TEAGUE. Dr. Hall, our fear is weapons, everybody's. Safeguards. If it weren't for the subject of weapons, what would we do in the nuclear field?

Dr. HALL. Well, we have not touched on our responsibilities in the other areas other than power and we do have programs, if I understand the question, we have many other . . .

Mr. TEAGUE. Is it true that if it weren't for the fear of weapons that we would push nuclear power in every way, form and fashion?

Dr. HALL. I think that's right. But I'm not so sure if you're talking about the U.S. now or the world.

Mr. TEAGUE. I'm talking about the world.

Dr. HALL. Well, it's the energy problem that I think that—some of these other decisons and what has happened—governments have come to us and I said earlier we now have nearly unanimous support for that part of our program which does provide a basis for controlling proliferation. And this is a series of national decisons. And the support for the budget, the support for the entire program—this reflects a series of national decisions. So on the one side, you have the goal of putting nuclear power into the grid next 30 to 40 to 50 years. On the other hand you have this agency which can, I'm quite serious at this point, can. And this is why I say I'm a little concerned about any state taking a unilateral action when you have a mechanism here with such unique political support of 110 states. That isn't a religious statement; this is somethng that I think is very, very important and very serious.

Mr. MILFORD. Some of my colleagues would argue though the point that the working of this organization and the support you think you have here did not prevent a weapons development in India.

Dr. HALL. Well, one of the tragedies of this age is the fact that, if I may say so in front of the public information officer, is that so many of the people in the press simply do not know what they are talking about in this field. Now, so you have a series of 2 plus 2 equals 5. Let me tell you what I mean in India.

The Indian atomic energy project as you know was not fully covered by safeguards. And until recently the policy of the U.S. has supported a sort of piecemeal coverage of safeguards. Plutonium derived for the so-called development in India came from a plant and facilities which were not under safeguards. Now the answer to the question is that if they were under safeguards, could (the device then produce?)? The answer is categorically "no." So the scheme of things is such that daily I picked up the paper and see that the weakness of safeguards is India. But India never was under safeguards. And the plant that produced the plutonium is a reprocessing plant that separated the plutonium for the . . . never was. So the true answer to the question is that if it were under safeguards now could this have happened? Answer: "no."

Mr. TEAGUE. Doctor, it seems to me that this organization could have the greatest influence on nuclear power in the world of any organization that we have. Did you people have an input, do you think, on President Carter's announcement? Did the Carter Administration consider what your organization thinks and what you are trying to do?

AMBASSADOR. I would say that the answer is generally "yes"—not in every detail, but there was a definite impact on the program of the present Administration as a result of consultations with the International Atomic Energy Agency. And that was seen most particularly at Saltzburg where there were as I see it, nuances on the part of the Administration's policy which take greater consideration of the interests of other countries and have involved not only the Agency, but other countries in the proposed international evaluation program on fuel cycles.

Dr. HALL. You see some of this in Senator Ribicoff and his committee who were here last November. And the discussions we had the, particularly on the export policy, I think some of it was reflected in the Presidential transmittals of the export proposed legislation to Congress. And here really for the first time we see the assumption of responsibility by the International Agency. We have a big role to play and this is as I said earlier—it seems to be now the policy of Australia and Canada. And the Soviet Union. An after all we are an international organization; we have a U.S. representative and the policy channel is that.

Well, I think on that specific, Mr. Chairman, that point perhaps we can have a cup of tea.

Mr. BREAUX. Can I ask one quick question? Fortunately or unfortunately, Dr. Hall, the district I represent in Louisiana has probably the largest number of underground salt domes than anyplace in the United States and some proposals to use those salt domes in my area for the storage of nuclear waste. I just wondered if you might comment briefly—on the safety aspects. People are just completely terrified of it and don't want to have anything to do with it.

Dr. HALL. If we could later on in the agenda, this is a question that will be handled—waste management. . .

Mr. MYERS. If I could just briefly . . . you mentioned something that was the connection of Saltzburg with the entire proposal. But the conference at Saltzburg happened after the proposal came to our Committee. I don't understand how you can state that Carter took into consideration this organization you call Saltzburg when he—already he'd given us the message?

Ambassador STONE. The Administration was represented in Saltzburg by Deputy Under Secretary Nye and Mr. Fri.

Both of whom made statements at Saltzburg with regard to U.S. policy. And it was those statements which were reflecting the Administration's view which I felt showed some modification in the attitude.

Mr. MYERS. OK, but the Chairman asked if the policy by the Carter Administration—the origination of the policy—was impacted at all by this agency. Not that they then come back and speak to the agency, but was it involved in the development and if Saltzburg happened after the message, then it clearly did not have if that's the only reference we have.

Dr. HALL. Could I make a short answer? A great deal of the President's policy was news to us.

[Meeting breaks for tea.]

[Following break:]

Mr. Chairman, our minutes are precious at this point and on the agenda I would like to have a few minutes of briefing on the way we think about uranium resources because there has been a bit of controversy throughout the world whether you have enough uranium or not, or what or how this relates to fuel cycle. If I could ask Mr. Cameron just to spend a few minutes on this because we do have a timetable.

Mr. CAMERON. Mr. Chairman, the uranium resources situation is dealt with in the agency in cooperation with the Nuclear Energy Agency of OECD, and we produce reports on the world's uranium resources on a two yearly basis. This report is compiled from government submissons, we compile the material and make comments on it, but the figures are as provided by governments. It is an unfortunate moment because the new 1977 book is in preparation and will be published about September. So I have not got the most up-to-date figures but I will give you a rough idea of what we think they are. The reasonably assured resources, which can be termed reserves in the true mining sense of the word approximate to two million tonnes, metric tonnes, at the present time. The estimated additional resources which are resources which are not delimited by something, but are resources which are surmised by the geologist to exist in extensions of deposits, come to about the same amount, to about two million tonnes. Now that second two million tonnes is subject to all the work that still has to go into it, it has to be thoroughly explored and delimited. So that there is a great deal of work to be done on that. Substantial real reserves is at the moment about two million tonnes.

Now before I would be poaching on Mr. Crimm's side of it, I think I ought to mention something about what the demand is to put this into perspective. The approximate demand to the year 2000 is on the most likely case about three million tonnes of uranium, and to the year 2025, about ten million tonnes, so we have a very large job in front of us to find enough uranium.

If, as Mr. Lane mentioned earlier, we have to look to a non-breeder future, the figure multiplies by a factor of three or four perhaps.

Mr. TEAGUE. Let met understand that, we look to a non-breeder future?

Mr. CAMERON. If we were to do that.

Mr. TEAGUE. But we don't, do we?

Mr. CAMERON. No, I don't think so. But, it has been——

Some people have suggested it.

Mr. TEAGUE. I know that Doctor, but how many nations are going to follow it?

Mr. CAMERON. But, if it were, you are looking at something like thirty million tonnes, by the year 2025.

Mr. TEAGUE. How many major nations are going to follow a non-breeder?

Mr. CAMERON. At this stage, none.

Mr. CAMERON. Anyway, it is one thing that we are going to have to take into account in our future estimates.

Mr. HALL. This question of resources comes up exactly on the point that you are making, in other words, if you view the future as non-breeder for a long time, then the question is, will you have enough uranium to sustain the Light Water Reactor future for the next twenty, thirty or forty years. What is your answer?

Mr. CAMERON. This is where the answer lies because if you are looking at ten million tonnes by the 2025, we have a big problem in finding it, but, the general opinion among most geologists is that it is not an insuperable problem. We look on the constraints and factors that have to be taken into account as three fold. The physical factors of whether that uranium actually exists in the world, in the near surface crust, the economic factors, and the political factors.

Now on the physical factors, there is a wide range of opinion, of weather that ten million tonnes exists or not, but the general consensus is that there is so much ground unprospected, unlooked at, that it by all reason it should be there. At the present moment, as you know, the world's uranium reserves are, eighty-five percent, are in four countries. And this is——

Mr. SCHEUER. Which four countries?

Mr. CAMERON. The United States, South Africa, Australia and Canada.

Mr. SCHEUER. Russia?

Mr. CAMERON. We don't know. But, it seems incredible that this bias should exist, and it really only means that the money in exploration has been spent on those countries. You have vast areas of the world that has equally favorable geological potential which hasn't been looked at.

Mr. SCHEUER. Which areas would those be?

Mr. CAMERON. Well, this is a subject which our geologists have been trying to define, but there are many general areas. The whole of the borders of the outlying Himalayan range on the southern side if favorably generally, a large part of the African continent, round the main shields is favorable, and the South American cordillera, the East side, all that is favorable ground, and it just hasn't been properly looked at. So, the tendency is to feel that if the work is done, the money is spent, and enough research and development put into the techniques, we could probably find it.

The second factor, which has always been considered is, is there enough available exploration funds? The total that you are looking at is about twenty billion dollars before the year 2000 to do the exploration, and about the same amount on capital expenditure.

Now at a recent AIF meeting the bankers said that this was not important, this could easily be found if the uranium industry generated enough confidence to bring in this capital.

The third, and most important of all, is the political factor, that is the availability of search areas and the availability of production rights and export rights. This is where a much more complicated situation exists. Are you aware, even in the main countries, such as Australia, you have big problems.

Mr. MILFORD. Shall we continue? Dr. Hall. Yes, two more minutes.

Mr. CAMERON. So that in my view, the solution to the political situation of finding the search areas is one of the major constraints on uranium resources in the future.

Mr. SCHEUER. What are the political constraints? These were economic constraints, of finding the twenty billion for exploration and the twenty billion for capital development.

Mr. CAMERON. Well, there are many countries who are unwilling or unable to grant the exploration rights. They are interested in their own uranium resources, but not in exporting them. We run into this—

Mr. SCHEUER. Have they explored them, do they know that they are there?

Mr. CAMERON. No, in many cases they are quite inadequately explored. But they are not willing to provide the exploration concessions.

Mr. SCHEUER. Is this a north-south problem? Is this a developing world problem?

Mr. CAMERON. Yes, I would say it is. But, even as I said, its not, you can't relate it purely to a developing country, we've had big problems for example, in Australia, until the Fox Report came out only two days ago, and even now its only providing a very limited development of some of the uranium deposits there. So there are these internal political problems.

Dr. HALL. I think the conclusion I derive from this is that the resources of uranium do not provide argument for or against the breeder. I think that this is the way I come out.

Mr. Krymm, would you disagree with that?

Mr. KRYMM. All but the short term.

Because our resources are sufficient to cover nuclear programs even at the maximum level, contemplated only two years ago all the way to the year 2000.

Mr. SCHEUER. What you are saying is, that there may be far more resources that are there, but that we do not know about, simply for the lack of exploration.

Mr. CAMERON. Exactly.

Mr. SCHEUER. Or, are you saying that we shouldn't run into any shortage before 2000, crisis situations, you're not really saying——

Mr. CAMERON. Not really, there should be no problem up to 2000, I indicated to begin with that about half the total reserves, the two million, has still to be blocked out. That is a purely technical job.

Mr. MYERS. Couldn't there be some kind of international exploration program without any commitment to export the uranium, just for the sake, for goodness sake, of finding out where it is? We could say "look, we want to find out where your uranium is, we are not going to charge you a thing for it", wouldn't that be a worth while international project, just to identify the source of uranium and then the second stage of the two-stage rocket would be to negotiate an arrangement that could be exploited fo the benefit of mankind. We're talking about a trillion dollars worth of nodules on the deep sea ocean bed, available for the benefit of mankind. It seems to me that we could apply the same kind of logic to uranium, that thats there for the benefit of mankind, and we know you have a national stake in it, you have absolute sovereignty, we're not questioning that, but for God's sakes, lets at least find out from the world point of view where the hell the uranium is, and then we'll get on to the second stage, of trying to figure what the devil to do with it, and you will have total sovereignty over your uranium, and you will have total control and you will have all the options, and you can preserve your options, but we just want to help find out where the world's uranium supplies are.

Dr. HALL. You have a very sensible proposal, and I hope that at some stage you will discuss this with the Department of State, and bring it back to us.

Mr. SCHEUER. I'm sorry our Ambassador isn't in the room, we could have have worked out the details over lunch.

Dr. HALL. Well, Mr. Cameron wanted to tell you that we already have a modest international program, but it's a modest one that wouldn't fit the——

Mr. MILFORD. Well, couldn't the World Bank fund something like this?

Mr. CAMERON. I don't think it's a matter of funding, they won't let you into the country to do it.

Mr. CAMERON. Sir, I'm happy to say that we are trying to do it, the idea, I think, was initiated by the United States, about two years ago, and it came through the International Energy Agency, through the Nuclear Energy Agency and we are participating in it. We are doing, at the present moment a purely bibliographical study of every country in the world and I'm in the midst of that at the moment. The second stage would be——

Mr. SCHEUER. You mean I just reinvented the wheel here——

Dr. HALL. The next stage is to invent us——

Mr. CAMERON. We are very limited in funds on this.

Mr. MILFORD. Gentlemen, let me warn you that we have about ten minutes left and we are going to have to leave and they still have material to cover.

Dr. HALL. Could we turn to the second item on the fuel cycle. Actually B and C could be discussed together. This is reprocessing, spent fuel waste management, and I think that one of our colleagues, our colleague is interested in some of the management problems, so Mr. Kaplan could you, really in about four minutes——

Mr. KAPLAN. Let me say that first of all you will find a hand-out of material largely taken from agency publications and I won't attempt to cover it in detail, but will give you the general specifics.

In terms of reprocessing plant capability, this is given on the first sheet, you will see that there is a cumulative capability in the world, excluding the simply planned economics of about 64,000 tonnes of spent fuel, and this can be equated by the relationship that 100 tonnes per year is approximately equivalent to 4000 megawatts of installed electrical capacity. Of this 64 thousand tonnes, the United States comprises about 20,000 tonnes through the year 1990, so that in essence we can say that the United States contribution to reprocessing capacity is about ⅓ of the world capacity excluding the Soviet countries, and you will see some details on the breakdowns of planned and projected, we might say that the plans which are shown in terms of capacity in the near future, lets say through about 1983–84 are fairly fixed, those that come in late in this time frame are somewhat more improbable.

Mr. MYERS. Which means that they are committed to——

Mr. KAPLAN. They are committed and the plants are already under construction, or in some cases in operation.

Dr. HALL. This is a very important table, because this sets out what the world is doing, except in the planned economy, which we don't have the information on on the chemical, or the fuel reprocessing. So here on one table you see that element of the President's program and the significance of it in reference to the world.

Could we quickly go on to——

Mr. KAPLAN. I'd like to just briefly go on to the next figure, this shows the cumulative quantity of spent fuel discharge based on power projection curves for the high and low estimate, again this is for the world, excluding the simply planned economies from now through 1990. I think what is pertinent here is to note that there are three portions of the graph, the bottom one fuel expected to be reprocessed from plants authorized for operation, these are the plants which are Mr. Myers are already in near term completion, or are operating already, and these would handle approximately 76,000 tons of fuel by 1990.

The next group, the fuel expected to be reprocessed from plants planned is—the middle group is fuel expected to be reprocessed from plants planned, this is much more uncertain, it is not clear that these plants will be built and the top curve represents the short fall that is fuel in storage which cannot be reprocessed because there is insufficient reprocessing capacity, using the low estimate of nuclear power projection. Now this means essentially that if you take simply the fuel in storage by 1990, cumulatively there would have been 30,000 tons of fuel and fuel in storage plus that from plants planned would be 76,000 tons. So if these uncertain reprocessing plants do not come into operation there will be essentially 76,000 tons of spent fuel in the world that need to be reprocessed, or dealt with in terms of storage or some other management.

Dr. HALL. What do you with this stuff, how do you store it, or can you store it?

Mr. KAPLAN. Experience with extended fuel storage is limited. The Canadians of course have been storing their fuel for quite some time, they look to water storage, that is, storage in water basins for perhaps up to 75 years without any particular modification of fuel. They are considering moving such fuel to air storage. Similar studies have been undertaken in other countries. I think the United States is about to embark in a major review of this practice. We have a program here in the agency to look at the world experience. But, it is clear that the clouding of the fuel in water storage will not last forever, that means that these elements must be either treated in some manner, put in secondary containers or dealt with so that the material in them does not escape due to failure of the clouding itself.

Dr. HALL. Are there any questions on the storage problem, because this has been a part of the public debate you know as to can you safely store the waste for the next thirty or forty x years when the waste itself contains halfway problems that literally are a thousand year problems.

Mr. KETCHAM. Do you have adequate short term storage capability here until you get into the reprocessing made in the United States. We have been anticipating reprocessing for so long that the short term storage is going to be a very critical problem unless construction takes place quite shortly. Is that a similar problem in Europe or——

Mr. KAPLAN. Well, I can answer that question. In the United States if no reprocessing is done through 1990 there will be about 38,000 tons of spent fuel, which will have to be stored.

Mr. BREUX. Where are they storing it now around the world?

Dr. HALL. That wasn't the question. The question was can it be stored, not how much. Tell them about——

Mr. KAPLAN. There are plans for building large scale storage facilities in——

Dr. HALL. Short term though——

Mr. KAPLAN. These are short term, these are to deal with lets say the next ten to fifteen years. The Federal Republic, France, or both are building expandable storage facilities. In the United States I think the position has been that the fuel, the power plants themselves must have storage capacity, unless some action is taken to build centralized repositories for such fuel. Other countries are proceeding with their reprocessing and hope to more or less keep abreast of the problem, so they would not expect to have more than perhaps two to three year backlog of fuel in storage.

Dr. HALL. I think the point you made is the conclusion in Western Europe, because Western Europe has had this problem for many years now, and so the short term storage has been pretty well solved, but the long term storage, as we all know, is still an enormous problem, but solveable.

Mr. KETCHAM. So the short term storage is not then on site, but——

Dr. HALL. No. I don't think the short term storage should prevent a full fuel cycle, let me put it that way. On the long term storage we fortunately have thirty or forty years to worry about that, and I think, well I'm an optimist based on the status of the art in the events we have already made. Now we've reached, with two minutes to go, we've reached one of the most important items, namely the nonproliferation policy consideration, the IAEA safeguard system, on point of fact we've sort of touched on this for the past two hours, but I, we have with us Mr. Schmeli from the Soviet Union who is senior person responsible, particularly for the information treatment which our inspectors are required to bring in and we wish to say, about two minutes on this one, and then perhaps I could close down with a few general remarks.

Mr. SCHMELI. If I may I would explain first the general organization of the Department of Safeguards. We have in this Department two operational divisions who are responsible for actual verification, inspection and verification of the materials, we have their Development Division responsible for development of methods, techniques and instruments, and very recently established the Division for Safeguards Information Treatments. The safeguards are actually two, operates under two types of agreements. Under agreement concluded according to the nonproliferation requirements, but still we have the second type of agreement which is for bilateral or trilateral agreements for those countries who are not signers or of nonproliferation treaty.

The procedures are such that the agency is reviewing the design information to be sent by the member states which are under safeguards, the countries are, sent us the reports, accounting reports about all conceptions or material balances which they are making, and to verify that information which is being sent to the agency and being processed here, inspections of the facilities are being made, where inspectors check the validity of information and the agreement of the claimed amounts of material with the actual.

As a result of those inspections the statements are being made about the results of the inspections, those results are being made known to the respective countries where the inspections are being made.

As far as the size of our work, I think that about 150 facilities are reporting. were reporting to us under NPT, and I think about a similar amount are reporting under non NPT.

Safeguards budget for '78 for Safeguards, is I think about 11 million dollars, from 44 million, which was quoted by Dr. Holtz, or ¼, and the staffing budget for 1977 for 311 professional officers as members of the Safeguards Department, for all activities of the Safeguard Department for inspections, for development work and for headquarters.

Dr. HALL. I think the main point here is that we have been in this business of safeguarding for about fifteen years, and we have developed an expertise that I think can provide everyone assurance, aided by the equipment that we have seen in the next room, that the job that you want us to do, that we can do, and do effectively. Occasionally you hear problems, Mr. Chairman, we've reached the item, number five, the last item, which we call nonproliferation policy in the IAE Safeguard System Mr. Schmeliff has described the general organization and the number of facilities which we inspect, which now are in the order of about 300, and I think the conclusion is that we are not new in this business, we now have been in this business for about 15 years.

Mr. MINETA. If I could very quickly, my colleague Mr. Milford has brought up the example of India, and you said if they had been under safeguards, then it would have been——

Dr. HALL. No device, no device.

Mr. MINETA. Now, the question is how do you bring someone under the umbrella of being under the safeguard, when under your own articles it says that "where the agency is requested by the parties concerned to apply safeguards," so its outside the control of the agency as to who comes under the umbrella——

Dr. HALL. That's right——

Mr. MINETA. Now, that's where the problem lies, as in this part here you show all of the countries that are the non NPT countries having significant nuclear programs.

Dr. HALL. May I answer this. This is something, if I may speak as an American now, that the Congress of the United States has the power to do something about, because most of these non NPT countries still rely on supplies and equipment and if the export——

Mr. SCHEUER. Only eminating from the U.S.?

Dr. HALL. And from other countries too. I'm developing sort of off-the-record policies for the U.S., because in the case of India, India cannot survive in the next ten years without help from the outside. Our Canadian colleagues have already taken a strong position on this, they feel a little embarrassed by what happened in May of '74, '75. So, what am I saying, the Terr ———— Reactor requires fuel, and that fuel comes from the U.S., they require other types of equipment which India itself is not able to build, so if you have a concerted policy through the mechanism of the suppliers that nothing will be exported unless it's under complete safeguards, then to answer your question it's not the agency——

Mr. MINETA. But if take that unilateral action, is there not someone else that would fill that gap to become the supplier if——

Dr. HALL. That was the second part of my answer, in other words, if this requires the cooperation among the suppliers, which has already started, we are not part of that, but we know what is happening, so if the suppliers themselves, in a concerted action, and this is reflected in the proposed export legislation, proposed by the President, then I think you are about 95% home to answer your question. So what is the answer to your question, the agency as an international secretariat can do nothing, but your representatives in collaboration with other supplier representatives can establish policy which would mean that what happened in India couldn't happen again.

Mr. MINETA. As Jim has talked about the agency or some other international body becoming the supplier of the capital for exploration purposes, is there a way that the agency could become the supplier and controller of the reprocessing. In other words, none can get additional fuels unless they return back what they have gotten in the first place.

Dr. HALL. We have statutory authority to do that, that type of thinking goes back twenty years really, when it was understood very early that the supply problem was essentially the basis of the control problem but, in the years that have gone by that has been somewhat overlooked until the past three or four years when it became clear among the suppliers in their hands they had the opportunity to establish conditions and denials unless the recipient conformed to certain policies. I think the ultimate of that is the Australian, the Canadian, and the draft legislation for your Congress. Namely, the export control.

Mr. SCHEUER. Aren't there some European supply companies that are really keen on selling nuclear plants?

Dr. HALL. Yes, and what this means is that you have to talk to these countries and develop a common purpose, and I think you can.

Mr. SCHEUER. Didn't the President try some jaw-boneing on that and really——

Dr. HALL. Yes, but that wasn't the way to do it if I may modestly say so.

Mr. SCHEUER. Tell us, what is the way to do it.

Dr. HALL. The way to do it is to have a collective approach through the suppliers, not a unilaterial concern.

Mr. SCHEUER. Maybe this, as Congressman Mienta mentioned, maybe this, the leadership to this thrust could come through your agency.

Dr. HALL. Well, we're ready, and again Mr. Chairman I hope I haven't overstated our case, but even if I have, I think we can match it. By that I mean I think we are capable of doing it.

Mr. MYERS. Dr. Hall, if I might sort of a broad question, it seems to me that on a world wide basis there is increasing activity in opposition to the utilization of nuclear power. Does your organization identify any world wide effort, organized world wide effort, in this regard, and if you have do you have a policy or program to deal with it.

Dr. HALL. Well, this has been discussed internally for some months as to what our responsibility was. We call it, well in the broadest sense, informing the public, and in a narrow sense, sort of reassuring on specific items as they come up, I mean if there's a leak, or an accident, to make sure that the leak or accident is not distorted in the press. But, within the House, and I think within our Board itself, at this stage, we do not have a clear cut policy. Now in identifying the groups or personalities throughout the world that contribute to this problem I am particularly amazed that there is such a variety. I eluded the one problem, that is generally an ill informed press reporting. A great deal of the headlines are related to that, this is the old theory in press, if you have rape, riot or revolution you make the headlines but, if you have a safe operating industry its not news. Even if there is an allegation of an accident, and the accident may even be on the conventional side, had nothing to do with the nuclear side, you read the article, and so point one, its a complicated, technical subject and here again I think that the American Congress has an important responsibility, you gentlemen not only understand, but also in providing the American people with the——

Mr. MYERS. Have you identified any organization, any structural organization whose intent is to remove total utilization regards to the Breeder or Light Water and do you react to those?

Dr. HALL. Yes, Friends of the Earth is one of them——

Mr. CAMERON. There are many that have national bureaus, National Secretariats, and they correspond, and they make conferences and its followed up rather well.

Mr. MYERS. On an international basis?

Mr. CAMERON. Yes, they profit of any international occasion where they can state their case.

Mr. TEAGUE. At Saltzburg we started on Monday and Saturday and Sunday the Friends of the Earth and a few other local groups met on an anti-nuclear conference, a counter conference, fortunately the demonstration, they had two, one with thirty-two people and the other with fifty-five, so it didn't disturb the tranquillity of our meeting at all.

Mr. Chairman: I would like to keep on all day, but we can't. May I say thank you on behalf of all my colleagues and to all these people who came out here and spent the morning, the Saturday morning, trying to educate us some, I thank you, you have certainly done a great job.

Dr. HALL. Thank you Mr. Chairman, I know my colleagues were delighted to have you here and I hope you come back, because I really think we have something to say that in the long run can add a bit to the peace of our rather complicated world.

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