

RECEIVED
LIBRARY
BERKELEY LABORATORY

MAY 20 1977

LIBRARY AND
DOCUMENTS SECTION

TRAVELS IN THE NEW WORLD

VOLUME I

For Reference

Not to be taken from this room

Glenn T. Seaborg

April 1977

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

TRAVELS IN THE NEW WORLD*

Glenn T. Seaborg

Volume I

*Prepared for the U. S. Energy Research and Development Administration
under Contract W-7405-ENG-48.

To
Otto Hahn
for his role in the discovery of nuclear fission
and
Enrico Fermi
for his key contributions to the achievement of
the nuclear chain reaction

"We had to conclude that our 'radium isotopes' have the chemical characteristics of barium. Speaking as chemists, we even have to say that these new substances are barium, not radium."

Hahn, January 1939

"On the morning of December 2, 1942, the indications were that the critical dimensions had been slightly exceeded and that the system did not chain react only because of the absorption of the cadmium strips....then this last strip was gradually extracted, close watch being kept on the intensity....the intensity started rising slowly, but at an increasing rate, and kept on increasing until it was evident that it would actually diverge."

Fermi, November 1945

"'Tis not so deadly long a story, but I must own, 'tis a passing tangled one, with much running hither and thither and an army of names to bear in mind."

John Barth, *The Sot-weed Factor*

CONTENTS, Volume I

	page
List of Abbreviations	xi
Preface	xvii
<i>Chapter</i> 1. Introduction	1
<i>Chapter</i> 2. Euratom	9
<i>Chapter</i> 3. France	46
<i>Chapter</i> 4. Germany	89
<i>Chapter</i> 5. Italy	125
<i>Chapter</i> 6. Benelux	147
<i>Chapter</i> 7. United Kingdom	171
<i>Chapter</i> 8. Sweden	218
<i>Chapter</i> 9. Japan	258
<i>Chapter</i> 10. India	308
<i>Chapter</i> 11. Pakistan	339
<i>Chapter</i> 12. Canada	362
<i>Chapter</i> 13. Puerto Rico	391
Index of Names	403

Countries Visited

Argentina	Lebanon
Australia	Luxembourg
Austria	
	Mexico
Belgium	Monaco
Brazil	Morocco
Chile	Netherlands
China (Taipei)	Norway
Colombia	
Congo	Okinawa
Czechoslovakia	
	Pakistan
Denmark	Panama
	Peru
Egypt	Philippines
Ethiopia	Poland
	Portugal
Finland	Puerto Rico
France	
	Romania
Germany	
Ghana	Scotland
Greece	Singapore
	Spain
	Sweden
Hong Kong	Switzerland
Hungary	Syria
India	United Kingdom
Indonesia	Union of Soviet
Ireland	Socialist Republics
Israel	
Italy	Venezuela
	Yugoslavia
Japan	
Jordan	
Kenya	
Korea	
Kuwait	

LIST OF ABBREVIATIONS

A

ABCC	Atomic Bomb Casualty Commission
ABM	Anti-ballistic missile
ACS	American Chemical Society
AECL	Atomic Energy of Canada Ltd.
AEG	Allgemeine Elektrizitäts-Gesellschaft (FRG)
AERE	Atomic Energy Research Establishment (Harwell, UK)
AGR	Advanced gas-cooled reactor
AID	Agency for International Development (US)
AIF	Atomic Industrial Forum
AKK	Swedish Atomkraft Konsortiet
ANL	Argonne National Laboratory
ANS	American Nuclear Society
ANSA	Agenzia Nazionale Stampa Associata (Italy)
AP	Associated Press
ASEA	Allmanna Svenska Elektriska Aktiebolaget (Sweden)
AVR	Arbeitsgemeinschaft Versuchs-Reaktor (Pebble-bed reactor)
AWRE	UKAEA Atomic Weapons Research Establishment (Aldermaston, UK)

B

BARC	Bhabha Atomic Research Center (Trombay, India)
BeV	Billion electron volts
BWR	Boiling water reactor

C

CANDU	Canadian Deuterium-Uranium Power Reactor
CBNM	Central Bureau of Nuclear Measurements (Geel, Belgium)
CEA	Commisariat à l'Energie Atomique (France) and Cambridge Electron Accelerator (US)
CEGB	Central Electricity Generating Board (UK)
CEN	Centre d'Etudes de l'Energie Nucléaire (Belgium)
CENG	Centre d'Etudes Nucléaires de Grenoble (France)
CERN	Conseil Européen pour la Recherche Nucléaire (European Organization for Nuclear Research)
CIC	Canadian Institute of Chemistry
CIP	Cascade Improvement Program
Cirus	Canadian-Indian-Reactor-Uranium-System
CNA	Canadian Nuclear Association
CNEN	Comitato Nazionale per l'Energia Nucleare (Italy)
CNRS	Centre National de la Recherche Scientifique (France)

D

DCM Deputy Chief of Mission
DERE Dounreay Experimental Reactor Establishment (Scotland)
DESY Deutsches Elektronen Synchrotron (Hamburg, FRG)
DFR Dounreay Fast Reactor (Scotland)
DIA USAEC Division of International Affairs
DOD Department of Defense (US)
DOR Deuterium-moderated, organic-cooled reactor

E

EBR-2 Experimental Breeder Reactor No. 2
ECCS Emergency core cooling system
EDF Electricité de France
EDT Eastern Daylight Time
EEC European Economic Community
EEI Edison Electric Institute
ENEA European Nuclear Energy Agency
ENEL Italian National Electric Power Agency
ERR Elk River Reactor
Euratom European Atomic Energy Community
Eurochemic European Community for the Chemical Processing of Irradiated Fuels (Mol, Belgium)
Eurodif Consortium of France, Belgium, Sweden, Spain, and Italy constructing gaseous-diffusion uranium-enrichment plant.

F

FAO Food and Agriculture Organization (UN)
FBR Fast Breeder Reactor
FFTF Fast Flux Test Facility (Hanford)
FIEN Forum Italiano dell'Energia Nucleare (Italian Nuclear Energy Forum)
FNEC Yugoslav Federal Nuclear Energy Commission
FOA Swedish National Defense Research Institute
Foratom European Atomic Industrial Forum
FRG Federal Republic of Germany

G

GE General Electric
GFK Gesellschaft für Kernforschung (FRG)
GKN Gemeenschap Kernenergiecentrale Nederland (Gelderland, Netherlands)
GKSS Gesellschaft für Kernenergieverwertung in Schiffbau und Schifffahrt m.b.H. (FRG)
GNP Gross national product

H

Helac	Helix Heavy Ion Linear Accelerator (University of Frankfurt, FRG)
HFBR	High-flux beam reactor
HFR	High-flux research reactor at Petten, Netherlands
HTGR	High-temperature gas-cooled reactor
HTR	High-temperature gas-cooled reactor
HTR(HT)	High-temperature gas-cooled reactor (helium turbine)
HTR(ST)	High-temperature gas-cooled reactor (steam turbine)
HUD	Housing and Urban Development Department (US)
HWOCR	Heavy-water organic-cooled reactor
HWR	Heavy-water reactor

I

IAEA	International Atomic Energy Agency
IANEC	Inter-American Nuclear Energy Commission
IFA	Norwegian Institute for Atomic Energy
IGE	International General Electric
IKO	Instituut voor Kernfysisch Onderzoek
ING	Intense neutron generator
INIS	International Nuclear Information System (IAEA)
IPA	International Platform Association
IPORI	Irradiation and Pest Control Research Institute (Pakistan)
ITREC	Italian thorium fuel element reprocessing plant

J

JAEC	Japan Atomic Energy Commission
JAIF	Japan Atomic Industrial Forum
JAPCO	Japan Atomic Power Company
JCAE	Joint Committee on Atomic Energy (US Congress)
JEEP-I	Joint Establishment Experimental Pile-I (Norway)
JPDR	Japanese Power Demonstration Reactor
JRC	Joint Research Center (Euratom)
JRR2	Japan Research Reactor 2
JRR3	Japan Research Reactor 3

K

KANUPP	Karachi Nuclear Power Plant (Pakistan)
KEMA	Electronic Materials Testing Company (Netherlands)
KEPCO	Kansai Electric Power Company (Japan)
Kev	Thousand electron volts
kg	kilogram(s)
KRB	Kernkraftwerk RWE-Bayernwerk B.m.b.H. (Gundremmingen, Germany)
KRITO	Zero power critical experimental research reactor, more recently called "STEK" (Petten, Netherlands)
KSTR	Netherlands suspension test reactor
KW	kilowatt
KWL	Kernkraftwerk Lingen (Germany)

L

LFR Low-flux research reactor (Petten, Netherlands)
LMEC Liquid Metal Engineering Center (Santa Susanna, California)
LMFBR Liquid metal cooled fast breeder reactor

M

MAAG Military Assistance Advisory Group
MATS Military Air Transport Service
MAUD Code name for British committee that investigated
feasibility of producing atomic bomb, 1940
Mev Million electron volts
MIT Massachusetts Institute of Technology
MLF Multilateral Nuclear Force (NATO)
MTR Materials Testing Reactor (Idaho site)
MW megawatt
MWD megawatt days
MWD/t megawatt days per ton
MWe megawatt electrical
MWt megawatt thermal

N

NASA National Aeronautics and Space Administration
NATO North Atlantic Treaty Organization
NFS Nuclear Fuel Services (US company)
NORA Norwegian Zero Power Reactor Assembly
NPD Nuclear Power Demonstration reactor
NPR New Production Reactor (Hanford)
NPT Treaty on the Non-Proliferation of Nuclear Weapons
NRTS National Reactor Testing Station (Idaho)
NRU National Research Universal (reactor) (Canada)
NRX Nuclear Reactor Experimental (Canada)
NS nuclear ship
NSF National Science Foundation
NUKEM A German nuclear fuel company

O

OECD Organization for Economic Cooperation and Development
OKG Oskarshamn Power Group (Sweden)
ORNL Oak Ridge National Laboratory (US)
OST Office of Science and Technology (US)
OSW Office of Saline Water (US)

P

PAEC Pakistan Atomic Energy Commission
 PAGR Prototype Advanced Gas-cooled Reactor
 PAT Pressurized water submarine reactor prototype (France)
 PCUT Italian Uranium Thorium Fuel Cycle Program
 PEON Consultative Commission for the Production of Electricity of Nuclear Origin (France)
 PFR Prototype fast reactor
 PINSTECH Pakistan Institute of Nuclear Science and Technology (Nilore, Pakistan)
 PNC Power Reactor and Nuclear Fuel Development Corporation, owned by Japanese government
 PRTR Plutonium recycle test reactor
 PWR Pressurized water reactor
 PX Post exchange (military)

R

R&D Research and development
 RAPP Rajasthan Atomic Power Plant (Indian)
 RCN Netherlands Reactor Center
 RWE Rhine Westphalia Electrical Works (FRG)

S

SAC Strategic Air Command
 SALT Strategic Arms Limitation Talks
 SCDST Special Committee on Development of Science and Technology (Japan)
 SCTF Sodium Component Test Facility (Netherlands)
 SCFI Sodium Component Test Installation (US)
 SEFOR Southwest Experimental Fast Oxide Reactor (US)
 SELNI Società Eletttronucleare Italiano S.p.a. (Italian Electro-Nuclear Company, Inc., Milano)
 SEMO Société Belgo-Francaise d'Energie Nucléaire Mosane
 SENA Société d'Energie Nucléaire Franco-Belge des Ardennes (Chooz, France)
 SENN Società Eletttronucleare Nazionale (Garigliano and Rome, Italy)
 SGR Sodium Graphite Reactor
 SGWR Steam-generating heavy-water moderated reactor
 SHAPE Supreme Headquarters Allied Powers, Europe
 SNAP Systems for nuclear auxiliary power (radioisotope-powered electric sources)
 SNM Special nuclear material
 SRC Science Research Council (UK)
 SRP Savannah River Plant
 SSEB South of Scotland Electric Board
 SuperHILAC Super Heavy Ion Linear Accelerator

T

THTR Thorium High Temperature Reactor
TNO Netherlands Organization for Industrial Research
TNP Group The Nuclear Power Group (UK)

U

U Uranium
UAR United Arab Republic
UHTREX Ultra High Temperature Reactor Experiment (Los Alamos, NM)
UK United Kingdom
UKAEA United Kingdom Atomic Energy Authority
UN United Nations
UNESCO United Nations Education, Scientific, and Cultural Organization
Unilac German heavy ion accelerator at Darmstadt
UPI United Press International
Urenco-Centec Consortium of UK, Netherlands, and West Germany developing ultracentrifuge uranium enrichment capability
US United States
USAEC United States Atomic Energy Commission
USAID United States Agency for International Development (same as AID)
USAIF United States Atomic Industrial Forum (same as AIF)
USEC US Mission to the European Communities
USIA United States Information Agency (domestic)
USIS United States Information Service (overseas)
USSR Union of Soviet Socialist Republics

Z

ZEEP Zero Energy Experimental Pile
ZPR Zero Power Reactor

PREFACE

Travels in the New World is an account, based on my journals, of my visits to some 60 countries during my tenure as Chairman of the US Atomic Energy Commission during the decade 1961-1971. The "new world" of the title is the world of nuclear energy, which has brought about such dramatic changes in our lives all over the planet, and beyond. Although much of the focus of the book is on the increasing use of nuclear electric power and other peaceful uses of nuclear energy throughout the world, as developed before and during the decade 1961-1971, there is also much emphasis on the role of science and technology in general in the growth and development of the countries visited. And throughout will be found the theme of working to prevent or minimize the spread of nuclear weapons capability that could otherwise be aided by an uncontrolled adoption of nuclear power; described in some detail are my efforts in numerous countries to promulgate the Non-Proliferation Treaty (NPT), which should play an indispensable role in future world stability. (This account does not include a description of the successful attainment of the Limited Nuclear Test Ban Treaty, nor the efforts toward a more comprehensive test ban treaty and arms limitation, which might be subjects for future publication.)

Narrative material is interspersed throughout, designed to help the reader understand the journal entries, which differ in the detail they encompass. These entries were recorded almost concurrently with the visits, or very soon thereafter, and are reproduced in essentially unedited form, except for the filling in more fully of the names of people, their connections, and the identification of installations and places visited. Thus they reflect the attitudes of the 1960s, which often anticipated a faster rate of installation and operation of nuclear power plants than has proved possible. Circumstances varied widely in allowing the opportunity to make these on-the-spot recordings. Fortunately a number of pictures were usually taken during the visits, making it possible to provide helpful illustrations throughout. Although the heavily scheduled business agenda allowed only minimal time for sight-seeing, I have included more than a proportionate share of scenic pictures in order to enliven the account.

This, Volume I, is written on a country-by-country basis. Included here are an Introductory chapter and 12 chapters on Euratom, France, Germany, Italy, the Benelux countries, United Kingdom, Sweden, Japan, India, Pakistan, Canada, and Puerto Rico. Although the focus is on the decade 1961-1971, earlier historical background material is included to help set the stage; some information for the period subsequent to 1971 has been added as the writing and editing progressed but this is limited to only a few of the most important issues. Volume II, well underway, will be published in a different style, on a trip-by-trip basis, covering my visits to some 40-odd other countries. A possible Volume III would be devoted to the Soviet Union where I visited more extensively than other countries; the two most important of these visits, in 1963 and 1971, have been covered in individual AEC reports, which makes it less urgent to complete that Volume, an accomplishment that my future schedule could preclude.

I am indebted to many people for help that has made this publication possible. The encouragement of Myron Kratzer, at that time Assistant General Manager for International Activities at the AEC, set the stage for the undertaking, and his cooperation, and that of his successor, Abraham S. Friedman, is very much appreciated. Howard Brown, Arnold Fritsch, Julius Rubin, Justin Bloom, Dan Wilkes, Cecil King, and Stanley Schneider, who individually travelled with me on many of these trips and often were burdened with the extra duty of helping me to take pictures and make notes, were most helpful. My secretaries, Marie Janinek, Mildred Cecil, and Mary Sweeney, worked hard to put my travel notes into presentable form. My especial thanks go to Betsy McFadden, who contributed so much to the early drafts, to other staff of the AEC Division of International Affairs, who have helped so much in gathering material, and to Jane Kingston, who put the manuscript into final publishable form.

G.T.S.

CHAPTER 1

INTRODUCTION

Travel is both a bane and a boon to those who have the privilege of serving their country in high position. My responsibilities arising from the international program of the United States Atomic Energy Commission required 21 intercontinental trips (three of them around the world) in addition to numerous journeys within North America. I visited some 60 countries and talked with their scientific and governmental leaders, including those of Communist nations. I understand that my visit with Leonid Brezhnev in 1963 was the only personal discussion he held with a non-Communist American until April 1972, when he talked with Secretary of Agriculture Butz.

These trips involved extended separations from my family, disruption of normal eating and sleeping habits, exhausting schedules at nearly every stop, intensive in-flight "homework" to prepare for the next visit, a host of minor frustrations and inconveniences of various sorts – and on return a mountain of accumulated work! But the rewards were great. Reflecting now on my ten years as Chairman of the USAEC, I am convinced that my personal discussions with scientists and statesmen of other nations, and visits to their countries and scientific facilities, contributed significantly both to the furtherance of our cooperative nuclear policies and to the advancement of peaceful nuclear programs and nuclear safeguards throughout the world. In a broader context, they deepened my awareness of the mounting desires of peoples everywhere to work together to solve age-old problems of disease and hunger and poverty, my realization of science's tremendous potential to respond to these desires, and consequently, my ability to help plan the programs that were needed.

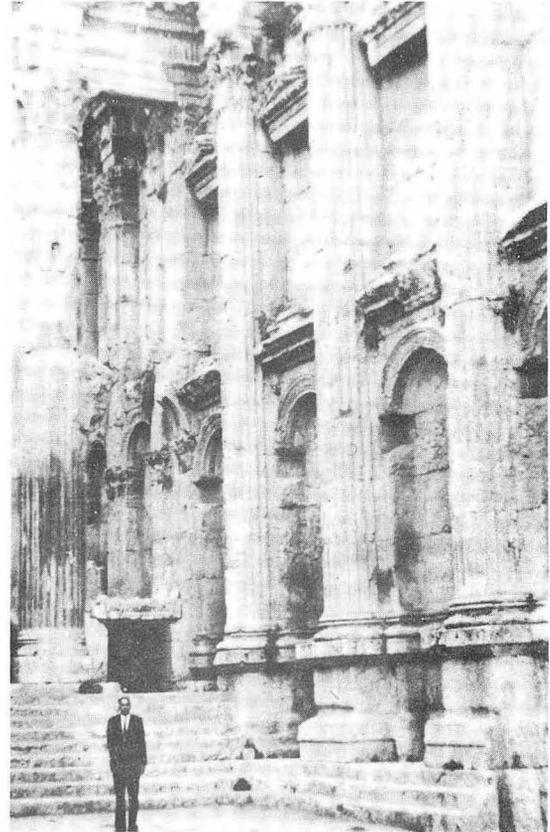
And then, of course, there was personal "spin-off" – the Danube at Budapest on a clear September day, Roman paving-stones on the Appian Way, the Bibi Khanym Mosque in Samarkand, Inca ruins in Peru, the Great Buddha at Kamakura, the Temple of Bacchus at Baalbek, the Acropolis in Athens, the ruins of Carthage, the house where Beethoven composed "Fidelio," the mighty Congo 2,000 feet below me winding through green jungle toward a dam construction site, canals in Venice, the charm of exotic animals in Australia, sunset over Scotland's downs – kaleidoscopic contacts with nature and the history of man.

But far better writers than I have related their journeys, reporting more dramatic events and offering more memorable descriptions, than can I. Why, then, do I tell my story? First, because it will, I hope, promote wider understanding of a subject of profound importance to our future and that of the world: international relations in the field of peaceful nuclear applications. It is my impression that great numbers of intelligent, highly-educated people – otherwise extremely well informed regarding international affairs – have little or no knowledge of the US "Atoms-for-Peace" program, aimed at helping to extend the benefits of the peaceful atom to all peoples, or of similar programs conducted by many other nations and groups of nations, or of the manner in which cooperative arrangements are initiated and conducted. I believe it will serve a useful purpose to tell something about the programs under way and about behind-the-scenes activities to make nuclear science an effective servant in man's striving toward a world of peace and understanding.



XBB 761-7040

Great Buddha, Kamakura, Japan. Arnold R. Fritsch and Glenn T. Seaborg in foreground.



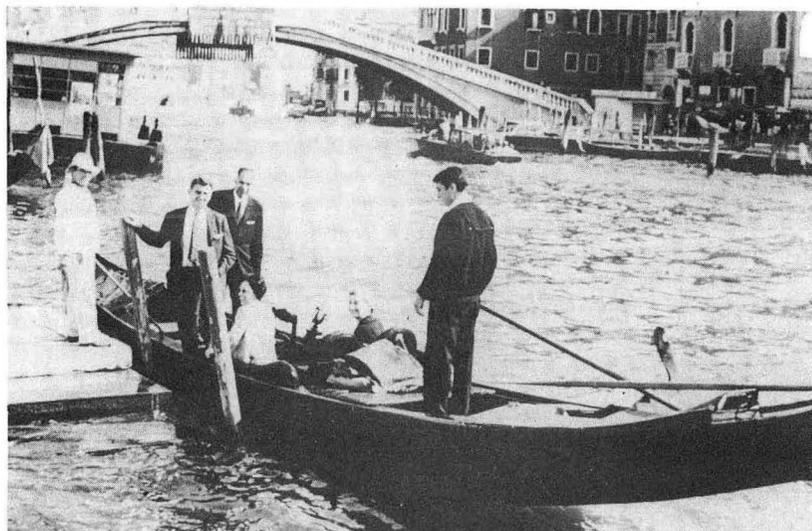
XBB 761-7041

Temple of Bacchus, Baalbek, Lebanon. Glenn T. Seaborg in foreground.



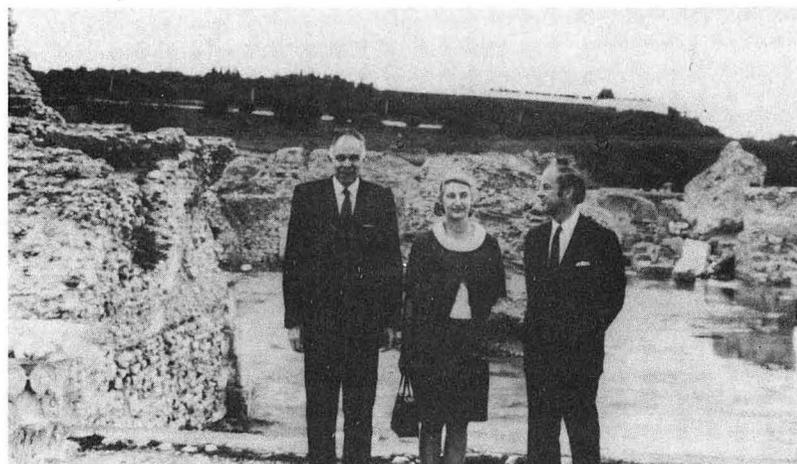
XBB 761-7042

Acropolis, Athens, Greece. Ambassador Phillips Talbot and Seaborg in foreground.



XBB 761-7043

Canal in Venice, Italy. Herman and June Pollack, Glenn and Helen Seaborg, boatman.



XBB 761-7044

Ruins of Carthage, Tunis. Glenn and Helen Seaborg, Ambassador John Calhoun.



XBB 761-7045

*Bibi Khanym Mosque, Samarkand.
Maya (guide), Seaborgs.*



XBB 761-7046

*Inca Ruins, Peru. (Left to right) Myron
Kratzer, Allan Dalton (behind Kratzer),
Robert Meyers, Robert Hollingsworth,
Seaborg, Donovan Zook.*



XBB 761-7047

*Kuringai Koala Park, Sydney, Australia.
Seaborgs, Maurice Timbs.*

Also, I think that the warmth of my reception everywhere and the generally gratifying results of discussions and meetings were symptoms of the growing recognition – both in the advanced nations and in the developing countries – of the importance of science and science policy to overall national policy. This recognition is leading to a new role for scientists in their own countries and on the international scene.

Science has long been international; physicists and chemists of other countries are familiar with my work, as I am with theirs. Now all of us find our special fields overlapping with broader fields that may have seemed remote in our student days, such as economics, national planning and international efforts to establish a workable world of peace. The mutual respect and confidence that marked our relations as scientists carry over into our exchanges in these broader fields. That is why, even at times when political relations between nations may be temporarily strained, their scientists can still talk to each other frankly and help pave a return to harmony and constructive common endeavor.

The Atoms-for-Peace Program and Its Results

The US Atomic Energy Commission, created by the Atomic Energy Act of 1946, was at first severely restricted in its authority to release unclassified nuclear information, even to longtime friendly nations for peaceful purposes. But as knowledge of the atom's potential contributions grew in such areas as medicine, agriculture, industry, and energy, scientists and government leaders became increasingly convinced that the United States and the few other nations possessing nuclear technology had an imperative responsibility to share its benefits with all.

Thus, in December 1953, President Eisenhower addressed the United Nations General Assembly and proposed the establishment of a program of international cooperation to promote the peaceful uses of nuclear energy and the creation of an international organization for this purpose.

The President's proposal evoked immediate response. Initiated by the United States, negotiations were started in the spring of 1954 to create the International Atomic Energy Agency. That August, the United States Congress opened the way for our Atoms-for-Peace program by passing the Atomic Energy Act of 1954, which authorized an international program "to make available to cooperating nations the benefits of peaceful applications of atomic energy as widely as expanding technology and considerations of the common defense and security will permit." Four months later, in December 1954, the United Nations General Assembly adopted a resolution calling for establishment of an international agency and for an international technical conference on peaceful nuclear applications.

The following summer, in August 1955, the First International Conference on the Peaceful Uses of Atomic Energy was held in Geneva under United Nations' auspices, providing the first opportunity for broad communication among nuclear scientists from around the globe. The Conference sparked increased support and impatience for the planned international organization, and during the next year, negotiations sped forward. On October 26, 1956, the Statute of the International Atomic Energy Agency (IAEA) was signed at UN Headquarters by 70 nations. The organization came into existence the following July 29th, and the IAEA's first General Conference was convened in Vienna on October 1, 1957.

6 Introduction

While plans for the world organization were being developed, efforts toward regional cooperation were also under way. The years 1954-58 saw the birth of the 11-member European Organization for Nuclear Research (CERN); the European Atomic Energy Community (Euratom), created by members of Europe's Coal and Steel Community; and the European Nuclear Energy Agency (ENEA), established within the framework of the Organization for European Economic Cooperation. To the East, eleven Communist countries agreed to set up a joint research institute at Dubna in the Soviet Union. And in the Western Hemisphere, the Council of the Organization of American States approved the formation of the Inter-American Nuclear Energy Commission (IANEC).

Meanwhile, pursuant to Congressional mandate, the USAEC had initiated a program designed to make the basic elements of nuclear technology and development available to other nations: research reactors and other nuclear research tools, special nuclear materials for research and power reactors, unclassified technology and documentation, and technical assistance including training, advisory services, and information. This cooperative program also embraced personnel and information exchange arrangements in specialized research and development fields, from which both the United States and cooperating nations were to benefit. In order to facilitate our collaboration with other countries and report on significant nuclear developments abroad, USAEC scientific representatives were assigned to the US diplomatic missions in a few key capitals.

For the most part these activities have been conducted under "Agreements for Cooperation in the Civil Uses of Atomic Energy." This is not always the case, however. For example, our arrangements with the Soviet Union, which do not involve the supply of special nuclear materials or reactors, have been carried on pursuant to a succession of "Memoranda on Cooperation."

At the end of 1971, Agreements for Cooperation were in effect with 30 individual nations and two international organizations (Euratom and the IAEA). Such agreements contain provisions for "safeguards," which are special reporting and inspection procedures to insure that no materials obtained from the United States, or fissionable products derived from them, are diverted to military purposes — in other words, to insure that the peaceful atom remains peaceful. Originally our bilateral agreements provided that the safeguard arrangements be implemented by the United States and the cooperating nation. The United States, however, has consistently held the position that safeguards administration should be assumed by a broad-based and impartial international organization as soon as possible. Beginning in the mid-60's, therefore, we initiated arrangements to transfer this responsibility to the IAEA with respect to our bilateral agreements. This transfer was made through conclusion of a trilateral agreement between the IAEA, the United States and the other nation concerned. The principle of international safeguards administration was further strengthened by the Treaty on Non-Proliferation of Nuclear Weapons, entered into force in March 1970, which committed non-nuclear weapon states party to the Treaty to negotiate agreements directly with the IAEA for the application of safeguards on source or special nuclear material in all their peaceful nuclear activities. I believe that our country's involvement in an international Atoms-for-Peace program has contributed much to insure the application of safeguards by other national suppliers of nuclear power reactors, and especially by the IAEA, in an energy deficient world in which so many countries are more dependent on this new source of energy than is the United States.

The effectiveness of the 1955 Conference on the Peaceful Uses of Atomic Energy in focusing attention on the atom's constructive uses and promoting international cooperation resulted in a second conference in 1958, a third in 1964, and a fourth in 1971. I attended the first two conferences as a member of the US delegation; at the third, I had the privilege of serving as Chairman of the delegation. While the main theme on this occasion was nuclear power — an area of mounting importance in view of the soaring demand for energy throughout the world — the whole spectrum of peaceful nuclear research and applications was covered. I was tremendously impressed by the scientific progress and global interest reflected in the exhibits and papers presented by the 77 UN member states and 10 specialized and related agencies participating. Most of all, I was heartened by the degree of international cooperation the world community had achieved in so short a time. I emphasized the significance of this aspect in the conclusion of my address to the assemblage in the Geneva Palais des Nations:

This international collaboration practiced so successfully in nuclear energy gives further strength to the thesis that science can serve as a common ground between all nations of the world. A uranium or plutonium atom knows no nationality. Through international conferences such as this, and other broader and more intensive programs of exchange and collaboration, science may be a leading factor in resolving the differences which still remain between countries.

After that third Geneva conference, it was with heightened optimism that I resumed my travels as a citizen both of Enrico Fermi's "new world" of atomic energy and of the wider new world of united effort. And when, as President of the 1971 Conference, I considered the striking advances of the intervening years and particularly the signing of the Treaty on Non-Proliferation of Nuclear Weapons, I felt that my optimism had been justified.

Virtually all my trips, timed in order to permit participation in particular events or meetings, provided opportunities for discussions on a wide range of unrelated topics. Thus, for example, my annual attendance at the IAEA General Conference afforded occasions for talks en route and at the Conference with representatives of many nations regarding projects or problems of special mutual interest to the United States and their respective countries. Often this meant resumption of discussions or negotiations initiated half a world away, on some other trip or in the United States. Therefore I shall begin my account by fitting the pieces together from various times and places, filling in the gaps as necessary, in order to convey a coherent picture of our arrangements with certain of the nations with which we cooperate.

In writing this account, I have drawn primarily on the journal I kept throughout the years of my USAEC chairmanship. My journal notes have been supplemented by explanatory or background material as seemed necessary or appropriate. I wish to emphasize, however, that I am making no attempt to tell the whole story of "atoms-for-peace." That would take many volumes. Therefore, I do not try to describe the international programs similar to ours being conducted now by many other nations. I do not seek to present a complete picture

8 Introduction

of the peaceful nuclear programs of the nations I visited, to report all aspects of our cooperative activities with each or to depict the work of the many USAEC members, staff, and contractor employees whose dedication, ability, and enthusiasm – in their offices and laboratories and on their own travels in the line of duty – have helped make these activities effective. My aim is to supply the basic information essential to an understanding of the purposes and significance of the visits and meetings in which I participated.

CHAPTER 2

EURATOM

The USAEC's international activities have been most extensive with the industrially advanced nations, especially those of Western Europe. This cannot be surprising; the foundations of nuclear science were laid in Europe, and many American scientists had studied there. Before and during World War II many European scientists, unable to pursue their studies in their homelands, came to this country to continue their work and contribute their talents to projects under way here. Furthermore, enough of the technology required for research and development survived Europe's wartime disruption and destruction to permit resumption of progress without long delay. Thus practicality combined with human associations to provide a firm basis for US-European collaboration in the postwar world.

While cooperation with Western Europe has included mutual defense purposes (and agreements for these purposes are in effect with individual NATO countries and with NATO itself), my meetings and travels were concerned primarily with non-military scientific collaboration. In this area we have worked with all the nations of Western Europe, both bilaterally and in international activities such as those conducted by the International Atomic Energy Community - Euratom.

Cooperation with Euratom has been a cornerstone of our international program in Western Europe. Therefore this was one of the first subjects to occupy my attention after I became Chairman of the USAEC early in 1961, and it was a constant matter of interest in the succeeding years.

Euratom, created by the Treaty of Rome signed in March 1957, is one of three supranational "communities" formed in the fifties by France, the Federal Republic of Germany, Italy, Belgium, the Netherlands, and Luxembourg. Its headquarters are in Brussels; a few elements are based in Luxembourg. It was created to coordinate and encourage the development of peaceful nuclear applications within its member states, particularly in order to lay down favorable conditions for the growth of nuclear industries.

Research and development activities were a prime Euratom concern from the beginning. In the spring of 1958 the Community launched a \$215 million five-year program to be conducted partly at four "Joint Research Centers" started between 1959 and 1961 in member countries (near Ispra in Italy, Petten in the Netherlands, Mol in Belgium, Karlsruhe in Germany) and partly through research contracts and "Contracts of Association" between Euratom and various organizations in its member states. Along with these research activities and other programs, the Community undertook "to guarantee, by appropriate measures of control, that nuclear materials are not diverted for purposes other than those for which they are intended." Thus, the Euratom Commission (the Community's executive body) was charged with establishing and implementing a system of safeguards involving inspections and reporting on nuclear materials within the territories of all member states, excepting only materials intended for defense.

The founding of Euratom was encouraged and welcomed by the United States, which consistently favored postwar efforts to promote European unity. The United States provided both moral support and technical advice during the course of the negotiations that led to the signing of the Euratom Treaty in 1957 and to the organization's actual inception in January of the following year. From the start, therefore, there existed between the United States and Euratom a special relationship unlike our arrangement with any other country or group of countries. Initial discussions regarding US-Euratom cooperation were undertaken even before the Euratom organization came into being and were intensified early in 1958. A preliminary agreement on intention to cooperate was signed in early summer 1958. Soon thereafter, the passage by the US Congress of the Euratom Cooperation Act of 1958 gave legislative fiat to a joint program of cooperation set forth in a US-Euratom Agreement for Cooperation signed in November of that year. In the same month - November 1958 - a USAEC Scientific Representative was assigned to the US Mission to the European Communities in Brussels.

The US-Euratom program included, first, a "Joint Reactor Program" primarily designed to further the early construction and operation of US-type light water reactors totaling approximately 1,000 MWe in the Community. Under the agreement, the United States made available \$135 million in long-term credit for US goods and services related to this program, assured the availability, on a deferred payment sale basis, of the enriched uranium required for reactor fuel, arranged advantageous terms and guarantees with respect to fuel elements and fuel-cycle costs, and provided technical assistance.

The goal of constructing 1,000 MWe of nuclear power capacity under this program was not to be realized, for various reasons. One important factor was a drop in the cost of conventional fuels used in power generation; another was uncertainty, on the part of Community utilities, regarding the technical and economic performance of nuclear power projects. Nevertheless, three nuclear power plants were constructed and brought into operation under the US-Euratom program: the SENN plant in Italy, 60 miles south of Rome (which started supplying power to the grid in January 1964); the KRB in Germany, 60 miles west of Munich (first power to grid late 1966); and the French-Belgian SENA in France near the Belgian border (connected to grid April 1967). While the total capacity (650 MWe) of these plants fell short of the quantitative goal, and while their construction took longer than expected, the Joint Program did thus achieve the basic objective of promoting the establishment of a European light-water power-reactor industry.

The reactor program was accompanied by a ten-year research and development program in the technology of proven US-type reactors. For this, each side authorized roughly equal funding (ultimately amounting to about \$28 million from each side, as compared with \$50 million from each originally contemplated for the first five years alone); and each side benefited from the exchange of technical information and personnel. Essentially, while all projects undertaken under this program were approved by a joint board, Euratom funds were used to finance those carried out in the Community and US funds were used for projects carried out in the United States.

In line with our determination that the US cooperation with Euratom should further peaceful aims exclusively, the Agreement contained comprehensive guarantees to that effect. It also provided for the establishment and implementation by the Community – with the assistance of the United States and frequent consultations and visit exchanges – of "a safeguards and control system designed to give maximum assurance that any material, equipment or devices made available pursuant to this Agreement, and any source or special nuclear material derived from the use of such material, equipment and devices, shall be utilized solely for peaceful purposes." An Annex setting forth the principles that would govern this system stated the Parties' understanding that these principles were compatible with and based on the safeguards provisions of the Euratom Treaty (as well as those in the Statute of the International Atomic Energy Agency and US Agreements for Cooperation with other nations).

Implementation of our cooperative program started promptly. Progress was slower than anticipated, however, especially with respect to the reactor construction program. The response of European companies to an invitation for bids to construct nuclear power plants was disappointing, and some problems arose in US-Euratom working relationships. At the time I became Chairman, the feeling had been developing with the State Department and the USAEC that special efforts were needed to strengthen our collaboration with Euratom and stimulate the Community's progress. This feeling was reflected in a letter written to me by Acting Secretary of State Chester Bowles on March 20, 1961, less than a month after I took office. "It seems to us in the Department most desirable that we address ourselves immediately to the task of achieving a more vital relationship between the United States and the... Community," Bowles wrote. Observing that "for the most part, the reasons the Joint Program for construction of power reactors in Europe has not progressed at the schedule originally anticipated were beyond the control of the parties on both sides of the Atlantic," and noting "the strides Euratom has taken in assuming leadership in nuclear research in the six countries," he expressed the belief that "it is time we took a fresh look at the possibilities open to us to revitalize and expand our cooperative efforts.... We might well look toward increasing our technical exchanges with Euratom in support of an expanded joint research program."

Improvement and extension of our cooperation with Euratom, then, were primary concerns in the spring of 1961, when I assumed my duties. At that time, particular difficulties had arisen in connection with an "Additional Agreement for Cooperation" approved by Congress in July 1960. The United States had viewed this Additional Agreement as designed primarily to meet certain immediate Euratom needs (particularly their requirements for special nuclear materials) with respect to specific projects. Euratom officials, however, had wanted and expected it to provide much broader assistance. They felt that the Agreement as approved was too limiting, especially as to the quantities of enriched uranium to be made available, the restricting references to particular projects, and the failure to authorize the lease (as an alternative to deferred payment sale) of uranium for power reactor fuel. These and other elements, in Euratom's view, weakened confidence in US support for the Community and its programs.

In late May 1961, Ambassador Walton Butterworth, our Ambassador to the European Communities, discussed these subjects with me in Washington, strongly recommending that steps be taken toward amending our agreements with Euratom to provide — insofar as feasible — broader support and greater flexibility along the lines desired by the Community. In the following days, the USAEC gave careful consideration to the many and complex aspects of the situation; and when in mid-June President Etienne Hirsch of the Euratom Commission, with the Commission's Special Adviser Federico Consolo and Dr. Jules Guéron, General Director for Research and Training, came to Washington, we were able to have useful discussions with them concerning our differences.

Hirsch, whom I met for the first time on this occasion, had an impressive, even exciting personality. He was the second Commission President. He was appointed by the Euratom member governments in January 1959 to complete the presidential term of Louis Armand (who had resigned after serving just one year) and in the fall of 1959 was appointed to a full two-year term. Hirsch, a Frenchman, was a dedicated "European" as well. (This may have been one reason why he was not reappointed when his full term expired in January 1962.) Guéron, also French, was also a strong supporter of the concept of European unity. I had known him since 1943, shortly after he came to Canada from the UK as a member of a group engaged in heavy water reactor research.

Our discussions with the Euratom representatives were devoted primarily to the Community's objections on a number of points in the Additional Agreement and particularly the arrangements through which operators of power reactors built under the Joint Program would be able to obtain fuel supplies. For example, our existing agreement provided for deferred payment sale, and Euratom wanted the option of leasing the material. Such a change involved the matter of interest and use rates and other related questions. Euratom also objected to the inclusion, in the reactor construction bid invitation, of a "Buy American" clause. In addition, they considered it essential to have greater flexibility in the use of special nuclear materials transferred from the United States for research purposes.

In the course of several talks, we became more fully aware of the difficulties caused by some of the existing limitations with respect to progress in the reactor construction program. President Hirsch and his colleagues, for their part, came to understand the legislative and other considerations we had to take into account. At our concluding session on June 15, attended also by Ambassador Butterworth, I was able to present Hirsch with compromise proposals that would represent concessions to Euratom concerns while still protecting the interests of the United States. On the question of sale *versus* lease, I suggested two alternatives: continued deferred payment, but at the favorable interest charge of 4%; or lease at 4-3/4% use charge, with a provision that would require Euratom to purchase the material whenever US operators were required to purchase their leased material. (In this event, however, Euratom would be entitled to purchase

the material on a deferred payment basis at a rate of interest identical to the use charge applicable to US industry at the time of conversion.)

Since President Hirsch could not make any on-the-spot commitments, he naturally responded cautiously, as indicated in the following excerpts from my memorandum on our conversation that day:

"His reaction was that these two proposals didn't present any additional incentives to their private utilities. Butterworth joined me in pointing out that the 4% interest rate could be considered as a concession, and also that we were offering leasing for the first time. Butterworth's general reaction was that the proposals were quite reasonable. I also gained the impression that Hirsch was not actually too displeased. Hirsch said that, of course, he would have to go back to his Council of Ministers for further consideration....

"I also said that we were prepared to accept his Council of Ministers' suggestion regarding the 'Buy American' limitation – the suggestion that the matter be handled by advising the interested utilities directly, rather than by including 'Buy American' language in the invitation....We also discussed some of the other items....We agreed that the matter of research cooperation was an important one, and that this would be investigated by our staffs....I said that I was favorably inclined toward the allocation of U-235 for research purposes along the lines that they had requested....

"In the course of the discussions I told them that I felt that Euratom was very important, beyond its immediate concern with atomic energy matters, as a symbol for the beginning of US cooperation with Europe in a substantive area.

"Mr. Hirsch and I agreed that we would have regular personal contacts, perhaps as often as twice a year."

At lunch the next day, when we gave further thought to our plan for regular personal contacts, Hirsch and I decided to meet the following fall after the IAEA Fifth General Conference. I expressed a preference for our meeting to be at the JRC establishment at Ispra, which I was anxious to visit in order to have a first-hand look at Euratom research activities. Hirsch cordially agreed, and arrangements were made for me to stop in Italy *en route* home from Vienna:

"Saturday, September 30, 1961 – Vienna to Milan

"We arrived in Milan at 11:30 a.m., and were met by Federico Consolo, Ambassador Butterworth, John Erlewine (USAEC Senior Scientific Representative in Brussels, where Euratom Headquarters is located), and others. I visited



XBB 763-7051

Ispira Laboratory, Sept. 30, 1961. (Left to right) Jules Guéron, Howard Brown, Seaborg, Etienne Hirsch.

Ispra with USAEC Commissioner John Graham and my staff members Howard Brown, Dan Wilkes and Cecil King. We received a briefing from Ispra Director Dr. G. Ritter, Hirsch, Guéron, Euratom Commission Vice President Enrico Medi, Commissioner Emanuel Sassen and others, and toured the Laboratory."

In the course of the visit described above, we had cordial and informal discussions on a number of topics, including additional R & D areas for US-Euratom cooperation – fast reactors, homogeneous-slurry work, and direct conversion were among the areas considered – and plans for negotiations on amendments to our Agreements, pursuant to our June conversations. We also discussed Euratom's need for large quantities of plutonium for its fast reactor program. The Euratom officials expressed the hope that the United States would provide this material. Although no decision on their request was possible at the time, I asked about plans for safeguarding the plutonium if we should supply it, and Guéron outlined their safeguards arrangements.

Upon my return to Washington I reported to the President on this visit as follows, in a letter dated October 10, 1961:

"On Saturday, September 30, I visited the Euratom research center at Ispra on Lake Maggiore, about 50 miles from Milan. The visit was the result of an invitation extended by Mr. Etienne Hirsch, President, European Atomic Energy Community, when he visited the USAEC in Washington last June. President Hirsch and key Euratom officers were hosts at Ispra.

"The principal research instrument at Ispra is a nuclear reactor similar to the CP-5 at the Argonne National Laboratory. The site is new, attractive, and growing. There are approximately 600 employees at Ispra at the present time, mostly German, French, and Italian, but also including scientists and technicians from Belgium, the Netherlands, and Luxembourg. A total staff of approximately 1,100 is planned for year-end 1961.

"The principal problem confronting Euratom at the present time, insofar as assistance from the United States is concerned, is the need for a firm commitment by the United States to furnish additional quantities of U-235 and plutonium for the future Euratom program and those of its member states. An Additional Agreement is now under consideration and the question of additional special nuclear material is being studied. Negotiations on the Additional Agreement are expected to commence in November in Washington. Procedures require that such an agreement, if successfully negotiated, must lay before the Joint Congressional Committee on Atomic Energy for 30 days after the Congress reconvenes in January."

The following winter, final negotiations were concluded regarding amendments to the US-Euratom agreements and went into effect in July 1962, allowing lease as well as sale of special nuclear material, authorizing provision of desired quantities of material for power and research application, extending the effective time of the agreements, and permitting a certain flexibility in the use of materials. Thus the problems of the preceding two years were for the most part resolved. It was time to look ahead to further developments in the US-Euratom relationship. Extensive discussions were possible during a stopover in Paris that fall:

"September 22, 1962 – Brussels to Paris

"I flew to Paris with my staff members Dan Wilkes, Chris Henderson, Cecil King, and Algie Wells (Director, USAEC Division of International Activities). We stayed at the George V Hotel.

"I met with Pierre Chatenet (who has succeeded Hirsch as President of the Euratom Commission), Jules Guéron, Federico Consolo, and Lawrence Bost of Euratom. We discussed the possibility of the United States furnishing plutonium for their fast reactor program. Then I had a talk with Guéron, as we walked along the Seine, on various Euratom and other matters.

"I had lunch alone with Chatenet at his home. We discussed the relationship of the United Kingdom to Euratom, and the US attitude and French attitude in this and other matters."

Upon my return to Washington, I made the following report to the President on my visit to the Euratom facilities and staff, in a letter dated October 9, 1962:

"The impact of history which the European community and the NATO alliance are making is well-recognized; but the growth of the peaceful atom in the European community (Euratom) – while somewhat slower than at first anticipated – is quickening.

"Perhaps the most vivid impression I gained on the trip was the role which Euratom is playing in the development of nuclear energy within the European community. I visited the Belgian and Euratom laboratory at Mol,* Belgium, where I found much important work in progress. (I had visited another Euratom laboratory, the Ispra laboratory, near Milan, Italy, during my trip to Europe a year ago; much important work is also in progress there.) Without question, Euratom is a dynamic organization which is enabling its member states to do what no one of them could do alone. In discussions with Monsieur Chatenet, President of Euratom, and members of his staff, I was

* See Chapter 6, p. 149

impressed by the breadth and depth of the research and development program undertaken.

"Euratom will be even further strengthened by the entry of the UK. As I mentioned previously, negotiations are now under way between the UK and Euratom; and while there are many unresolved issues, I feel certain that the UK will be an active partner within a few years. You will recall that one of these unresolved issues is the treatment of classified information and 'know-how' that the UK has received from this country through our broad military and civil exchange agreements."

The previously mentioned discussion with Chatenet regarding the possibility of our supplying plutonium for Euratom's fast reactor research program was one of many related talks in which USAEC officials participated about that time. The USAEC had a strong fast breeder research program under way. Euratom's activities in this field embraced projects at the Joint Research Center establishments and also, through association contracts in effect or being negotiated with organizations in France, Germany, and Italy, projects that were included within the national programs of those countries. Progress on both sides of the Atlantic seemed likely to be advanced by cooperation. I explored the question fully upon my return from Europe in 1962, and not long afterward I was able to write President Chatenet that (in the framework of our Additional Agreement for Cooperation) we would be able to provide the amount of plutonium they were then requesting (about 430 kilograms) for use in facilities included within Euratom's fast reactor program, on the assumption that mutually satisfactory arrangements for a comprehensive exchange program would be developed. Details of such an exchange were negotiated in the following year, through staff consultations and correspondence. The resultant arrangement (formalized in an exchange of letters dated May 27, 1964), was the most important step in our cooperation with Euratom since negotiation of the 1962 amendments to our agreements. Our related sale of plutonium for use in the Community's breeder programs was unique because it was the only large-scale plutonium supply we had agreed to thus far. In addition to enabling Euratom to move ahead with its own research, the US-Euratom fast reactor exchange arrangement had the important advantage of reducing duplication of effort in an area of great interest to the United States.

Referring again to my 1962 meeting with President Chatenet, I should comment on one other topic mentioned in the above excerpt from my journal. In 1962, there was general expectation that the United Kingdom would soon become a member of the European Communities. The United States considered this a desirable prospect. France (under DeGaulle) opposed such a development, however, and the French veto in January 1963 prevented British entry at that time. Not until the meeting between French President Pompidou and UK Prime Minister Heath, in May of 1971, did the gate finally swing open.

Having visited Ispra and Mol, and in view of the increasing range of our research and development cooperation with Euratom, I was naturally eager to see the other JRC establishments. In the fall of 1963, after attending the Seventh IAEA General Conference in Vienna, I found an opportunity to visit the JRC's European Transuranium Institute at Karlsruhe, as well as some of Germany's extensive national facilities there.

"September 27, 1963 – Vienna to Stuttgart, Karlsruhe,
and Baden-Baden

"I flew to Stuttgart with Amie Fritsch (my Technical Assistant), Wells and King. We were met by Erlewine and W. W. Williams of the US Embassy, Bonn. I was interviewed at the airport by the US Armed Services Radio. We were driven to the German Nuclear Research Center at Karlsruhe. Here we first had an hour's briefing on the research program. We had lunch with a number of people at the Center, and then toured the FR-2 (12 MW heavy water reactor) area, the isochronous (50 MeV deuteron) cyclotron area (that I had suggested in 1957 to Seelmann-Eggebert, during his visit to Berkeley, they build at Karlsruhe), and the Transuranium Institute (under construction – to cost \$20,000,000). Walther Schnurr (Technical Director of Karlsruhe) and Erwin Willy Becker (Head of the Institute for Nuclear Process Technology) were our guides. We were also accompanied by Prof. Karl Wirtz (Head of the Laboratory for Neutron and Reactor Physics), Prof. Wolf Haefele (Head of the German Fast Breeder Reactor Project), Prof. Walter Seelmann-Eggebert (Head of the Laboratory for Radiochemistry), and Dr. Rudolf Greinfeld (Administrative Director of the Center). After a social hour, at which I spoke about my May trip to the USSR to discuss cooperation in the peaceful uses of nuclear energy and the US nuclear power program, we were driven to Baden-Baden and checked into the Hotel Europaeische Hof. We visited the huge gambling casino there."

My visit to the Euratom project at Karlsruhe, though brief, gave me the impression that work there was progressing well; it seemed evident that the Institute would make significant contributions in the years to come. Back in Washington, I reported to the President, in a letter dated October 7, 1963, on this visit:

"While in Europe, I also had the opportunity to visit West Germany to inspect one of their two large government-supported nuclear laboratories at Karlsruhe and to have discussions in Bonn with Minister Lenz of the Ministry for Atomic Energy. As you know, West Germany did not have an active program in the peaceful uses of nuclear energy until 1955, and one could readily observe their determined effort to recapture lost ground.

"At Karlsruhe we visited their 12-megawatt research reactor and 50-MeV isochronous cyclotron. Both appeared



XBB 763-7048

*Visit to German Nuclear Research Center at Karlsruhe, September 27, 1963.
(Left to right) Karl Wirtz, Wolf Haefele, Walter Seelmann-Eggebert, Seaborg,
Walter Schnurr, W. W. Williams, Rudolf Greinfeld, and Erwin Willy Becker.*

to be well-designed facilities. It was interesting to note that at Karlsruhe fundamental work is proceeding on isotope separation techniques in addition to the gas centrifuge work. We were also informed that, under a recently completed cooperative agreement with France in the field of heavy water moderated reactors, a dual Franco-German project may be organized to construct a large reactor of this type.

"While at Karlsruhe I also took the opportunity to visit the Euratom project there which is now under construction -- the European Institute for Transuranic Elements. This project seems to be progressing well and may make significant contributions in years to come.

"During my brief visit to Bonn, it was interesting to note that Minister Lenz did not raise any substantive issues, although there were several pending. I can only assume that this gives credence to the rumor that Minister Lenz will step down in the forthcoming Adenauer retirement."

Developments a year later necessitated talks in Brussels with Euratom Commissioners and their staff during a stopover between the 1964 Geneva Conference on the Peaceful Uses of Nuclear Energy and the Eighth IAEA General Conference. During this 1964 trip, incidentally, and some of my subsequent journeys, my wife, Helen, was able to join me, and her name will appear from time to time in this account. My group and I flew from Geneva to Brussels the evening of September 9, in order to start our meetings the next morning:

"Thursday, September 10, 1964 -- Brussels

"Met with John Tuthill, our Ambassador to the European Communities, and staff at his headquarters to discuss the meeting with Euratom officials. Then went to Euratom headquarters to meet with President Chatenet, Euratom Commissioners Paul de Groote, Emanuel Sassen, and Robert Margulies to discuss USAEC-Euratom relationships; emphasized US determination to terminate bilaterals and thereafter channel through the Euratom Supply Agency whatever special nuclear materials we provide for member countries. Also discussed the Geneva Conference, fast breeder exchange program, cooperation in organic coolant-D₂O moderator reactor development, the executive merger of the European Community, etc. Fritsch, Myron Kratzer (Director, USAEC Division of International Affairs), Russell Fessenden (Tuthill's Deputy), Tuthill, Charles Schank (USAEC Scientific Representative in Brussels), Dixon Hoyle (USAEC Division of International Affairs), *et al.*, participated. Went to lunch with same group, hosted by Chatenet at Val Duchesse.

"Helen visited Ghent with Mrs. Tuthill, Mrs. Fessenden, and Mrs. Schank. Later Helen, Dan, Arnie, and I visited Waterloo. Helen and I had dinner at the Metropole Hotel, and walked around the old part of town after dinner."

Some of the subjects discussed in our meetings in Brussels reflected changes that were developing in the relationships between the three European communities and in Euratom's relationships with its member states. In 1964 negotiations were under way between Euratom, the European Coal and Steel Community, and the European Economic Community that resulted in a treaty providing for their eventual unification in one overall organization. This merging of the Communities, which was to start in June 1967 with the fusion of the three executive commissions, was to take place gradually with a view to completion by June 30, 1970. While the merger plan appeared to represent a significant step toward stronger European unity, it was sure to have some effect -- just what effect could not yet be known -- on Euratom programs. One uncertainty, for example, was the financing of nuclear research activities. So far these activities had been conducted according to five-year plans for which funds were approved at the start of each five-year period. The second such multiannual program had been initiated in 1963. The approach that would be taken by a unified Commission, within the broader framework of the merged Communities, toward the financing of nuclear activities was an unknown factor. Considering our cooperative activities with Euratom in research, we were of course intensely interested in plans and expectations for the future, and ways in which our collaboration might be affected by the contemplated merger.

The matter of terminating the bilateral agreements the United States had signed with all Euratom members (except Luxembourg) before Euratom came into being was also one of great concern to the United States. For various reasons, particularly in order to support the European Community concept and also in order to permit the widest possible administration of Euratom safeguards on special nuclear materials within the Community, we considered it desirable to allow the bilaterals to lapse on reaching their termination dates. This "fold-in" -- as the step was dubbed -- would in no way interfere with cooperative activities under way with the separate member states (which I shall discuss later). Our position was that the change would merely mean that US-origin special nuclear materials for their national programs would be supplied through the Euratom Supply Agency under our agreements with the Community; but Euratom member states were somewhat apprehensive lest fold-in have an unfavorable effect on our bilateral collaboration. As indicated above, during our meeting with the Euratom Commissioners in September 1964 I stressed the importance the United States placed on allowing our individual agreements with member states of the Community to terminate and then supplying the material needs of these nations through Euratom channels. In light of our discussions, it seemed clear that most of the member nations would go along with our position without strong objection. France could be expected to present difficulties, but the primary concern of the other members appeared to be simply a desire for reassurance that termination of the bilaterals would not adversely affect our support for their national programs. I feel that the strong personal assurances I was able to give, reinforcing communications and other discussions, did much to allay misgivings on this score.

The future relationships between Euratom and its member states were of importance to us also in our arrangement for exchange of information in the field of fast breeder reactors, on which (as I have said) we had reached agreement in May 1964. Through this arrangement, we had access to information about member nations' work in this field by virtue of Euratom's pertinent "Contracts of Association" with its members. Whether these contracts would be continued and what Community funding (if any) would be provided for fast reactor research were, therefore, questions that significantly affected the usefulness to us of our arrangement with Euratom in this area.

These problems continued to receive attention during the succeeding months, along with the related matter of safeguards administration. From the beginning the United States has firmly held to the desirability of eventually having IAEA safeguards applied on a world basis. While we considered Euratom safeguards administration within its member states an internationally effective system -- and a considerable step forward from bilateral safeguards -- we envisioned the day when these states would accept the IAEA safeguards system. As opportunity offered in our contracts with officials of Euratom and its member states, we raised the question of possible steps toward that day.

Euratom-related matters were prominent in a conversation I had in Washington with Bertrand Goldschmidt of the French Atomic Energy Commission on February 12, 1965, when expiration of the Belgian bilateral -- and hence the start of "fold-in" -- was less than six months away:

"Goldschmidt was clearly against bilateral fold-in, although not as adamant as I had expected. In response to my question whether he would sacrifice Euratom for the bilateral, Goldschmidt responded in the negative. (Kratzer later commented that this response was at variance with his understanding of Goldschmidt's position.) Goldschmidt stated that he did not object to Euratom safeguards, but that he could not accept supply through Euratom, because this would infringe on French prestige. In response to Goldschmidt's comment that France wants to maintain a close relationship with the United States, I responded that it was not necessary to arrange exchanges through Euratom, nor was a bilateral agreement necessary. For example, the United States has exchanges with the Soviets (also India) that are not covered by a bilateral. Regarding the eventual application of IAEA safeguards within the Community, although Goldschmidt stated that this would be out of the question, I received the impression that it was not entirely unacceptable. I also had the impression that Goldschmidt seemed to be seeking a way to cooperate with the United States without a bilateral."

As I mentioned earlier, our 1964 exchange arrangement with Euratom in the area of fast breeder reactors provided that we would supply the plutonium required for the Community's programs in this field. The maximum

amount of plutonium authorized under the European Cooperation Act of 1958 - 500 kg - was sufficient to cover their initial requirements. It was far from enough to meet their longer-term needs, however; the European Commission estimated that an additional 1000 kg would be necessary for projects under way. In view of the growing power reactor construction programs in member states, the Commission also wanted a large increase in the maximum amount of contained U-235 authorized under the Act. Considering the potential use of plutonium (as well as highly enriched uranium) in weapons production, the USAEC felt it was particularly important to be sure of adequate safeguards against any possible diversion of this material, before submitting to Congress legislation to amend the Cooperation Act. Early in 1965 agreement was reached on the establishment and activities of a "Joint US-Euratom Technical Working Group" for periodic review of the effectiveness and implementation of the Euratom safeguards system. The results of the facility visits and other verification activities of this group generally justified our confidence in the Euratom system. We felt, however, that at some facilities - especially fuel fabrication facilities where increased quantities of plutonium would be handled - it was essential to have intensive inspection arrangements in effect when such material was on hand. The meetings and negotiations involved in reaching agreement on this matter took time, which together with certain other factors significantly delayed legislative authorization of the increase desired by the Community.

Euratom's pending request for increased plutonium and enriched uranium supplies, the problem of fold-in, safeguards, and other matters were subjects of lengthy discussions during meetings in Europe in the course of a trip I took in March 1966 in connection with a number of other concerns in addition to US-Euratom collaboration. In Paris, the French again broached the idea of extending their bilateral agreement with us. I again replied that the United States intended to allow the French-US bilateral to lapse when it expired in November. "The French seem to dispute this intention of ours incessantly," I noted in my journal with a touch of exasperation, even though the French attitude was no surprise. From July 1965 to January 1966 France had boycotted the institutions of the European Economic Community, in opposition to proposals that had been advanced regarding the future financing of the EEC's common agricultural policy, a plan for financial independence of that Community, and suggestions for increased powers for the European Parliament. Although a compromise had, superficially, mended the breach between France and the EEC, we had little reason to expect the French to soften the opposition they had already manifested toward termination of their bilateral agreement with us in the peaceful nuclear field. (However, at this March 1966 meeting, of which I shall speak again in describing our bilateral cooperation with France,* it became clear that the French had finally realized the firmness of our intention; and the US-French bilateral was allowed to lapse on reaching its termination date in November 1966.)

* See Chapter 3, pp. 59-60.

Two days after meeting with the French in Paris, I went to Brussels for talks with Euratom officials, taking the opportunity first to visit the JRC establishment and others in Belgium, including the Eurochemic reprocessing plant of the European Nuclear Energy Agency (ENEA), another multilateral organization with which the USAEC was cooperating:

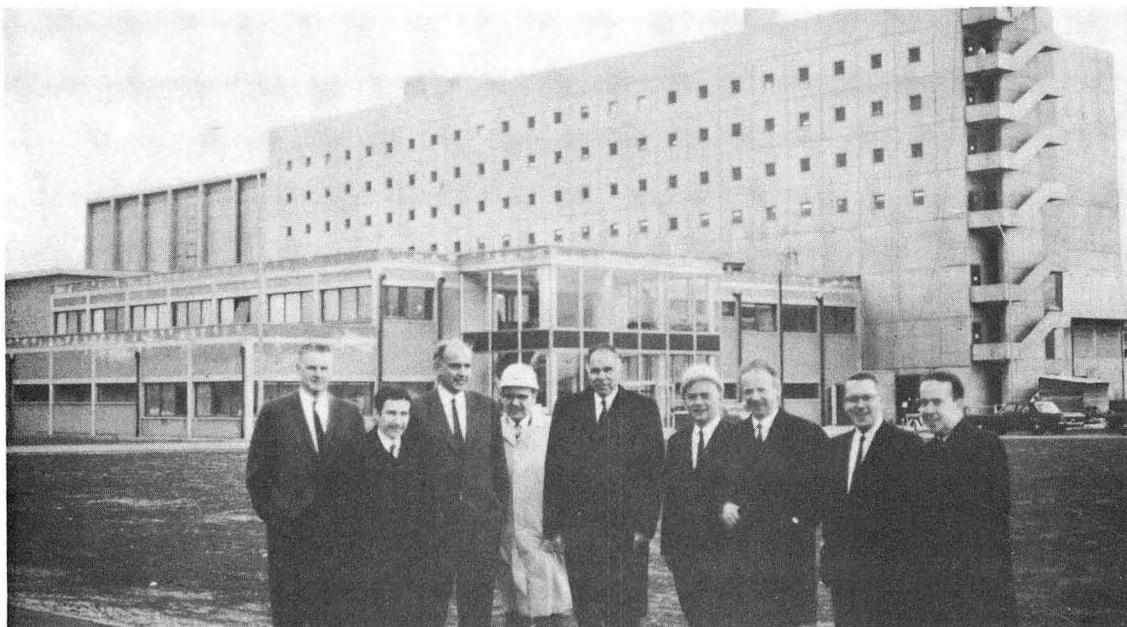
"March 11, 1966 - Mol, Geel, and Brussels

"...I drove to Mol, Belgium, with Dr. Rudolf Rometsch (Director of Eurochemic, later* to become IAEA Inspector General), ENEA Director General Einar Saeland, Dr. Martin Biles (USAEC Scientific Representative in Paris), and Arnie Fritsch. At Mol we visited Eurochemic plant (should start up within a year), where we were joined by T.J. Barendregt (Technical Director). I discussed with Rometsch the problem that would arise if countries which had agreed to IAEA safeguards wished to utilize Eurochemic reprocessing facilities, for which Euratom administered safeguards by agreement with ENEA. Larry O'Donnell and Theodore Iltis were present, as well as Earl Shank (of ORNL, on assignment to Eurochemic), and Richard Stien (ENEA Legal Division). We also visited the Belgian Laboratory (CEN) where Dr. Guéron, Julien Goens (General Manager, CEN, Mol), P. Dejonghe (Director, CEN, Mol), and E. Vandenbenden (Head, Joint Group, CEN-BN, for Pu Fuel Fabrication) joined us. We saw the plutonium fuel processing facility. Also visited Euratom Central Bureau of Nuclear Measurements (CBNM) at Geel, hosted by Guéron, where I said a word to the assembled staff and where we saw the 50 - 100 MeV electron linear accelerator. There we met Jean-Marie Salomé (French scientist at CBNM), Jozef Spaepen (Director, CBNM), Karl-Heinz Böckhoff (German scientist at CBNM), Karl-Friedrich Lauer (a German scientist at CBNM), Paul Debièvre (a Belgian scientist at CBNM), Henrik Moret (a Dutch scientist at CBNM), and Alfred Spornol (a German scientist at CBNM).

"I drove to Brussels with Guéron and Fritsch. We discussed the US hope that Euratom will publish their safeguards and put a facility under IAEA safeguards. We also discussed organic-cooled reactors exchange, etc.

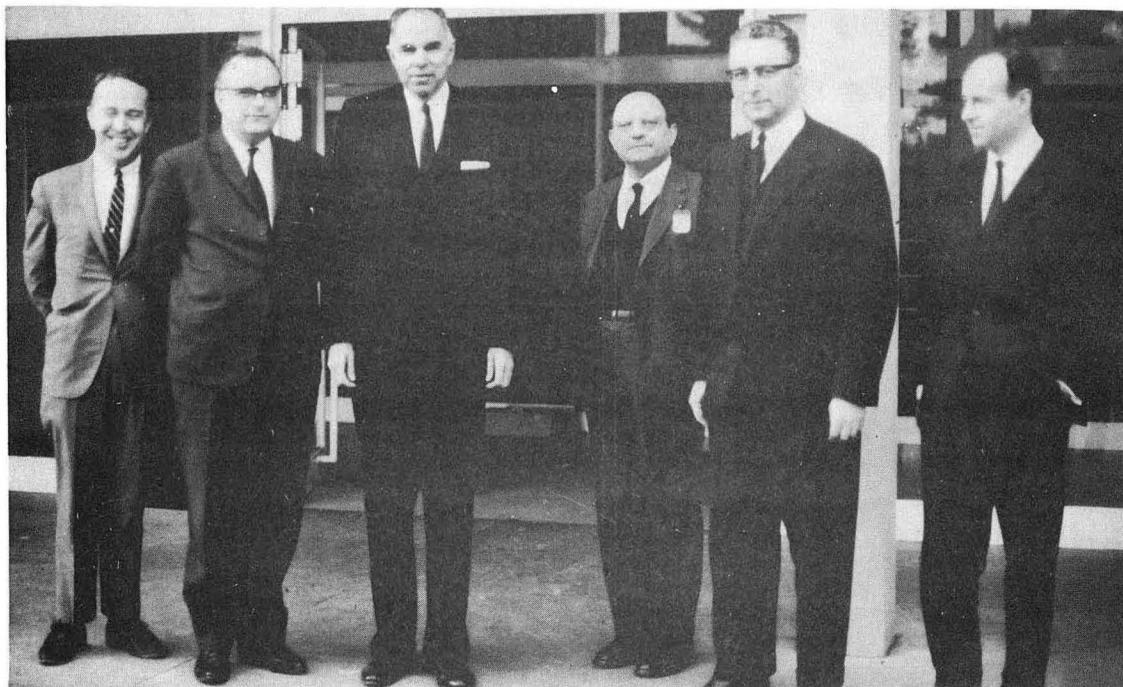
"I had dinner at Val Duchesse with Ambassador Tuthill, Minister Fessenden, and Euratom officials, President Chatenet, Commissioner Antonio Carrelli, Commissioner Paul de Groote, Commissioner Emanuel Sassen, Director-General of Executive Secretariat Giulio Guazzugli-Marini, Director-General for Research Dr. Jules Guéron, Director-General for External Relations Franco Cancellario d'Alena,

*He assumed this office in 1969.



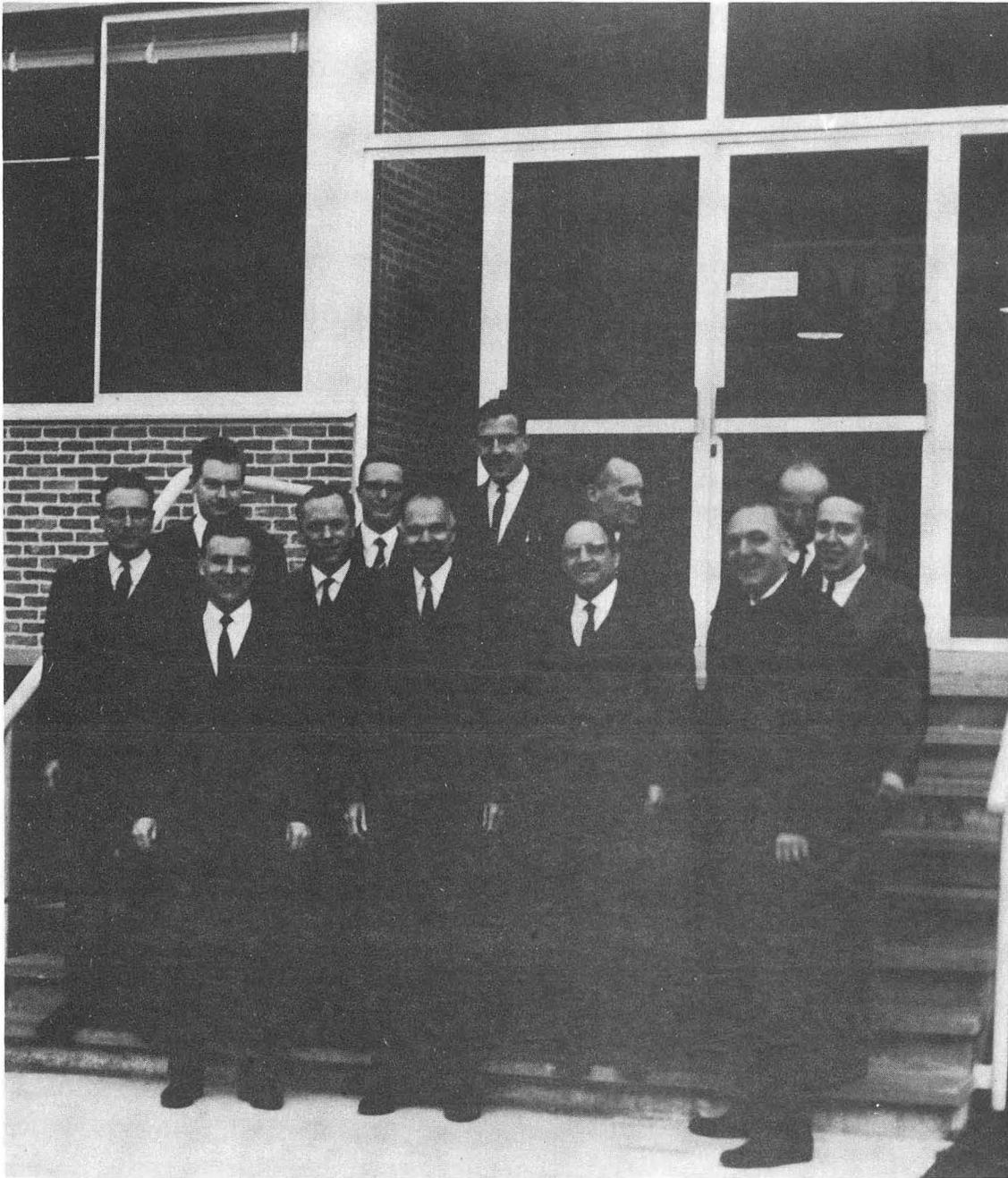
XBB 763-7049

Visit to Eurochemic plant at Mol, Belgium, March 11, 1966. (Left to right) Martin Biles, Richard Stien, Rudolf Rometsch, Earl Shank, Seaborg, T. J. Barendregt, Einar Saeland, Theodore Iltis, and Larry O'Donnell.



XBB 763-7050

Visit to Belgian Laboratory (CEN) at Mol, Belgium, March 11, 1966. (Left to right) Larry O'Donnell, P. Dejonghe, Seaborg, Jules Guéron, Julien Goens, and E. Vandenbemden.



XBB 757-4971

Visit to the Central Bureau for Nuclear Measurements (CBNM, Euratom) at Geel, Belgium, March 11, 1966. (Left to right) Julien Goens, Jean-Marie Salomé, Jozef Spaepen, Karl-Heinz Böckhoff, Karl-Friedrich Lauer, Seaborg, Paul Debièvre, Jules Guéron, Hendrik Moret, Arnold Fritsch, Alfred Spagnol, and Larry O'Donnell.

Director-General for Legal Services Theodor Vogelaar, Director-General for Supply (and Safeguards) Fernand Spaak, Director for External Bilateral Relations René Foch, Hans Michaelis, H. H. Haunschild, and Tristan de Creeft. Americans present included Fritsch, Larry O'Donnell (Assistant for Military Arrangements in our Division of International Affairs), USAEC Scientific Representative (Brussels) Theodore Iltis, and Richard Johnson (Political Officer in the US Mission to the European Communities).

"After dinner Chatenet and I spoke on the value of Euratom-US cooperation. We retired to another room where I spoke to Sassen, Carrelli, Spaak, and Johnson. I suggested that Euratom publish its safeguards regulations and procedures and place some facility under IAEA safeguards as United States and United Kingdom have done -- the response to the first of these was favorable but they offered obstacles to the second."

In advancing the suggestion that Euratom place some facility under IAEA safeguards, I acted in accordance with a decision the USAEC had reached in consultation with the State Department prior to my trip. I have already mentioned the US policy objective of worldwide administration of a single international safeguards system -- that of the IAEA. While we recognized the practical and political difficulties that impeded Euratom acceptance of that system, we felt by the spring of 1966 that an oral representation to the Community, proposing at least a gesture in that direction, would not be inappropriate. Both the United States and the United Kingdom had voluntarily placed some facilities under IAEA safeguards, and some support from a united Europe appeared increasingly desirable. As indicated above, however, the Euratom response was not favorable. The Director General for Euratom Safeguards, Fernand Spaak, differentiated between the United States and United Kingdom situation on the one hand and the Community situation on the other. In the United States and United Kingdom, he pointed out, IAEA safeguards applied at only a few installations, whereas in the Community all peaceful nuclear installations were already under international (i.e., Euratom) safeguards. Furthermore, argued External Relations Director René Foch, if an installation in the Community such as the Eurochemic reprocessing plant were submitted to IAEA safeguards, this would mean pressure on the Germans to submit their own reprocessing plant (then under construction) to the IAEA system and after that, all their atomic installations. This, he said, would mean discrimination within the Community, i.e., against Germany and in favor of France. (Although this point was not made directly, the possibility of French acceptance of IAEA safeguards on its Marcoule or Cap de la Hague reprocessing facilities was, clearly, non-existent.)

Regarding the question of Eurochemic's reprocessing fuel from countries that had accepted IAEA safeguards, Foch hoped it would be possible to make use of provisions in the IAEA system that permitted transfer of nuclear material from such a nation to a state where it would be under

safeguards "generally consistent with" IAEA safeguards. (As it turned out, the problem did not arise; during my period as USAEC Chairman, no country which had committed itself to accepting IAEA safeguards found it necessary to have material reprocessed at Eurochemic.)

Another subject discussed in the course of the evening was "barter." This was an arrangement (in force only temporarily and authorized in only a few cases) whereby a nation purchasing enriched uranium from the United States for a power project might make partial payment toward the value of the contained natural uranium component by deliveries of its own natural uranium in the form of UF_6 . Commissioner Sassen expressed dismay over the fact that the Dutch GKN-Dodewaard project had not been approved for barter and that the only two projects approved in the Community were German (KRB-Gundremmingen and KWL-Lingen). This "discriminatory treatment," Sassen said, would puzzle and offend a country that felt particularly close to the United States.

I replied that I understood the disappointment, which — I pointed out — would be felt also by other projects turned down for barter. I said that in general we expected that the planned initiation of toll enrichment (enrichment by the USAEC of customer-owned natural uranium) in 1969 would permit new power projects abroad to obtain most, if not all, of their fuel via this method. (Legislation authorizing the introduction of toll enrichment after December 31, 1968, had been passed by Congress and signed by the President in August 1964.)

When I reported on this trip to the President (in a letter dated March 15, 1966), I included the following summary of my Euratom visit:

"I then visited the Belgian Nuclear Laboratory at Mol, and toured their plutonium fuel element fabrication facilities. We discussed a project they have under way to irradiate plutonium fuel in the Enrico Fermi Reactor near Detroit, Michigan. A final visit was made to the Euratom Nuclear Standards Laboratory where I met with the staff and visited their 50 MeV linear electron accelerator.

"That evening I had dinner with the Euratom Commissioners, the senior Euratom staff, Ambassador Tuthill, Minister Fessenden, and others. We had an opportunity to have a frank discussion about the barter decisions made within the past few weeks by the United States. In this area, Commissioner Sassen, the Dutch member, was very concerned about denial of barter for the Netherlands GKN Reactor. As a matter of course, he felt it necessary to press the argument for barter in this case even though the issue was closed and he knew it. I did have the opportunity during the course of the evening to discreetly suggest to Commissioner Sassen (who is the Euratom Commissioner primarily concerned with safeguards), Mr. Foch (Director of External Relations) and Mr. Spaak (Director of Supply) the possibility that (1) Euratom better publicize their

safeguards system so that other countries could be as aware of the fine job they are doing as the United States is, and (2) Euratom or its Member States consider the possibility of joining with the US and the UK as one of the 'big three' Western nuclear powers to place one of their nuclear facilities under IAEA safeguards as a gesture of their growing concern over nuclear proliferation and their confidence in the IAEA system. Commissioner Sassen was very responsive to the first point. It was noted that while Euratom had been in their early developmental stages of the safeguards system they had not wanted to overplay their hand. However, since safeguards had now become an accepted operation, they felt it quite reasonable to consider further dissemination outside the Euratom community of information about their system of controls and its results. As regards the possibility of turning over a facility to IAEA safeguards, Commissioner Sassen was very doubtful. He and Mr. Spaak indicated a number of areas, both technical and political which would give them difficulties. I concluded, however, by noting that this is an area they should keep in mind, with the view toward making gradual but definite progress and Commissioner Sassen agreed with this philosophy.

"Also during the course of the evening, we had an opportunity to discuss the Euratom request that we recently received for an additional 1000 kilograms of plutonium. I noted that this matter was under active consideration by the AEC."

During the months that followed our Brussels meeting in the spring of 1966, the many topics of common US-Euratom concern (including particularly the Joint R&D program, fast breeders, an exchange being developed in the field of nuclear science information handling, and the activities of the Joint Technical Working Group in our joint endeavor to meet evolving safeguards requirements) were discussed in many meetings here and abroad, between USAEC and Euratom staff at various levels. Meanwhile the steps involved in the agreed-on merger of the three European Communities were being initiated. On June 5, 1967, Jean Rey, then Commissioner of the European Economic Community (EEC) in charge of its External Affairs Division, was named President of the single Commission of the European Communities that on July 1st was to succeed the three existing Commissions of the EEC, Euratom, and the Coal and Steel Community. A few days after his designation he came to Washington to confer with top US Government officials on the principal questions of mutual interest. I met with him on June 10. He was accompanied by Curt Heidenreich, Director of Euratom's Washington office. Thomas W. Fina of the State Department, my Special Assistant Arnold Fritsch, and Abraham Friedman, Deputy Director of the USAEC Division of International Affairs, were also present. After congratulating Mr. Rey on his new appointment and outlining some of the areas in which the United States and Euratom were cooperating, I stated my hope and expectation that our cooperation would continue. During the conversation, I mentioned that I would be in Europe

in September to attend the IAEA General Conference and offered to visit the European Commission in Brussels to discuss our future relations. Expressing the view that the current Middle East crisis might accelerate nuclear power development in Western Europe, I assured Mr. Rey that the United States would be a reliable supplier and would continue to offer enriched uranium to foreign users at a non-discriminatory price with long-term guarantees, while also putting our toll enrichment system into effect.

Mr. Rey, though observing that as yet he had no authority to speak, declared that in principle he favored the continuation and deepening of our cooperation. He welcomed my offer to meet with his Commission in September. Regarding nuclear power development, he said that one of the new Commission's first tasks would be to formulate a general energy policy.

The meeting in Brussels took place as planned in September. *En route*, I first completed by staggered tour of Joint Research Center establishments (started six years earlier with my visit to Ispra!) with an extremely interesting visit to Petten in the Netherlands, where my group and I were briefed on both the Euratom operation and the activities at the Netherlands National Nuclear Research Center, also located there. After that visit, which I shall describe at some length when discussing our bilateral cooperation with the Netherlands,* we flew on to Belgium:

"Thursday, September 21, 1967 - Amsterdam to Brussels

"(USAEC Commissioner) Gerald Tape, Julius Rubin (my Technical Assistant), Myron Kratzer, Dixon Hoyle, Jules Guéron and I flew to Brussels. (Helen and Jo Tape had taken an earlier flight.) I sat next to Guéron and we discussed Euratom's problems.

"We were met at Brussels by Melvin Manfull, Deputy Chief of the US Mission to Belgium. We went to the offices of the US Mission to the European Communities (USEC). We conferred in the office of John Schaetzel, Ambassador to the European Communities; the group included Ambassador Schaetzel, George Vest (Deputy Chief of Mission, USEC), Richard Vine (USEC Counselor for Political Affairs), Peter Hansen (Staff Assistant to Ambassador Schaetzel), Howard Brown, and James Goodby (member of Vine's staff). We discussed plans for our meetings with the European Communities Commissioners at dinner tonight and tomorrow.

"We went to dinner at Villa Lorraine as the guests of Vice President Fritz Hellwig of the Commission of the European Communities. (President Rey was in Strasbourg addressing the European Parliament.) Present were Guido Colonna (Italian Member of the Commission), Fernand Spaak (Director General

* See Chapter 6, pp. 153-158

of Energy), Hans Michaelis (Director General of Research), Guilio Guazzugli-Marini (Director General of the Joint Nuclear Research Center), Franco Cancellario d'Alena (Director General for Euratom Supply Agency and Euratom Security Safeguards Control), Jules Guéron (Adviser for Research to the Community Commission), René Foch (Director of External Relations), Gabriele Genuardi (member of External Relations), Ambassador Schaetzel, Curt Heidenreich, Tape, Rubin, Kratzer, Brown and Hoyle.

"I sat between Hellwig and Guazzugli-Marini. During World War II Hellwig was an American prisoner of war, held at Fort Reno in Oklahoma.

"Hellwig made some after-dinner remarks and delivered a toast, to which I responded and invited President Rey and the Commissioners to visit the USAEC.

"Helen and Jo Tape visited Rembrandt's house in Amsterdam this morning, and after lunch flew to Brussels to join us. They were met by Mrs. Iltis and Mrs. Hoyle. They went shopping for lace, and visited Grand Platz, which is dominated by the Gothic spire of the Town Hall and the gabled guild houses.

"They had cocktails at the Schaetzels' with Mmes. Spaak, Vest, Vine, Schaetzel, Iltis, Hoyle, Guéron, Michaelis, Foch, and Mr. and Mrs. Howard M. Warrington (he is a publisher I've known for many years). Helen and Jo had dinner at the Vests' home with Mmes. Vest, Vine, Hoyle, and Iltis."

"Friday, September 22, 1967 - Brussels

"I went with Tape, Rubin, and Brown to the US Mission where we met Kratzer and Hoyle and worked on my remarks for our meeting this morning with the European Commission and its staff.

"We then went to the meeting at the Euratom Headquarters. We met in a conference room with Vice President Hellwig, Commissioner Colonna, Guazzugli-Marini, Cancellario d'Alena, Foch, Michaelis, Karlheinz Reichert (Hellwig's Deputy Chief of Cabinet), Michel Amory (member of Foch's staff), Guéron, Genuardi, Heidenreich, Spaak, Iltis, Kathleen H. Shea (USAEC Attorney, Brussels), and Goodby.

"Vice President Hellwig welcomed us and called on me to make some opening remarks. Hellwig made remarks in response, described the role of Euratom activities in the newly unified Communities, and tried to explain the future of the fast breeder reactor.

"I told them I didn't think they should rely solely on the fast breeder reactor, but should have a back-up program on thermal breeder reactors involving the thorium-U²³³ cycle.

"Hellwig said he planned to visit us in the US during the last half of October. I reiterated my invitation to the others."

In my opening remarks at this meeting, I emphasized particularly the special nature of US-Euratom cooperation. On this point I said:

Our cooperation has been a unique one not only for us, but also for the European Communities as well. For us, the cooperative arrangement under the Joint Program is unique in several respects. It is the only one of our many partnerships which involves major expenditures and financial commitments in direct support of nuclear power development outside the United States. Furthermore, our programs of technical cooperation are more comprehensive and detailed than those with any of our other partners. Finally, Euratom has been by far the largest recipient of USAEC-produced nuclear materials.

On the part of the European Communities, Euratom is distinct in having a major program involving the direct operation of facilities, the sponsorship of research and development, and the support of industry. Thus, the relationship between the United States — particularly the Atomic Energy Commission — and Euratom has been one of close and active technical cooperation. And I believe I would be correct in saying that, for Euratom, cooperation with the United States has been by far the largest and most active of its numerous external relationships.

Going on to speak briefly of our Atoms-for-Peace program in general, I expressed my belief that "this program has been an unprecedented one" and that its success could be measured, among other means, by its adoption by other nations with advanced peaceful nuclear programs. I added:

It is measured, too, by the fact that today in Western Europe many of the principal peaceful applications of nuclear energy — including the manufacture of complete power reactor systems of the latest proven design — are being carried out and improved upon with a cumulative investment in development which represents only a small fraction of that initially required.

After then emphasizing the fact that US-Euratom cooperation resulted in benefits for us as well, I proceeded to an overall history of our cooperation and a review of specific areas included. In connection with our fuel policy, I was glad to be able to inform the Commissioners of the reduction, announced just the day before, in the USAEC price for enrichment services, from \$30 to \$26 per unit of separative work. Stating our awareness of the interest

being expressed in construction of an enrichment plant in Europe, I pointed out that the capacity of existing US diffusion plants (able to meet long-term enriched uranium requirements of the United States and its friends abroad for reactors built through the late 1970's) provided both Europe and the United States with a relatively long period in which to make decisions about the need for additional separation capacity and the best way of meeting this need. I reported that we would soon be submitting to Congress proposed legislation increasing the amount of U-235 authorized for supply to Euratom from 70,000 to 215,000 kilograms, and the amount of plutonium from 500 to 1500 kilograms. (This legislation, designed to meet the greatly increased needs of the Communities, which I have already discussed, received Congressional approval two months later and became law in December 1967.)

I also emphasized to the Commission the high importance we attached to the Non-Proliferation Treaty (on which negotiations were well advanced) and to its effective implementation by safeguards administered or verified by the IAEA:

The ability of the United States to cooperate in the field of peaceful uses of nuclear energy has always been dependent on our being able to assure ourselves that US materials and assistance are employed only for peaceful purposes. Our safeguards arrangements provide us with that assurance — but they do not, of course, preclude any country from engaging in a military nuclear program without reliance on direct US assistance. The NPT would close that gap and would thereby provide strengthened assurance that US assistance was in no way contributing to a country's military nuclear potential. I am thoroughly convinced that the Treaty, far from hindering cooperation in peaceful uses, can only enhance such cooperation... by avoiding the dangers of a further spread of nuclear weapons. I would not want to leave you with any doubt as to how important the US Government regards this objective, nor as to our conviction that its attainment can be insured only through a widely adopted non-proliferation treaty....

In the subsequent discussion, Vice President Hellwig remarked that the previous US draft NPT had been closer to the Communities' views than was the latest draft, submitted by the USSR. I replied that this was not surprising, since we were trying to find a compromise between the United States and Soviet positions. Hellwig said that while the Commission understood this, it was very difficult to accept points that touched on the Communities' fundamental interests. And the principle of non-discrimination within the Communities as to the safeguards system was, he said, fundamental. The Communities did not have many sovereign rights, he went on, but the safeguards system was one such right and a very important one.

It seemed evident that the European Commission was still favoring a form of verification that would require the IAEA to accept paper assurances from Euratom as to the effectiveness and integrity of the latter's system. I did not believe that such arrangements would be acceptable to the USSR, any more than regional safeguards systems of groups of countries in the

Soviet bloc or the Middle East, for example, would be acceptable to us. I believed, therefore, that Euratom member states must be persuaded to recognize that verification, if it was to be acceptable, must involve some degree of physical access to their territory.

With respect to US-Euratom cooperation in the fast breeder area, we were naturally interested in knowing the prospects for renewal of the Communities Association Contracts with member nations active in this field. I emphasized that we would prefer to cooperate with a strengthened Euratom rather than on a bilateral basis. Hellwig acknowledged that there had been problems, but indicated that the Commission was optimistic about their resolution.

Despite Hellwig's optimism, the fast breeder association contracts were allowed to expire, and during the next two years it began to appear that our cooperation with Community members in this field might have to take place largely through direct bilateral exchange arrangements. This would not require reintroduction of bilateral Agreements for Cooperation, however, since any special nuclear materials we supplied would be channeled through Euratom, in accordance with our established policy.

My customary report to the President, written October 5, 1967, includes the following summary regarding Euratom:

"I should next like to comment briefly about my meeting with Euratom officials. Since President Rey, who called on me this past June in Washington during his informal visit prior to assuming his new office, was presenting his address to the European Parliament in Strasbourg, Euratom was represented during our discussions by Vice President Hellwig of Germany, who will have primary responsibility for atomic energy affairs in the new Commission, and by Commissioner Colonna of Italy, who will have the important responsibility for industrial policy.

"While it was clear that the new Commission is still familiarizing itself with its responsibilities, and is deeply preoccupied with the issue of British entry into the Common Market, I believe that fusion of the Commissions and the appointment of many new and competent members had instilled a renewed spirit of enthusiasm in both the Commission and its senior staff. This spirit will obviously be tested to the utmost in the future efforts to restore the pace toward European integration which has been affected so adversely by the policies of General DeGaulle.

"During my visit to Brussels, the new Commission was completing its work on a proposed response to the US request for views on the most recent Soviet draft of Article III of the NPT.

"I reiterated to the Commission the high importance which we attach to the non-proliferation treaty and to its effective implementation by safeguards, administered or verified by the IAEA. I have subsequently noted that the European Commission is still proposing a form of verification that would require the IAEA to accept paper assurances from Euratom as to the effectiveness and integrity of its system. I do not believe that such arrangements will be acceptable to the Soviets, nor would they be acceptable to us if regional safeguards systems of groups of countries, for example, in the Soviet Bloc or the Middle East, were involved. I believe we must press the Euratom member states to recognize that verification, if it is to be acceptable, must involve a degree of physical access by IAEA inspectors to their territory. In view of the United States' readiness to place its peaceful nuclear program under IAEA safeguards, such a position on our part would appear to be entirely reasonable."

A month after our Brussels meeting with the European Commission, the familiar concern of French-Euratom relationships was one of many subjects touched on in the course of extensive discussions in Paris with the French regarding their national program:

"Monday, October 16, 1967 - Paris

"...We discussed their relationship with Euratom (with respect to fast breeder development). They hope to negotiate a renewal of their Contract of Association which expires on December 31, at the end of their second five-year program. The agreement with Euratom would include Rapsodie, Masurca and critical facilities. This is also the case for German-Euratom facilities like Sneak at Karlsruhe. However, in each case, the prototype reactors, like the French Phenix reactor (250 MWe), would not be a part of cooperative agreements with Euratom. Phenix is scheduled for start of construction in 1969."*

As I have already indicated, hopes for renewal of the French-Euratom Contract of Association in fast breeder development proved unfounded. For Euratom, in fact, the July 1967 merger of the Executive Commissions coincided with the start of a period of deep uncertainty about its future. The second five-year research program was completed at the end of 1967. The new joint Commission found it impossible to reach agreement with the member states on a third multiannual program because of dissension regarding the selection and funding of projects, apportionment of cost, the proposed broadening of JRC activities to include non-nuclear areas, the authority of the Supply Agency to continue acting as sole channel for purchase and transfers of special nuclear materials for member nations, enlargement of the Communities

* Excerpted from a meeting described in Chapter 3, pp. 63-65

to permit entry of the United Kingdom (with which negotiations had been reopened) and perhaps other nations, and various other factors. DeGaulle's France maintained a posture of intransigence amid efforts to achieve compromises, but to a certain extent the other partners shared responsibility for the interruption of progress – admittedly halting, but still progress – toward unified policies and programs in the nuclear field. In any case, "interim" limited one-year research programs were passed successively from 1968 through 1972 – each time in the hope that before December rolled around again a solid basis could be laid for long-term activities. The Contracts of Association in the fast reactor field that had expired were not renewed. *De facto* cooperation did continue in this field and some others, however; and in the area of controlled thermonuclear fusion, after a year's lapse, new association contracts were signed between Euratom and organizations in member nations. Thus it was possible to avoid termination of major programs and keep the JRC functioning. Nevertheless, personnel reductions at the JRC establishments and general misgivings about the future had a depressing effect on morale; and some strikes occurred at Ispra, the largest JRC establishment.

The difficulties and frustrations of this long transitional period should not be allowed to obscure positive factors. Though results and decisions were slow in coming, genuine efforts were under way to reassess Euratom's role in the new situation, redefine its objectives as necessary, and thus assure its ability to continue contributing to the Communities' progress in science and technology. There was a general feeling that Euratom's future would be characterized by less emphasis on research itself and greater involvement in the commercial-industrial aspects of nuclear development. Euratom's mission was also expected to be extended to research in some non-nuclear areas. Broad surveys, studies, and consultations were undertaken with the aim of developing specific proposals on which agreement could be reached among the member states.

Furthermore, there were at the same time signs of great vitality in the European nuclear scene. There was an impressive trend toward multi-national cooperation involving Euratom nations but not under Euratom sponsorship – for example, in certain reactor development projects. Of particular significance to the United States was an upsurge of interest in the idea of establishing facilities in Europe for enriching uranium for power reactors. Work on various enrichment methods had been under way for years in some Community nations and in the United Kingdom; and of course both France and the United Kingdom had already constructed gaseous diffusion plants, primarily for military purposes. Essentially, however, all nations remained dependent on the United States for the enrichment of uranium for power reactors, because the high capacity of our plants enabled us to produce economically the large quantities required for nuclear power stations. Now, with power projects multiplying all over Europe as well as in the United States, and concern rising about the ability and willingness of the United States to continue meeting other nations' needs indefinitely, there was a new urgency in the desire for European independence in the enrichment area. The high costs of constructing and operating facilities seemed to rule out the undertaking for one nation alone. International cooperation seemed

imperative; but the questions of where, when, by what method, and by whom were not easily answered. Articles were written, discussions were held; studies were undertaken by individual groups and nations as well as by the Commission of the European Communities and other international entities. Amidst all this ferment, in the fall of 1968 it became known that the United Kingdom, Germany, and the Netherlands, which had been conducting independent programs in the ultracentrifuge method of isotope separation, were considering a joint project aimed at eventually starting commercial production of enriched uranium by this method.

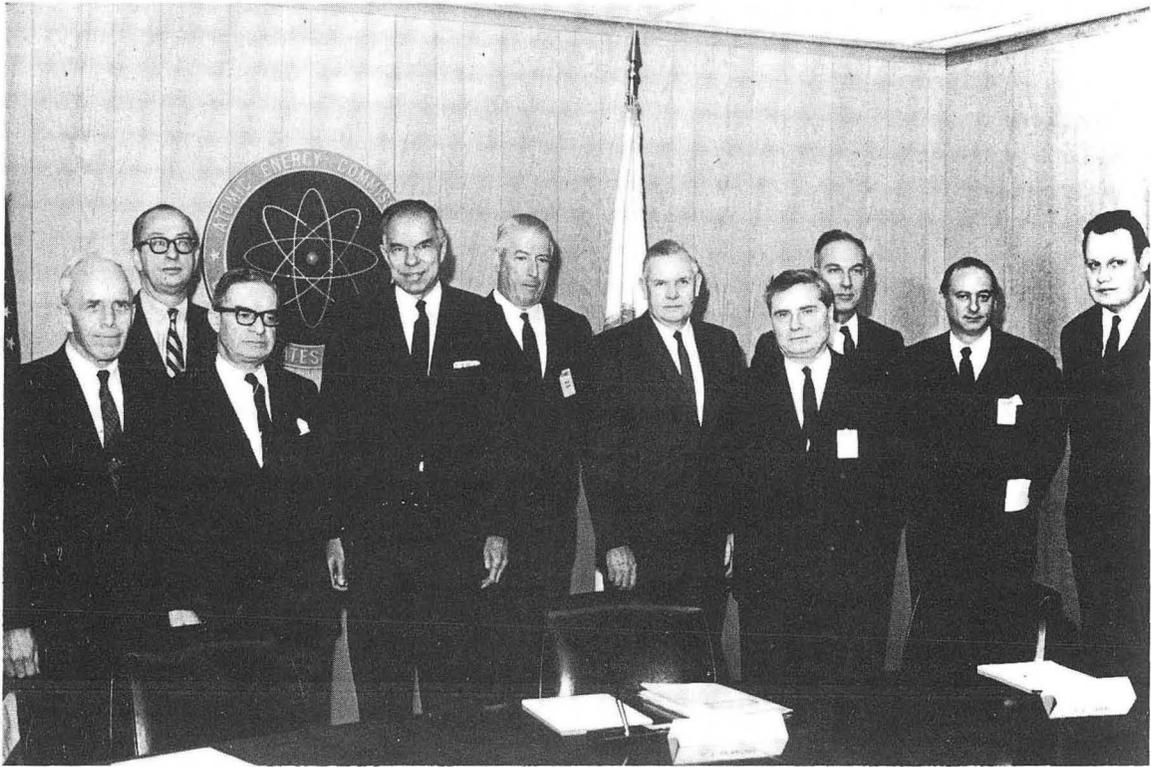
These developments in Europe required careful consideration — attended by a certain feeling of tightrope-walking — on our part. We wished to give Euratom the fullest possible support during the difficult period it was traversing, while at the same time trying to divine the best approach from the point of view of US interests with respect to the manifold problems.

We were especially anxious to see Euratom reach a satisfactory agreement with the IAEA on the subject of future safeguards administration. The approaching signing (July 1968) and entry into force (March 1970) of the NPT, which would commit non-nuclear weapon states party to the Treaty to agree to IAEA safeguards, made this essential. Some kind of agreement would have to be worked out reconciling IAEA safeguards administration with safeguards administration by Euratom. Until such an agreement was reached, Euratom nations would not ratify the NPT. Their failure to ratify would create serious difficulties with respect to US-Euratom cooperation; for as an NPT party, the United States would be committed not to provide source or special nuclear materials, or equipment for the use, processing or production of special nuclear materials, to non-nuclear weapon states unless the materials were subject to IAEA safeguards.

As might be expected, matters of such importance to the future of the Communities' scientific and technological activities, to US-European collaboration, and indeed to peaceful nuclear applications throughout the world, were subjects of discussion in many meetings with Community officials during these years. I shall mention a few of those in which I participated.

Instead of visiting us in October 1967, as first planned, Vice President Hellwig accompanied President Rey in an official visit to Washington on February 7, 1968. Several meetings during their visit provided opportunities to exchange views on a wide range of mutual interests. Hellwig and Rey, accompanied by Raymond Rifflet (chef de cabinet to President Rey), René Foch (Director of Foreign Relations, General Directorate for External Relations of the Communities), Pierre Dachateau (Deputy chef de cabinet to Jean François Deniau, Commissioner for Financial Control of the Communities), and Curt Heidenreich (Director of Euratom's Washington office), met with me for discussions in which USAEC Commissioners Wilfrid Johnson and Gerald Tape also participated, as well as Robert Schaetzel (our Ambassador to the Commission of European Communities).

The NPT and the related question of safeguards were discussed on more than one occasion and were the overriding topics during a meeting whose



XBB 763-7052

Visit with Commission of the European Communities, USAEC Headquarters, Washington, DC, February 7, 1968. (Left to right) Wilfrid E. Johnson, Robert Schaetzle, Jean Rey, Seaborg, Fritz Hellwig, Gerald F. Tape, Raymond Rifflet, René Foch, Curt Heidenreich, and Pierre Dachateau.

participants included Adrian Fisher, Acting Director of the US Arms Control and Disarmament Agency, and John Leddy, Assistant Secretary of State for European Affairs. The positive attitude displayed by both Rey and Hellwig showed that the European Commission was genuinely anxious to find solutions to the difficult problems confronting them. Saying that Community members would probably ask the Commission for its opinion as to whether the NPT conflicted with their obligations under the Euratom treaty, Rey told me that on the basis of an initial examination, he felt that the latest NPT draft represented a great improvement over previous versions and could be accepted providing all parties interpreted certain language the same way. Therefore, Rey continued, early contacts with the IAEA seemed indicated in order to explore this question of interpretation. If the exploration showed that both Euratom and the IAEA had the same ideas about Euratom's status as an international organization and the feasibility of reaching a satisfactory verification arrangement insuring the continued viability of Euratom safeguards, the Commission would be more inclined to advise member states to sign the NPT. The Euratom safeguards system had to be retained, Rey insisted, since it had the merit, among others, of applying in all six nations. (France had made clear its intention not to sign the NPT; and even if it signed, France - being a nuclear weapon state - would not thereby become subject to IAEA safeguards, which under the Treaty were applicable to "non-nuclear weapon states." Therefore abandonment of the Euratom safeguards system might mean the termination of any international safeguards arrangements in France.)

Rey indicated that the Commission planned to seek Council of Ministers approval for early contacts with the IAEA. Hellwig said that a two-step program would be proposed: the first step would involve formal technical information exchanges on the two safeguards systems; the second would be the actual drafting of an agreement, which it was felt would not start until after the treaty was opened for signature on July 1, 1968. Both Fisher and I emphasized the desirability of the Commission's consulting closely with us before submitting its plan for an agreement to the IAEA. I said that I hoped we could work in advance with both Euratom and the IAEA in order to avoid incompatible drafts.

Vice President Hellwig asked whether we would be obliged to halt nuclear fuel supplies to Euratom if, later, the United States had ratified the treaty but the Euratom countries had not because agreement with the IAEA on the safeguards matter could not be reached. Fisher pointed out that even after the United States, Soviet Union, and United Kingdom had ratified, two years would pass before the NPT safeguards provisions came into effect. We believed that if Euratom used its time wisely, this would be sufficient; if negotiations were conducted in good faith, we did not foresee any trouble. (Unfortunately, over three years were to pass, after that meeting with Rey and Hellwig, before the European Commission finally obtained a mandate to enter into formal negotiations with the IAEA on the safeguards matter.)

Seven months after our February 1968 discussions in Washington, I met with the European Commissioners again, this time in Brussels. In

addition to the IAEA-Euratom safeguards problem, we touched on several other topics of mutual interest during our conversations then at Val Duchesse:

"Thursday, September 19, 1968 - London to Brussels

"Fritsch, Kratzer, William Rice (USAEC Representative in London) and I arrived in Brussels at noon. At the US Mission to the European Communities we were met by Jim Goodby (Schaetzel was in Paris to see Ambassador George Ball). DCM George Vest accompanied us to the Chateau Val Duchesse, where we were scheduled to attend a luncheon with representatives of the Commission of European Communities.

"On the way, Vest mentioned Schaetzel's hope that the United Kingdom would explore their cooperative program on the gaseous centrifuge program on a broader scale with European partners rather than with only Germany and the Netherlands.

"At the Chateau Val Duchesse we were met by Fritz Hellwig, Emanuel Sassen, Wilhelm Haferkamp (Member of the Commission, responsible for energy policy, supply agency and safeguards), Cancellario D'Alena, Fernand Spaak, Pierre Kruids (R & D Division, Water Reactors), Axel Herbst (Director General, Foreign Relations), Piero Squartini (Member of Rey's Cabinet, responsible for science and technology matters), Walter Pauly (Director, Foreign Relations in science, technology and nuclear affairs), Arnold DeStordeur (R & D Division, Fast Reactors), and Pierre Marien (R & D, High Temperature Gas Cooled Reactors).

"After lunch we retired to an informal room, where Hellwig and I made short, informal statements on the value of this meeting. He brought greetings from President Jean Rey and Commissioner Gaetano Martino who couldn't be present. At my request, Hellwig described the present status of the Communities and the Euratom budgets, their problems in conducting non-nuclear work in the Communities' laboratories, and their problems of organization of fast reactor programs.

"Hellwig had to leave, and Haferkamp raised the question of why the United States limited them to obtaining 50% of the plutonium from the US utilities, and why we sell some plutonium to our industry for \$10 a gram when we charge them \$43 a gram. I explained the equity of the 50-50 sales arrangement and that the \$10 price is a subsidized price to support our research program and that they could do the same for their industry if they wished.

"We also discussed the IAEA-Euratom safeguards problem. I suggested a cooperative program between the United States and Euratom on safeguards research.

"I explained our Cascade Improvement Program and the difficulty of their competing with our incremental U-235 fuel price. I asked about their plans, if any, to build enrichment plants and they said a study of their policy would be completed by the end of the year.

"After the meeting, we walked around the grounds, taking some pictures and movies. Krays talked with Kratzer, Iltis and me about the possibility of a cooperative research program at the Hanford Plutonium Recycle Test Reactor (PRTR) in which Euratom would get the benefit of a reduced plutonium price.

"We visited the Chapel of St. Anne on the hill behind the Chateau. This was built in the 12th century. The resident caretaker showed us through the church."

In connection with the Communities' exploration of the feasibility of building enrichment facilities, the European Commission began some years ago to express interest in the idea of obtaining US enrichment technology for such a plant. For example, this subject was broached by Vice President Hellwig during a meeting in Washington on November 12, 1968, when he and many other Euratom and member nation representatives were in town to attend the AIF-ANS annual meeting. After first telling us something of the Foratom (the European equivalent of the Atomic Industrial Forum) and other studies being made in Europe on the matter of enrichment facilities in Europe, Hellwig inquired as to the possibility of technological cooperation between Euratom and the USAEC in this area. I replied that we would give consideration to his question. As a matter of fact, our long-standing policy of not cooperating with other nations in the enrichment area was already under review in the light of the world-wide trend to nuclear power. Even if we increased our enrichment capacity, as we planned to do, our foreign customers wanted to have -- and eventually would surely have -- an alternative source of supply. The desirability of cooperating with them to that end certainly merited careful study.

Another subject that recurred in our meetings with Euratom officials during these years was our requirement that, of plutonium purchased from the United States, at least 50% had to be purchased from the USAEC (at a price considerably above that offered by US private industry and by sources in some other countries), and that the amount of plutonium purchased from a single US private supplier could not exceed 75% of the quantity that that supplier had available. Commissioner Wilhelm Haferkamp, who, as may be recalled, brought up this point during our Brussels talks in September 1968, returned to the subject during a visit to Washington in May 1969, when many other topics were also discussed. On the plutonium supply question, we were able to tell him that efforts were under way to liberalize terms after 1970. Earlier in this meeting, incidentally, we had confirmed our satisfaction with agreements reached by the Joint Technical Working Group regarding

intensive safeguards inspection (which I have mentioned previously) at facilities where US plutonium was to be located, and that we were therefore prepared to proceed with the pertinent supply contract.

I should point out here that, as already anticipated at the time of this meeting with Haferkamp, our restrictions regarding plutonium purchases were discontinued at the end of 1970. Plutonium was becoming available in increasing quantities in the United States and abroad. The simple factor of economics, in a field where competitors were selling the material on more favorable terms, took precedence here over our unilateral policies and made a change inevitable – even though it came too late to be of much help in finding buyers for our product.

In the fall of 1970, *en route* to the 14th IAEA General Conference in Vienna, I stopped off at Karlsruhe, where I had an opportunity to revisit Euratom's Transuranium Institute:

"Monday, September 21, 1970 – Karlsruhe

"Justin Bloom (my Technical Assistant), Abe Friedman and I rode to the Karlsruhe Center. On our arrival at the European Institute for Transuranium Elements, we were met by Dr. Otto Haxel (Professor of Physics at Heidelberg University and a member of the Karlsruhe Center's Board of Directors), Dr. Clyde McClelland (Scientific Attaché at the American Embassy in Bonn), and Mr. Woesler, responsible for international activities and protocol at Karlsruhe. We were introduced to Roland Lindner, Henry Mattys and Werner Muller, who described their work on chemical separation of transuranium elements. They have a supply of six grams of ^{243}Am and five grams of ^{244}Cm which they received from Oak Ridge National Laboratory (ORNL) and are using extraction chromatography to separate and purify the two isotopes. The manipulator-controlled hot cells employed for this purpose were used previously to separate ^{242}Cm , which was made into a heat source for a nuclear battery. Part of the americium and curium is being converted into oxides for physical property studies. Another part will be irradiated to form heavier nuclides. Bromate oxidation is used to oxidize americium to a higher oxidation state for the separation process. I was told that an arrangement had been made with the AEC to receive one microgram of ^{252}Cf but the Institute would like to increase this amount to five or ten micrograms. I said I would look into the possibility on my return to the United States.

"I was also told that the movie that had been made by the German company of the Berkeley work on element 104 (in which I appeared giving a lecture) had been shown on the German 'Third Program' (educational TV) and that Ivo Zvara (of the Soviet Dubna Laboratory) had been shown also describing his work on 104."

During my discussion of our bilateral cooperation with Germany, I shall have occasion to refer again to this visit,* when I was a guest of German scientists rather than of Euratom officials.

At the conclusion of his three-year term of office, on June 30, 1970, Jean Rey was succeeded as President of the Commission of the European Communities by Franco Maria Malfatti. President Malfatti visited the United States the following spring, and an opportunity to review current USAEC-Euratom problems with him came at a luncheon in his honor at the State Department. There were a number of urgent matters. First, we were on the point of formal negotiations with Euratom with a view to further amending our Additional Agreement for Cooperation (or, alternatively, entering into a superseding Agreement). Exploratory talks in this connection had already been held. Euratom's principal aim was the liberalization of the conditions under which Community users could obtain US enriched uranium, and we were amenable to this.

At the same time, we were deeply concerned over Euratom's continued unsettled state. This significantly reduced the value to us of our cooperative activities, especially in the fast breeder area. Another problem was the lack of any real progress toward a Euratom-IAEA understanding regarding safeguards administration under the NPT. In line with our adherence to the Treaty, we had recently initiated the practice of requiring our foreign toll enrichment customers to accept our position that if the services we contracted to provide under new toll enrichment contracts proved incompatible with our commitments under the NPT, then we would have no obligation to continue providing these services. Euratom had been notified of this requirement during the negotiation of a toll enrichment contract to supply a reactor under construction at Doel in Belgium — the first contract for part of the additional U-235 authorized in the 1967 amendment to the Euratom Cooperation Act. These were the principal topics raised during our post-luncheon discussion on April 6, 1971:

"After the luncheon I joined Malfatti and we discussed Euratom-USAEC relations. I indicated that the extension of our agreement for cooperation was mired in the problems besetting the Euratom aspects of the European Communities, and Malfatti agreed. He indicated that these problems were being worked on, but there still was difficulty in budgeting for research and development beyond one year at a time. He said one of the problems was to work out a relationship between research and industrial aspects.

"I emphasized our concern that they resolve the problem of providing information to us in the fast breeder field in exchange for the information that we provide to them. I also raised the problem of their establishing a Euratom mandate to

* See Chapter 4, pp. 118-120.

negotiate with the IAEA regarding safeguards so that progress could be made toward a Euratom agreement with the Agency on safeguards application under the Non-Proliferation Treaty. He said they were working on this, but emphasized a recent difficulty: he said that our notification that the USAEC has no obligation to continue enriching services in the event that performance of this service proves to be incompatible with the obligations the United States has assumed pursuant to the NPT had been sprung on them without advance notice, and this had led to consternation and distress among a number of the members. I said that this resulted from a commitment that we had made with Secretary Rusk at the time of the negotiation of the NPT that such a requirement would apply to future long-term supply contracts in order to assure adherence to the NPT. I said that our people should discuss this further and indicated that I might look into this."

Regarding our provision of enrichment services for customers in Euratom countries, I have spoken of their concern as to continued US ability to meet their needs, their interest in the establishment of an alternative source of supply, and their inquiries about the possibility of our sharing our technology to that end. I have also mentioned a policy review being conducted in view of such inquiries, which had come not only from the European Communities and its members but also from Australia, Canada, and Japan. This policy review led to the announcement in July 1971 of the decision that the United States was "prepared to undertake exploratory multilateral discussions with the other nations which had expressed interest in constructing uranium enrichment facilities based on US gaseous diffusion technology." In line with this decision, talks were initiated with the Community nations and others.

At the time I write (February 1976) there has been no announcement of plans for European involvement in construction of a gaseous diffusion facility utilizing US technology. However, the French-dominated consortium, Eurodif, whose other members are Belgium, Sweden, Spain, and Italy, has decided to go ahead with their construction of a gaseous diffusion plant as a means to uranium enrichment independence for Europe. At the same time Urenco-Centec, an alternative enrichment undertaking financed by UK, Netherlands, and West Germany, plans to provide enrichment capability through the ultracentrifuge technique, which has the advantage that it can be operated on a smaller scale and the potential to be more economic than the gaseous diffusion method, but has the disadvantage that it is not yet a proven technology.

As I have indicated, Euratom entered the seventies with serious problems unresolved. But despite the complexities of these problems, persistent efforts to solve them resulted eventually in progress on two of the most vital issues: the application of IAEA safeguards with respect to the non-nuclear weapon state members of the Community, and development of

the long-range research programs that seem to me an essential Community activity. In the fall of 1971, at the 15th General Conference of the IAEA, Mario Pedini of Italy made the welcome announcement that the Council of the Communities had approved the long-awaited mandate for negotiations with the IAEA on safeguards. These negotiations were conducted successfully during the ensuing year. By September 1972 basic agreement had been achieved on arrangements for IAEA verification of Euratom safeguards in a way that appeared compatible with the NPT. Details of implementation were hammered out in the following months; and on April 15, 1973, the Euratom-IAEA safeguards verification agreement was signed in Brussels by IAEA Director-General Sigvard Eklund, European Commissioner Ralf Dahrendorf, and the representatives of Belgium, the Netherlands, Luxembourg, Italy, and the Federal Republic of Germany. This major step paved the way for ratification of the NPT by those countries.*

The obstacles to a long-range research program persisted through 1972, when for the fifth time a one-year program had to be accepted. But at last, on February 6, 1973, the Council of Ministers approved a four-year program including both nuclear and non-nuclear research. This assured the continued existence and wider usefulness of the Joint Research Center establishments. Meanwhile, the final barriers to the Commission's enlargement had been removed, and the UK, Ireland, and Denmark had formally become members in January 1973. The entry of the UK, in particular, greatly increased the scope of nuclear research facilities and applications within the Community.

Whatever the future holds, Euratom has at least partially accomplished its original aims. It has certainly promoted industrial growth in the nuclear field, and it has just as surely helped advance peaceful nuclear research and applications in its member states. The desired unity in these areas has admittedly not been achieved, partly at least because the industrial progress attained has spurred commercial competition between the nations. Nevertheless, in a sense Euratom may be said to have laid the foundation for the growing transnational cooperation — between the industries of two or more countries in specific nuclear areas, such as advanced reactor development and fuel reprocessing — that may ultimately assure optimum use of Europe's facilities and resources. Euratom's role and objectives as a subordinate part of "the Communities" in a changing Europe are still not clearly defined. But I tend to believe that the uncertainties will be overcome and that international cooperation in nuclear power will continue to contribute significantly to European progress.

* See Chapter 31.

CHAPTER 3

FRANCE

France presents an example of a country which decided to become an independent nuclear power and succeeded in doing so. This shows that the initial members of the "Atomic Club" had no monopoly on nuclear know-how and talent.

Established in 1946, France's Commissariat à l'Energie Atomique, or CEA – the French Atomic Energy Commission – was originally concerned exclusively with nuclear research and development for peaceful applications. During the early 1950's, however, mounting sentiment in favor of nuclear military autonomy, led first to plans for the production of plutonium in quantities of military significance, and then to an atomic submarine project and the start of preliminary weapons studies. Two factors in particular, in the 1955-56 negotiations directed to the creation of Euratom, provided fuel for those in the French Government and Parliament who resolutely opposed continuing dependence on the United States and the United Kingdom. One of these factors was a proposal for inclusion, in the Euratom Treaty, of clauses aimed at guaranteeing the peaceful nature of European nuclear activities and hence requiring all members to renounce military applications. This was unacceptable to France. The Government declared that no condition in the Treaty would be allowed to restrain France in the military field, and announced its intention to conduct weapons research. Two years later the decision was made (strongly endorsed by General De Gaulle, who became Premier in June 1958) to construct an atomic bomb by 1960. This goal was achieved with the first French nuclear test explosion on February 13, 1960, in the Sahara.

Another factor in the crystallization of France's resolution to gain nuclear independence was the exclusion from the Euratom Treaty of what some had seen as one of the principal objectives of Europe's future nuclear industry: construction of an isotope separation plant to free Europe from the necessity of seeking enriched uranium supplies from the United States and United Kingdom. After lengthy negotiation, a proposal for inclusion of this objective was finally abandoned. France then resolved to undertake the project alone, and construction of the Pierrelatte facility in the Rhone Valley started in 1960.

The French deserve great credit for their scientific and technological skill in achieving their goal. It is unfortunate, however, that they felt this was necessary. The course they followed impeded progress toward European unity, increased the difficulty of attaining effective nuclear arms control, and was attended, inevitably, by friction and mistrust between France and the United States. But throughout the period of strained US-French relations, rooted to a large extent in the element of military nuclear cooperation or rather its lack, our cooperation in peaceful nuclear applications remained active and, indeed, one of the bright spots in our relations. Among the reasons for this were the close personal associations that had developed between nuclear scientists around the world – such as my friendship with Bertrand Goldschmidt.

I first met Bertrand on July 21, 1942, when he arrived at the Metallurgical Laboratory at the University of Chicago for what was planned as a two- or three-week stay.

Bertrand was then about 30 years old. Almost ten years earlier, when he was completing his studies at the Paris School of Physics and Chemistry, he had been selected by Marie Curie as her future assistant. Madame Curie's death in February 1934 came before he could actually start research under her direction, but his brief contact with her, as described in his book *The Atomic Adventure*, may have played a significant part in his decision to concentrate in the nuclear field.

After the invasion of France, Bertrand joined the Free French Forces, which assigned him to the UK team engaged in research into the feasibility of an atomic bomb. The British wanted him to become familiar with the chemistry of plutonium. They therefore arranged for him to have some experience at the Met Lab, where I headed the team working to devise methods of extracting the plutonium required for the Manhattan Project.

The "two-week" assignment lengthened to three months. Soon after Goldschmidt's arrival in Chicago, the decision was made to transfer to Canada the UK team concentrating on heavy water reactor research. Goldschmidt was one of four French scientists – another was Jules Guéron, whom I have mentioned in connection with Euratom matters – to be assigned to the new Canadian project, which could not get under way until October. Meanwhile we had Bertrand with us, and we were glad to have him. He was outstandingly competent as a scientist and also impressively industrious, whole-heartedly willing to put in the long hours compelled by schedule pressures and goals during that tense period. (He earned the inelegant name "Pig" by the voracious way in which he consumed his work.) In addition, he already displayed the talent for administration and capacity for responsibility that were eventually to take him to the highest ranks of the CEA. Both he and Guéron participated in the creation of the CEA in 1946; from then until 1959 Goldschmidt headed the Commission's Chemistry Division, and since 1960 he has served as its Director of External Relations and Programs. For many years he represented France on the IAEA Board of Governors, and on the UN and IAEA Science Advisory Committees.

Not least of all, Bertrand is excellent company. We all enjoyed him, both in the Lab and during times of relaxation. My wife and I came to know him and later his wife well, and a lasting friendship developed between us. In the years between our association at the Met Lab and the time when I assumed my duties as Chairman of the USAEC, we saw each other many times. While the war continued, we met sometimes in connection with research related to the Manhattan Project. I recall in particular a trip I took to Canada in September 1944 for discussions with Goldschmidt, Guéron and other Montreal Project chemists, in order to review progress and make detailed discussions regarding the future course of our research. After the need for such meetings passed, we took opportunities to get together whenever circumstances permitted, in France during my occasional trips overseas, in the United States when Bertrand came to this country or to Canada.

When we met later in our official capacities as representatives of our respective governments, our friendship continued to be a source of great personal pleasure. At the same time, I believe it was a constructive element in Franco-American relations in the nuclear field. In 1961 the two-century-old bond between France and America was under heavy stress, and more difficult times were to come. President De Gaulle's suspicion of Anglo-American policies, his coolness to the new supranational organizations inspired by France's own Jean Monnet and favored by the United States, his determination that France should have an independent nuclear strike force – all this inevitably affected contacts between French and American officialdom right down the line. But thanks to our long-standing friendship, rooted in our work together, there was never any awkwardness about my meetings with Goldschmidt; in addition to many other occasions, we met each year at the General Conference of the IAEA. As I have already indicated, in fact, US-French relations in the peaceful nuclear field have remained generally cordial even when cooperation has not been so productive as we desired. All through the sixties our representatives in the USAEC Paris Office, established in 1956, found the CEA doors open to them.

Our cooperation with France in the peaceful nuclear field was formally initiated with an Agreement for Cooperation that came into effect on November 20, 1956. This provided for a broad exchange of unclassified information in reactor technology, associated health and safety problems, and isotope and radiation areas; it provided also for the supply of special nuclear materials for research purposes and for use in research reactors, materials testing reactors, and reactor experiments.

By the time I became USAEC Chairman the United States had transferred to France large quantities of U-235 in fuel for research reactors, heavy water for reactors at the Nuclear Studies Center at Saclay, and 345 shipments of radioisotopes. There were two USAEC Depository Libraries in France (at Paris and Saclay); training in the United States had been arranged for approximately 100 French scientists and US consultants had been provided in 13 areas ranging from high energy, solid state, and reactor physics to electronics.

In addition to a civil agreement, a Mutual Defense Agreement signed in 1959 was in effect. Pursuant to this agreement, a contract had recently been signed for the supply of highly enriched uranium – to total finally, in shipments started in January 1961 and completed two years later, 170.9 kilograms of 90% enriched material – for the land prototype reactor constructed for France's nuclear submarine project.

In 1961 the French civil nuclear program comprised highly advanced projects and plans in both the research and power areas. Three reactors built primarily for plutonium production were in operation; several for electricity production were under construction or definitely planned. For her power generation plants France had designed its own national type of reactor: natural uranium-fueled, graphite-moderated, and gas-cooled. It had also launched a major R&D program in fast breeder reactors, and was engaged in research in other advanced reactor types as well.



XBB 732-1084

Seaborg and Bertrand Goldschmidt (Sir Roger Makins, Chairman, UK Atomic Energy authority in center background) at 6th General Conference of the IAEA at the Hofburg Palace, Vienna (Sept. 18, 1962).

In telling of our relations with Euratom, I have mentioned several matters that have occupied us also in our bilateral dealings with France. For example, there was their reluctance to accept the termination of our bilateral Agreement for Cooperation. Another concern was our difficulty – after expiration of Euratom's Contracts of Association with member nations in the fast breeder field – in obtaining information generated in France's Rapsodie breeder project, for which we had supplied plutonium pursuant to the 1964 US-Euratom technical exchange arrangement, and for which we had started leasing highly enriched uranium well before that. The developing nature of US-French relations with respect to these and other questions, including – in the early sixties – decisions on areas to be covered under technical exchange arrangements formalized in 1963, made periodic USAEC-CEA meetings essential.

My initial contact with the French as USAEC Chairman occurred in Washington in the spring of 1961, only a month after my appointment. Ambassador Hervé Alphand came to see me on April 20, accompanied by Embassy Counselor Pierre Pelen and CEA representative François de Laage. The USAEC Assistant General Manager for International Activities, Algie Wells, was also present. During our introductory conversation, the Ambassador and I found we had many mutual acquaintances in the nuclear field. The Ambassador spoke cordially of relationships with the USAEC and the existing cooperation. He had not come, he said, to discuss matters of principle, but he did wish to bring certain "irritants" to my attention.

One of these concerned the French desire to buy fission chambers (for use in their land-based submarine prototype) of the standard type that was used with US reactors. These, however, contained uranium enriched up to 93%, and France had been told they could not obtain U-235 enriched higher than 90%. As a result, the fission chambers required special fabrication and were more expensive. Accordingly, they had decided not to buy them in the United States. Mr. Wells explained that the bilateral agreement between the United States and France limited the enrichment of material to 90%. Mr. de Laage said that the needed fission chambers could be fabricated in France and agreed that an amendment to the bilateral agreement was not warranted for this item. The Ambassador said he had brought the point up so that I would be aware of the kinds of problems that arise. He said that France did not want to presume to tell the United States what its law should be but France hoped that in areas that did not involve legal restrictions cooperation might be more forthcoming.

At this meeting both French and Americans spoke of the value of having nuclear representatives in each other's capitals – de Laage in Washington, and USAEC Scientific Representative John Rouleau in Paris. Their full-time appointments illustrated, it was felt, the extent of the cooperation between the CEA and the USAEC.

In October 1961 came my first opportunity to meet with CEA officials in Paris. With other members of our delegation to the Fifth IAEA General Conference, I interrupted my stay in Vienna with a quick trip to the French capital on September 30 to participate in discussions scheduled over the next two days:

"Sunday, October 1, 1961 - Paris

"I had dinner at Bert Goldschmidt's with Francis Perrin, CEA High Commissioner (one of France's greatest nuclear scientists, and a member of the original Commission appointed in January 1946), Jean Renou (Chief of the Department of Foreign Relations, under Goldschmidt), (USAEC Commissioners) John Graham and Leland Haworth, Jim Ammons (Liaison Representative in the USAEC's Paris Office) and others. The French made a number of requests for more US collaboration in both civilian and military matters."

The increased collaboration desired by the French involved four main elements:

1. They wanted to participate in the instrumentation aspects of at least one of the weapons tests being conducted at our Nevada test site.
2. They wanted our assistance in the construction of their gaseous diffusion facility; they hoped to purchase conventional equipment in the United States and also to be given access to our stainless steel technology for the diffusion process.
3. They wanted to obtain US plutonium for use in their fast reactor program. (I could see some technical benefit to us from such cooperation, but it was clearly necessary for us to explore the question of the extent to which our furnishing plutonium for the fast reactor program would release French-produced plutonium for weapons projects.)
4. In connection with their submarine program (for which, as I have said, we were supplying enriched uranium for the land prototype reactor), they asked whether we would supply the enriched uranium required for an operating prototype submarine.

The following day we met again at lunch:

"Monday, October 2, 1961 - Paris

"I had lunch at the Crillon Hotel with Pierre Guillaumat (French Minister for Atomic Energy), Perrin, François de Rose, Graham, Haworth, Wilkes and others. I attended a reception given by Ambassador and Mrs. James Gavin (US Ambassador to France) at their residence in honor of Air Force Secretary Eugene Zuckert."

I was glad to have this opportunity for discussion with Pierre Guillaumat. He was one of the principal figures in French nuclear development. He had played a key role in the CEA's enormous expansion during the years 1952 - 1960, a period of impressive accomplishment including establishment of the research and production centers of Marcoule, Grenoble and Cadarache.

Guillaumat and his colleagues repeated their four major requests, listed above. I assured them that I would explore all these questions with our Department of State and Defense.

In accordance with my promise, I took up these matters with the appropriate USG elements after my return home. Regarding the French request for plutonium for their fast reactor program, the conclusion at that time was that it would be preferable for them to obtain from the United Kingdom the amount they needed for this purpose. I wrote Perrin about this plutonium question; with respect to the other three requests, I thought it might be best to reply orally and informally, just as the questions had been raised. I therefore invited de Laage to come to see me, so that I might give him a message to relay to Dr. Perrin. He met with me and Algie Wells at H Street on January 16, 1962.

I told de Laage that I was sorry that it would not be possible for us to receive French observers at the Nevada Test Site because of classification considerations. I hoped, however, that the CEA observers who had witnessed the Gnome experiment had found their observations worthwhile and that information currently being analyzed would be of further interest to France. ("Gnome" was the first experiment conducted under our "Plowshare" -- Peaceful Nuclear Explosives -- Program. It took place on December 10, 1961.)

On the request for assistance with their gaseous diffusion plant, I explained that it would not be possible for the French to obtain any specialized technology but that there would be no objection to their purchasing conventional equipment from commercial suppliers, provided the sale and transfer did not in any way involve the communication of restricted data. (As things turned out, little or no equipment was purchased in the United States for the Pierrelatte uranium enrichment plant.)

Going on to the third request, I asked de Laage to inform Perrin that it was premature to explore the question of whether the United States would be willing in the future to supply U-235 for use in operational submarines. De Laage then asked me whether I thought we could supply some highly enriched uranium for use in a series of criticality experiments. We had already received a request in this connection, and Algie Wells explained that the staff was studying the matter and had asked the CEA for more detail regarding the proposed use of the material. This information was pertinent to the question of whether it would be used for peaceful or military purposes. I stated that if the quantities were within the limits specified in our bilateral agreement and if the research planned was for civil rather than military purposes, I saw no reason why the material could not be made available. (The information requested was in due course received. It showed that the research planned was indeed of a civil nature, and our bilateral agreement was amended in mid-1962 to permit our supply of enriched uranium for the criticality experiments.)

The following autumn I met with CEA officials in Paris again and also had an opportunity to visit some of their nuclear facilities. I was impressed with the great effort the French were obviously devoting to their atomic energy program, as well as by the quality of their work. One felt an enthusiasm and sense of purpose that had grown even in the year that had passed since my previous visit; there seemed no doubt that France was resolutely embarked on the road to complete nuclear independence. They were still hoping to obtain the types of US aid previously requested:

"Monday, September 24, 1962 - Paris

"I met with Perrin, Pierre Couture (CEA Administrator General), Goldschmidt, and Renou at CEA headquarters. We discussed their request for plutonium for fast reactors and their requests for diffusion plant aid, submarine aid, weapons cooperation, etc., which they requested last year, which we again refused. I met with Gaston Palewski (Minister of State for Scientific Research, Atomic and Space Affairs) at 2 rue Royale - a get-acquainted call. His office overlooks the square where Marie Antoinette was beheaded.

"In the afternoon, I flew to Orange in a MATS plane with Dan Wilkes, Chris Henderson, and Cecil King (of my staff), Wells, Goldschmidt, Abe Friedman (USAEC Scientific Representative in Paris), Jacques Mabile, de Laage, Jacques Asty, Jacques Yvon, and Pierre Falquet. We flew over Pierrelatte on the way - this is the place where the French are building their gaseous diffusion plant. Construction of head-end stages were well under way in a large building reminiscent of our Oak Ridge plant. After arriving in Orange, we visited Marcoule, where we saw one of three production reactors (operating at 220 MW) and the plutonium extraction plant."

That aerial overview of Pierrelatte was a highlight of my trip. It was not only extremely interesting but also significant in being the first view of the facility by American observers. The buildings appeared to be almost complete. I was told that the French estimated the total cost of the production plant to be about \$1 billion, with start-up scheduled for 1965-66. (Actually, start-up finally took place in stages over a period of years beginning in early 1965, when some low enriched material was produced; the high enrichment sections reached operational status in 1967.)

The flight that day was memorable in another respect - we started out in the wrong direction. We had arranged to fly over the nuclear power centers being constructed by Electricité de France (EDF) near the city of Tours on the Loire River. When we noticed we were flying southeast instead of southwest, we told the pilot that we seemed to be going away from our destination. He kept telling us not to be concerned, he knew what he was doing. When, after a while, we began to circle a small village with absolutely nothing nuclear to recommend its attention, we again spoke to the pilot. He said he had done just as he had been asked - to fly around the town of *Cours*. By then it was too late to return to Tours and so my observation of the French EDF nuclear power program had to be postponed for subsequent visits.

With respect to the plutonium requested by the French for their Rapsodie fast reactor project, our initial reaction had been, as I have said, that it would be best for them to obtain this from the United Kingdom. They felt, however, that the United Kingdom's asking price was prohibitive. I told them, therefore, that we would explore the matter further. Because of our own technical interest in this field and our contemplated involvement in the broader Euratom reactor program with which the French project was

now associated, I felt that we should consider supplying the plutonium required. (We did subsequently decide in favor of supplying plutonium for this project pursuant to a technical exchange agreement with Euratom, as I have mentioned; but the quantity required for the first core of Rapsodie was obtained from the UK.)

On the following day, September 25, 1962, we visited the Cadarache Research Center where the French fast breeder program and certain other projects are based. There we saw the land-based pressurized water submarine reactor prototype (PAT), for which the US was supplying 90% enriched U-235 under our Mutual Defense Agreement. We also saw the Pegase fuel testing reactor, then nearing completion, and the Rapsodie reactor, in an early stage of construction.

In the course of our discussions these two days, the French expressed interest in cooperating with us in the detection of underground nuclear tests. Since I believed at the time that this could be useful to us and there was a considerable amount of unclassified information on this subject which could be made available to them, I thought of exploring this matter with the Department of Defense. Nothing ever came of this, however.

Back in Washington, I reported to the President (in a letter dated October 9, 1962) the following comments on my visit to France:

"In France, one feels an enthusiasm and sense of purpose that has grown even in the year that has passed since I last visited there. There is no doubt that France is embarked resolutely down the road to nuclear independence. Its atomic energy officials are apparently convinced that they will attain the goal ultimately.

"One cannot help but be impressed with the great effort the French are devoting to their atomic energy program, as well as the outstanding quality of their work.

"I report the following observations, conscious of the policy questions surrounding the possible US assistance to the Government of France to advance her nuclear military capability and the arguments opposed to and in favor of such assistance. I am persuaded, from observations made on this trip, that the French will succeed in achieving a nuclear production capability within the next few years. Even though they may be faced with technical, and possibly financial, difficulties which have forced postponement of their original schedule, they are moving ahead vigorously and enthusiastically with the construction of facilities for the production of U-235 at Pierrelatte. *En route* by air to visit the plutonium production site at Marcoule and the research and development center at Cadarache, we were permitted to fly over Pierrelatte. The aerial view of this gaseous diffusion complex was a highlight of my visit. The buildings appear to be almost complete and are similar in appearance to our facility at Oak Ridge. I was told that they estimate the total cost

of this production plant, when completed, to be about \$2 billion, with start-up scheduled for 1965-1966.

"The most pressing problem confronting the French in their civilian nuclear reactor program is obtaining plutonium for their so-called Rapsodie fast reactor experiment. Initially, we had suggested that France explore the possibility of obtaining plutonium from the UK, but the French feel the UK's asking price is prohibitively high. Because of our technical interest in this project and our involvement in the broader Euratom reactor program with which it is now associated, the Commission is giving consideration to supply plutonium to the Rapsodie project, as well as to the more pressing plutonium requirements of the European community."

My next discussions in Paris took place on May 31, 1963, when I was on my way home from my first visit to the Soviet Union. USAEC General Manager Al Luedecke, Wells, Friedman, and I met with Perrin and Goldschmidt at CEA headquarters; afterwards Bertrand and I lunched together at the Hotel Crillon. During these two conversations we discussed a wide variety of topics, including the French weapons program, the then still unsettled question of plutonium for Rapsodie, fuel for Pegase, the seismic detection program, and Pierrelatte. One question in which I was interested was whether Germany or any other country might be participating or considering participation in the Pierrelatte uranium enrichment project. At this time the USAEC had already submitted to Congress proposed legislation which would enable us to provide toll enrichment of foreign uranium for foreign reactors on a long-term basis. Assuming that this legislation was approved – and it was passed, as I have reported in connection with Euratom, in the summer of 1964 – this would presumably lessen any interest other countries might have in becoming involved in the Pierrelatte operation. To judge by Goldschmidt's response, there was in fact no thought of such involvement at that time:

"Goldschmidt said in a most definite manner that there have been no arrangements for financial assistance or cooperation with West Germany or Italy in connection with the construction of the Pierrelatte gaseous diffusion plant and no such cooperation is contemplated. He said that such cooperation would clearly not be in the interests of France, that France is prosperous and can easily manage the cost for this plant. He indicated that when the plans were being made in 1956 for the construction of Pierrelatte, the six countries of Euratom (Common Market countries) were consulted with regard to the possibility of their cooperating in the venture. Two or three small countries such as Sweden, Denmark, and Switzerland were also consulted but not in as serious a manner. When none of these countries indicated an interest in cooperating, France decided to go it alone.

"Goldschmidt said that possibly sometime within the next few years, France might approach the members of Euratom again with the proposal that France, now capable of building a gaseous diffusion plant, would offer its knowledge to the group in connection with a possible joint effort to build another gaseous diffusion plant somewhere in Europe. This second plant would be solely for the purpose of producing low enrichment U-235 for use as nuclear fuel in power reactors, thus making the European members independent of the United States and England in this respect."

It is clear that the idea of European independence from the United States with respect to enrichment has been supported consistently by the French from the time Euratom was conceived. And some years after the above conversation, in the spring of 1971, France did come forward with a firm offer to cooperate with other nations (not, however, "Euratom members" as such) in planning construction of an enrichment plant to meet the needs of power reactor programs in Europe.

A few days after the meeting with Goldschmidt mentioned above, I had a chance to renew my acquaintance with Minister Palewski. He came to Washington to give a major address to the World Food Congress (sponsored by UN-affiliated Food and Agriculture Organization), and he took advantage of the occasion for discussions with several US Government leaders concerned with international scientific affairs. He and I met on June 6, 1963, for a useful review of US-French nuclear cooperation and related matters.

French officials responsible for nuclear matters, including Goldschmidt and Perrin, came to the US for discussions many times during those years. The annual IAEA General Conferences also provided occasions for periodic conversations on the various aspects of our cooperation; so did the 1964 and 1971 Geneva Conferences and events elsewhere attended by representatives of our two countries. Furthermore, the presence of the USAEC Scientific Representatives in Paris and numerous visits to France by USAEC headquarters staff closely involved in our international programs made direct US-French consultation possible on a frequent basis.

In late 1963, pursuant to CEA-USAEC discussions in such meetings and in correspondence, arrangements were made for the consolidation and extension of unclassified information exchanges between our organizations. These arrangements were formalized in an exchange of letters between Algie Wells and Jean Renou. The areas of cooperation specified included fast reactors, gas-cooled reactors, fuel element technology, special materials studies, reactor safety, reactor physics, waste management, fuel element reprocessing, test reactors, and transuranium elements. These exchanges, which included visit and assignment exchanges, developed in a generally satisfactory manner. After the establishment of the US-Euratom technical exchange arrangement with respect to fast reactors, our exchanges with the French in this particular field continued under our arrangement with Euratom by virtue of the French-Euratom Contract of Association in the breeder area.

During the next two years situations and developments pertinent to US-French nuclear cooperation made personal high-level meetings essential.

Since I had no opportunity to meet with CEA officials in France in 1964 or 1965, I was particularly glad that visits by Perrin to the United States permitted conversations here on such matters as our exchanges, the friction over our "fold-in" policy (our policy of letting our bilateral agreements with Euratom member states expire and thenceforth channeling through Euratom any special nuclear materials the United States supplied to those states), the French position with respect to Euratom, safeguards application, and France's continuing technical progress in both military and civil areas. On November 10, 1964, over lunch at the Mayflower Hotel, (USAEC Commissioners) John Palfrey and Gerald Tape and I had an interesting discussion with Perrin ranging from the French nuclear weapons test program to speculation as to where the Chinese (who had conducted their first successful atomic bomb explosion on October 16) had obtained the weapons grade U-235 for their weapon. Some of the other subjects raised are indicated in these excerpts from my notes on that meeting:

"Perrin said that Pierrelatte is starting up without trouble and that they should begin having some 2% product (2% concentration of U-235) within a month or two. A second stage enriches product to about 5%, a third stage to about 20%, and a fourth and final stage to weapons grade. (These are approximate figures from memory of the conversation.) He said that there were some small problems connected with handling of materials, the connections of one part of the plant to another, and the final stage, but that these should be rather readily solved.

"We also discussed the matter of reactor safeguards. He said that France was in favor of safeguards for the prevention of proliferation of nuclear weapons. He said that they are not planning to apply safeguards to the nuclear power plant which they may build in Spain near the French border, in cooperation with Spain, using natural uranium from Spain. The arrangements for this project have not yet been completed. He feels that, since the natural uranium comes from Spain, they don't have much of a basis on which to insist on safeguards. However, they would apply safeguards to any chemical processing plant that might be built in Spain with their assistance.

"I asked whether France would be willing to accept IAEA safeguards on a plant like SENA, as a substitute for Euratom safeguards. He said that they prefer US safeguards first, and then Euratom safeguards as a second choice, and IAEA safeguards would be their last choice. (He said to me in a meeting before lunch that France objects to the transfer of the supply of fissionable materials function from the present bilateral arrangement to Euratom.)

"He said that France feels they should be treated just like England on the safeguards question because they are a nuclear power just like England. Thus, they won't buy natural uranium from Canada because Canada insists on safe-

guards for them [France], but doesn't require safeguards for England.

"He told us that the French had not demanded safeguards on the uranium which they furnished for the Dimona reactor in Israel, but that they had an agreement with Israel that it would be used only for peaceful purposes.

"We also discussed the NATO Multilateral Nuclear Force (MLF), and Perrin explained some of the French objections. He felt that the best solution would be a joint British and French nuclear alliance. When we pointed out that this would not really take care of the Germans and the Italians, he said he felt that the Germans should simply be made to adhere to their treaty obligations not to produce nuclear weapons, and he felt that the Russians would insist on this to the extent that it would be impossible for the Germans to make nuclear weapons."

A year later (on October 22, 1965), accompanied by Pierre Falquet of the French Embassy, Francis Perrin came to the USAEC headquarters again, to see Commissioner Tape and me and principal USAEC staff concerned with international activities. On the question of fold-in, Perrin seemed less concerned than before about the prospect of receiving special nuclear materials from us through Euratom. He said, however, that France attached political importance to having a bilateral agreement (since in their view Congressional approval was a significant factor), even one which did not cover materials supply and even though it was unnecessary for most of our cooperative activities. I said we would find it difficult to enter into such an agreement, which would create a precedent I believed the White House would oppose. Dr. Perrin recognized this but hoped it would be possible to find some means of establishing a framework of overall cooperation which could be supplemented by exchange of letters in specific fields. (Actually, of course, no special mechanism or framework was required for our cooperative activities. As we repeatedly emphasized to the French and other Euratom members, these would continue as before, unaffected by expiration of our bilateral agreements. The only difference would be that special nuclear materials for the individual national programs would be supplied by us through the Euratom Supply Agency.)

Among the other topics discussed on this occasion, the most important was the question of safeguards. Noting that France was not in agreement with US policy on this, Perrin declared that it was, nevertheless, completely against proliferation. France, he said, might be even more opposed to proliferation than we; he cited their attitude on Germany (enforce the Treaty of Paris, under which Germany was committed not to develop nuclear weapons) and on the MLF. On the latter, I remarked that, contrary to the French, we considered the MLF a step in support of non-proliferation.

Perrin expressed some reservations about the effectiveness of IAEA safeguards in preventing proliferation. However, he did say that it was important for the Agency to establish safeguards for chemical processing

plants. He mentioned that the Eurochemic plant at Mol, Belgium, might be a suitable facility to place under Agency safeguards. It is interesting to note the difference between the French view as expressed at this time, and on the other hand the view of Euratom, which proved unreceptive when I suggested the following spring that Eurochemic be placed under IAEA safeguards.

When telling of discussions with Euratom officials in March 1966, I mentioned a talk with the French during that same trip. The questions of fold-in and safeguards administration were the principal subjects raised in our meeting then:

"Wednesday, March 9, 1966 - Paris

"Ambassador (to France) Charles Bohlen, Arnie Fritsch (my Special Assistant), Martin Biles (USAEC Scientific Representative, Paris), Theodore Iltis (USAEC Brussels office), Larry O'Donnell (USAEC Division of International Affairs), and I called on Alain Peyrefitte, French Minister Delegate for Scientific Research and Atomic and Space Affairs, and his aides (Jacques Martin and two others) in Peyrefitte's office overlooking the square where Marie Antoinette was executed (same office where I visited Minister Pawlewski in September 1962). I reaffirmed that the United States intends to allow French-US bilateral to lapse when it expires in November. We also discussed safeguards. Peyrefitte said France is in favor of safeguards. I told him that in the long run all countries must accept IAEA safeguards.

"We then attended a reception at Ambassador Bohlen's residence. Present were Fritsch, O'Donnell, Biles, Ambassador John Tuthill, Stanley Cleveland, Peyrefitte, Robert Hirsch, and others.

"I attended a stag dinner at the residence of Ambassador Cleveland with Lemmitzer, Bohlen, Phil Farley, Kim Stanley, and Arnie Fritsch. There was much discussion of De Gaulle's decision yesterday to withdraw from integrated NATO force and his demand that US troops withdraw from France or go under French control."

My report to the President on this trip, dated March 15, 1966, included the following comments on France:

"I met with Ambassador Bohlen at the American Embassy and then went with the Ambassador to meet with Alain Peyrefitte, French Minister Delegate for Scientific Research and Atomic and Space Affairs. A matter of present concern between France and the US in the field of the peaceful uses of nuclear energy is the proposed lapse in November, 1966, of the bilateral agreement for cooperation between our two countries. As a matter of policy, the United States is allowing the bilateral agreements of all Euratom Member States to lapse so as to strengthen the European Community concept and to deal with

one organization (Euratom) rather than six on such matters as supply of nuclear materials. The Euratom route presents uniformity to the Member States in cooperating with the US. The French Agreement would be the second one to lapse (the Belgium Agreement lapsed last year), and the French Government has been quite opposed to this course. However, in the past few weeks the French have come to realize the firmness of the US position and are now seeking face-saving moves. During my discussions with Minister Peyrefitte we agreed that one such move might be the exchange of letters between myself and him, in which we would assure one another of our continued cooperation in the peaceful uses of nuclear energy – cooperation which does not require a formal agreement and which is intended to take place in any case. The other concern that Minister Peyrefitte expressed about the bilateral agreement concerned the matter of safeguards. He noted quite clearly that the French Government was not now prepared to accept IAEA safeguards in lieu of the Euratom safeguards. I agreed with Minister Peyrefitte that Euratom safeguards are equivalent to IAEA safeguards, but noted that in the longer-term future the inevitability of a single international system of IAEA safeguards was clear. During the course of our meeting, Minister Peyrefitte also expressed the view that France did not favor proliferation nor did it propose to underwrite new non-nuclear countries' ambitions to become nuclear powers.

"Following the formal meeting with Minister Peyrefitte there was a small reception at Ambassador Bohlen's residence for Minister Peyrefitte and other high-ranking members of the French Atomic Energy Commission. I had the opportunity there to have a lengthy discussion with Robert Hirsch, Administrator General of the French Commissariat à l'Énergie Atomique (CEA). Mr. Hirsch, contrary to expectations, did not seem to be at all concerned about the lapse of the bilateral agreement.

"Following the reception I was a guest at a dinner meeting hosted by Ambassador Cleveland, which included General Lemnitzer and Ambassador Bohlen. The main topic of dinner conversation was of course the announcement the previous day by President De Gaulle of his plans for French withdrawal from NATO."

Just six months later, on September 8, 1966, Bertrand Goldschmidt came to see me in Washington with Jean Dard, Atomic Energy Attaché at the French Embassy. Termination of the bilateral agreement was now imminent. Goldschmidt was concerned about the formalities, especially with respect to the transfer of safeguards on materials we had supplied, including the heavy water being used in their advanced converter reactor development program. Goldschmidt first suggested a letter from me to Hirsch, but we finally agreed that this would be handled by the Department of State.

I observed to Goldschmidt that all such problems had been met and successfully solved in the Belgian turnover and that the French fold-in would proceed the same way.

We had some discussion of a France-USSR agreement for cooperation in high energy physics, which was to be signed pursuant to negotiations that had taken place in Moscow in May. Regarding the planned installation of a French bubble chamber at the USSR's Serpukhov facility, Bertrand pointed out that the agreement was unusual in that it provided for France to continue to be responsible for operation of the bubble chamber, and this would require 40 French technicians and their families to be permanently stationed there.

During this meeting Bertrand discussed a number of other topics of interest:

Pierrelatte. Progress was better than expected, he said, with the portion up through 25% enrichment operating satisfactorily and the highly enriched section ready to begin operation. The plant would be completed three months ahead of schedule, which had been mid-1967.

French Computer Program. Goldschmidt indicated that the French had decided to develop independent computer capability and were considering, as head of a state-run organization with this aim, the head of the Pierrelatte project. (This was Robert Galley, who later, in July 1968, was appointed Minister Delegate for Scientific Research and Atomic and Space Affairs.)

Gas Centrifuge. While they had been able to improve their gaseous diffusion process by a factor of three since starting construction of Pierrelatte, the French were apparently not (so far as Bertrand indicated) doing much work on the gas centrifuge or other separation processes.

French Procurement of US Light Water Reactors. Electricité de France (EDF), the French State electric utility, had favored this, but the Government discouraged it "because of the bilateral fold-in."

French Nuclear Submarine. Development was proceeding very successfully.

During this period, as was indicated in Goldschmidt's remarks, there was growing French interest in the potential advantages of US-type light water power reactors. This was reflected again, less directly, in a brief conversation I had on the subject less than two months later with Pierre Masse, EDF President. Mr. Masse, with Hendrik Casimir (Director of Research, Phillips of Holland) and Raymond Klein and Georges Ferne of the Organization for Economic Cooperation and Development (OECD), came to USAEC headquarters on November 1, 1966, to consult Commissioner Wilfrid Johnson and me on a broad range of nuclear-related subjects, particularly government-industry relations and reactor development plans. In our exchange regarding power reactors fueled with enriched uranium, Mr. Masse stated that the French recognized the advantages of enriched uranium as fuel and the low capital investment required for such reactors *vs* natural-uranium reactors. He did not, however, touch on the policy differences which we knew existed between certain decision-making groups in France on the question of whether to stick

to France's own line of power reactors or turn to construction of light-water, enriched-uranium types such as were being marketed with increasing success abroad by the US nuclear industry and being adopted, in basic concept, by the nuclear industries of certain other countries.

Not until after De Gaulle's resignation from the Presidency in April 1969 was this policy conflict finally resolved and the decision made to turn to the light-water plant. Meanwhile French nuclear power planning continued to be based on their national reactor line, although they did start considering inclusion of at least one light-water power facility, with a view to obtaining economic and operating experience beyond that gained from the SENA plant built under the US-Euratom program.

I spoke earlier of a program of technical exchanges between the USAEC and the French CEA that was consolidated in 1963 under the Wells-Renou letter exchanges. While developments were satisfactory in some areas included in this program, activity was reduced as the years passed. Cooperation in the field of fast breeder research, especially, became increasingly unsatisfactory as the French Contract of Association with Euratom in this field approached its termination. The 1964 US-Euratom exchange arrangement, which in effect superseded the earlier US-French arrangement, provided that we would receive through the Community information the latter received from member states under its Contracts of Association in fast reactor research and development. Strictly speaking, the French-Euratom contract expired at the end of 1966. Special action was taken by the European Commission in mid-1967 to continue its period of effectiveness until the end of Euratom's second five-year research program — i.e., until the end of 1967. We received progressively less information on the French project, however, although we were still supplying reports on our fast breeder program to France through Euratom. This was a matter of serious concern to us. Aside from this, changes had occurred generally in the areas of mutual US-French interest since the initiation of our consolidated program in 1963; and constructive revision was long overdue. I took the opportunity to discuss the matter with Goldschmidt during conversations at the 1967 IAEA General Conference. His reaction made it clear that the French too favored a revitalization of our cooperation in order to insure useful exchanges in fields of common interest:

"Tuesday, September 26, 1967 — Vienna

"...[At the opening session of the IAEA] I met Goldschmidt and told him that Fritsch and I planned to visit Saclay on October 16, on our way to attend the Marie Curie Symposium in Warsaw. He was delighted.... He later suggested that I visit CEA officials in Paris, instead of Saclay...."

"Wednesday, September 27, 1967 — Vienna

"...After lunch with Director General Sigvard Eklund, Goldschmidt suggested to me that US and French AEC staff members hold annual meetings, perhaps alternating between the United States and France. I said I would give him our reaction to this suggestion...."

This idea was developed more fully in the course of our subsequent Paris meeting, where we also received a useful briefing on the current status of some of their priority programs:

"Monday, October 16, 1967 - Paris

"Fritsch, Abe Friedman (Deputy Director, USAEC Division of International Affairs - DIA), Joseph DiNunno (USAEC Scientific Representative, Paris), Ed Piret (Scientific Attaché at the US Embassy), and I rode to the headquarters of the Commissariat à l'Energie Atomique. There we were joined by Robert Brand (Economic Counselor, US Embassy). The six of us attended a conference with CEA officials Robert Hirsch, Francis Perrin, Bertrand Goldschmidt, Jules Horowitz (Chief of Reactor Directorate), Maurice Pascal (Director of Administration and Director for Industrial Policy), and Jean Renou (Chief, Department of Foreign Relations).

"Hirsch opened the conference by suggesting that the CEA and the USAEC hold meetings, chiefly at the staff level of Division Directors, etc., about once a year, alternating between Paris and Washington. These would be arranged on an informal basis. I agreed that this would be desirable and feasible. The first meeting might be held in Washington in February or March of next year, a time that would suit Hirsch. We would discuss such topics as reactor development. Friedman will come to Paris on the way home from Warsaw to start working out the details for such a meeting, such as proposed topics to be discussed. We would prepare such an agenda before each meeting. Goldschmidt will visit New York starting November 14; therefore, it was arranged that he will visit Washington on November 10 to continue discussion of arrangements for our first meeting.

"Perrin will visit the United States to attend the 25th anniversary observance of the first nuclear chain reaction at Chicago on December 1 and 2. He will come early and visit us in Washington on November 27 or 28, and then visit Oak Ridge.

"Hirsch described their reactor program, dividing it into three parts: (1) cooperation with Electricité de France, (2) fast reactors, and (3) advanced converters, or heavy water program.

"We began by discussing fast reactors. Their Rapsodie reactor went critical at the first of the year and has worked well ever since. The fuel has reached 8000 MWD per ton and is accumulating irradiation at the rate of 1000 MWD per ton per month. They hope that the fuel, which is mixed oxides of uranium and plutonium, will hold up until 30,000 MWD per ton or more.

"We discussed their relationship with Euratom....

"They mentioned that they had been refused permission to send a man to work on the SEFOR program in the United States. It is not clear how this was blocked but they think it may be settled now."

The reference above to SEFOR was to the Southwest Experimental Fast Oxide Reactor designed and built by General Electric under USAEC contract, and located near Fayetteville, Arkansas. The Gesellschaft für Kernforschung (GFK), a nonprofit corporation of the Federal Republic of Germany, participated in this project for itself and on behalf of Euratom, contributing about \$5 million in exchange for participation (including personnel assignments to the project) and access to information developed. As the French mentioned during our Paris meeting of October 1967, a personnel assignment they had proposed had been rejected by General Electric. (Our contractual arrangements for this project, as for most industrial reactor development work, allowed for contractor acceptance of assignees on a case-by-case basis and did not give the USAEC the right to require acceptance.) The French were correct in thinking, however, that the matter had finally been settled satisfactorily from their point of view: arrangements were made for their representative to be assigned to SEFOR in early 1968.

At the 1967 Paris meeting, other aspects of reactor development programs were also covered:

"I brought up the problem of the uncertainties of the success on a timely and economic basis of the sodium-cooled fast reactor program which is the main line of development in so many countries. There are also safety questions to be resolved. It is for this reason that the United States has a number of back-up programs in the fast reactor field (gas-cooled and steam-cooled) and back-ups to the fast reactor (the high-temperature gas-cooled reactor, the light-water breeder, the molten-salt reactor, and a heavy-water program). We briefly described the US program.

"Hirsch then turned the discussion to CEA cooperation with EDF. EDF is now outlining their next five-year plan. This will include a look at light-water reactors to see if they can compete in France, under their special conditions, with gas-cooled graphite reactors. They have a commission making a study of this and the probable result will be that EDF will include a light-water reactor in their system, built in France under license with a US firm. They will probably choose either a pressurized-water reactor (PWR) or a boiling-water reactor (BWR). They may possibly choose both, although this isn't so likely. We told them it is not possible to predict at this time which would be the best choice. They mentioned as differences between French and US conditions the cost of money and the cost of fuel. One disadvantage of choosing both PWR and BWR is the increased cost of the fuel in such a case.

"We discussed reactor safety and mentioned that they could talk to DiNunno, who is an expert on this, and that Peter Morris, Director of the USAEC Division of Reactor Licensing, and Nunzio Palladino (Chairman, USAEC Advisory Committee on Reactor Safeguards, and Dean, College of Engineering, Pennsylvania State University) will be in Paris next month and available for such discussions.

"Hirsch then turned the discussion to advanced converters. The heavy water reactors might have advantages due to the fact that fuel reprocessing is not required, if the fast reactors are delayed in development. They said that the adoption of organic-cooled reactors by French utilities is hampered not by technical problems but by political-industrial attitudes. (The CEA has devoted considerable effort to the development of a heavy-water moderated reactor, fueled with slightly enriched uranium, as a potential bridge between proven-type power reactors and the future fast breeder facilities. Our cooperation, in supplying both heavy water and the enriched uranium required, has been a significant help in this effort.)

"I asked them about their uranium supply picture. They said it is good. They have found a good supply in Niger, recoverable economically in quantities of 1000 tons per year within five years and twice that within ten years. They have an arrangement with Argentina and have discussions underway with Brazil and Indonesia.

"In response to a question they said they haven't decided yet whether to build a plant for the production of heavy water. Also, in response to a question, they said their Pierrelatte plant for the enrichment of uranium is working fine. A new plant built on the basis of the knowledge they have acquired would, of course, be much cheaper to build than Pierrelatte."

As planned, Goldschmidt and Perrin came to the United States in November 1967, Goldschmidt first in order to receive the Atoms-for-Peace Award in New York on November 14. This Award was given by the Ford Company as a memorial to Henry and Edsel Ford. It was presented periodically, over a 14-year period ending in 1969, to scientists from many nations in recognition of distinguished contributions to the field of peaceful nuclear applications. The recipients included a number who, like Goldschmidt, were members of the IAEA Scientific Advisory Committee.

The CEA officials' visit permitted a preliminary exchange of views on topics to be included in an updated exchange, and tentative plans were made for the first of the annual meetings contemplated.

Perrin's presence in Washington also afforded an opportunity for discussion of other matters of major concern. The High Commissioner, accompanied by French Embassy Atomic Energy Attaché Jean Dard, called on me on November 27. Others present at this meeting were Commissioner Gerald Tape, DIA Deputy Director Abraham Friedman, and the DIA Assistant Director for Agreements and Liaison, William Yeomans. The French inclination toward light water reactors was clearly indicated in Perrin's remarks about safeguards application under the NPT. Emphasizing the French position that conclusion of the treaty should not result in any changes in the application of safeguards in France, he said that he had raised this question because France was currently considering the possibility of constructing boiling water or pressurized water reactors and would have to make a decision in three or four months on the character of their reactor program for the period beginning about 1971. If they were to build boiling water or pressurized water reactors, the enriched uranium would have to come from the United States and they would want assurance that only Euratom, and not IAEA, safeguards would be applied to this material. He stated that rather than accept IAEA safeguards they would not build such enriched uranium reactors. In response to a comment by Dr. Tape that someday France's military requirements might be fully satisfied and that the Pierrelatte plant would then be able to supply the enriched uranium requirements of the reactors, Commissioner Perrin said that the Pierrelatte plant was too expensive to operate for this purpose and that, if France's military requirements should be satisfied, he would expect the plant to be shut down.

During the CEA-USAEC staff discussions regarding updating the Wells-Renou exchange program, a tentative decision was made to meet in the spring of 1968 to develop details of future exchanges. At that time, however, Euratom - having failed in December 1967 to agree on a third five-year research program and having approved only a one-year holding operation - was trying desperately to achieve an acceptable compromise on a multiannual program to follow the "interim year." We were, of course, reluctant to engage in any bilateral agreements that might conceivably have an adverse effect on Euratom's efforts. Therefore it was not until November 1968 that the first broad-composition meeting on technical exchanges took place. On November 12, 1968, I attended a reception marking this event, at the French Embassy in Washington, where I talked with Goldschmidt, Jean Renou, Jean Dard, and the French Ambassador to the US, Charles Lucet. I attended the opening meeting on November 14 to welcome the French group headed by Goldschmidt and stress our interest in continued technical cooperation; and CEA High Commissioner Perrin spoke in a similar vein at the closing session on November 15. During their discussions these days, USAEC and CEA staff agreed on technical exchanges in seven major areas: reactor development and technology; physical research; isotopes development; biology and medicine; operational safety; safety reviews and regulatory procedures; and nuclear materials management and safeguards. The fast reactor field was not included.

In the spring of 1969, Robert Hirsch visited us in Washington, together with Goldschmidt, Jean Dard, and Maurice Pascal. On March 15, 1969, a dinner at the French Embassy was given by Ambassador and Mrs. Lucet in honor of Hirsch, Goldschmidt, Dard, and Pascal, and for the presentation of the title of Commander in the Legion of Honor to Isidor I. Rabi (member of the Scien-

tific Advisory Committee to the IAEA). I attended, as well as Congressman Craig Hosmer and Chet Holifield. On March 17, I met with this French delegation in my offices. Present with me were USAEC Commissioners Wilfrid Johnson, Gerald Tape, and Frank Costagliola; Myron Kratzer, Assistant General Manager for International Activities and Director, DIA; Abraham Friedman; Milton Shaw, Director of the Division of Reactor Development and Technology; and my Special Assistant Julius Rubin. We had a useful meeting:

"Monday, March 17, 1969 - Washington, D.C.

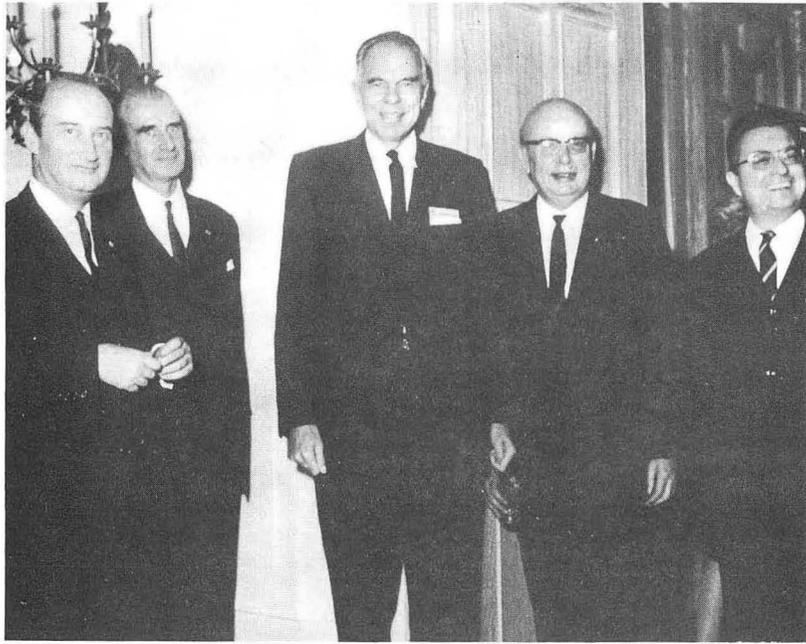
"We first discussed Plowshare, and Hirsch and Goldschmidt said that they had had underground weapons testing, especially in granite, which might include information of interest to us. They suggested bilateral cooperation in the Plowshare field. I emphasized that the IAEA would probably have to play a role and said that in any case we would not give them an immediate answer on this. They... indicated that they could become a supplier of Plowshare services.

"We then discussed uranium enrichment and they continued to express their concern over the tripartite arrangement for the development of the gas centrifuge involving the United Kingdom, West Germany and the Netherlands. I indicated that the gas centrifuge would not be economically competitive in the United States for some time but that we couldn't speak for the members of the tripartite consortium because they may want to develop an independent, even though small, capability in order to have a fallback capability. Thus, they might get most of their enrichment services from the United States but be ready with some experience in case they felt they needed to be independent at some stage. I pointed out that Europe has higher cost power than the United States and lower requirements than the United States and perhaps had made some advances which made them interested in the gas centrifuge. I indicated, however, that there probably had not been any breakthrough in gas centrifuge technology by these three countries.*

"We then discussed the philosophy of nuclear power development in the United States. They were concerned about the slowdown in the ordering of reactors by US utilities, and I indicated that this was normal and that we still project 150 million kilowatts for 1980.

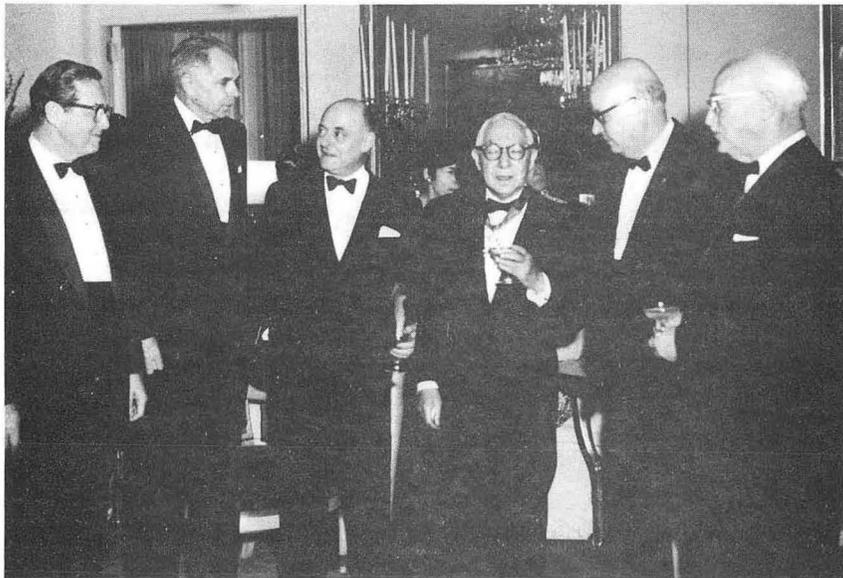
"We discussed the matter of safeguards in fabrication plants in France. We said that we still felt that we must insist on intensive inspection with respect to Euratom fabrication facilities where US materials are handled.

*See Ch. 2, pp. 37,44.



XBB 761-7000

Reception at French Embassy, Washington, D.C., November 12, 1968. (Left to right) Bertrand Goldschmidt, Jean Renou, Seaborg, Ambassador Charles Lucet, Jean Dard.



XBB 761-7001

Reception at French Embassy, Washington, D.C. March 15, 1969. (Left to right) Congressman Craig Hosmer, Seaborg, Robert Hirsch, Isidor Rabi, Ambassador Lucet, Congressman Chet Holifield.

"As a final item we discussed US-French technical cooperation and expressed concern that their industrial picture might impede the exchange of information regarding fast reactors; they assured us that this wouldn't be so. They asked whether we might supply some 300 to 500 tons of heavy water for their heavy water power reactor that they are planning, and we indicated that, since we are not in the heavy water supply business, we couldn't assure this, but that we would look into it. They need the heavy water by 1974.

"We decided that the next US-French Technical Cooperation meeting on the staff level, similar to the one held in the United States last November, would probably be held in Paris in the autumn."

The CEA-USAEC staff meeting on technical changes did take place in Paris in the fall of 1969 as anticipated and led to constructive development of our arrangements. The French now agreed to an exchange in several aspects of fast reactor development, including the particularly important area of fuel element technology. Meanwhile, however, the last US scientist assigned (under our breeder information exchange with Euratom) to the French fast reactor project at their Cadarache center had completed his assignment; the French had been unwilling to extend his stay, and he had returned to the United States in July 1969.

In November of that year the French Government announced its decision to build atomic power plants based on US reactor technology and, at least in the near term, to confine work on France's national gas-graphite line to the research level. This radical revision in French plans was in accord with firm recommendations made to the Government as early as April 1968 by the "Consultative Commission for the Production of Electricity of Nuclear Origin" (PEON) headed by Jean Couture, Secretary General for Energy. Though not released until long after submission, the recommendations of the "Couture Report" became known in essence; and the Government's decision had been rather generally expected for some time. The French move virtually completed the world-wide shift from natural uranium to slightly enriched uranium reactors. The United Kingdom and Sweden had already made this change; now only Canada was keeping exclusively to the natural uranium reactor in nuclear power programs.

The plan to construct reactors requiring enriched uranium fuel intensified France's interest in establishment of a separation facility in Europe. This was one of the subjects uppermost in High Commissioner Perrin's mind when he and Pierre Villaros (Jean Dard's successor as their Embassy's Atomic Energy Attaché) came to see me at USAEC Headquarters on April 23, 1970:

"Perrin explained there were a few problems he wished to discuss with me and for about the next forty-five minutes explained the basis for a French conclusion that a uranium

enrichment capability would have to be established in Europe. The fact that enriched reactors purchased by France over the next four or five years would result in a 50-50 split with their natural uranium capacity made it essential for France to join with other European countries in establishing an enrichment facility. Perrin noted that German participation was vital to this objective and, since the centrifuge project initiated by the UK-Dutch-German Agreement would not likely provide reliable technology before another ten years, it appeared a diffusion plant would have to be constructed starting about 1975. Perrin urged that a US decision be made at an early date as to whether, and under what terms, US technology would be made available to such a project.

"Perrin stated the main basis for the centrifuge effort in Europe was recognition that higher electricity costs and higher interest rates would prevent a European diffusion plant from matching the US price for separative work. He suggested that French diffusion technology was not very far behind US technology, but the Germans would likely not agree to building a diffusion plant in the absence of the best technology available.

"I told Perrin that the US Government was studying this subject and we would let him know the conclusions, as he had requested, at the earliest possible date."

Wide-ranging talks with CEA officials were possible during an extremely interesting stop I made in France in the fall of 1970, on my way to the IAEA 14th General Conference. I was especially glad to have a chance to visit there at that time, not only because I had not been in France for several years but also because I was particularly anxious to say good-bye to Robert Hirsch, who was soon to leave the CEA and with whom my relations had been most pleasant, and to meet his designated successor:

"Thursday, September 17, 1970 – Paris

"I rode with USAEC Scientific Representative Joe Lafleur, Justin Bloom and Abe Friedman to the CEA Headquarters. We attended a luncheon with Robert Hirsch, André Giraud (who is to replace Hirsch as CEA Administrator General), Bertrand Goldschmidt and Jean Renou. I talked to Goldschmidt about his three-month stay at the Met Lab in 1942.... He recalled that we gave him a black briefcase and a small replica of a pig feeding trough (because he worked in the lab like a pig) at his farewell party. He spoke of various details of our work and life at the Lab, such as my chemistry group's Tuesday evening meetings and my disgruntlement with one associate who never worked at night.... (Later on this same trip, in Vienna, Goldschmidt reminded me of a particular incident of Met Lab days, amusing in retrospect: the container of an important sample had broken and the sample

had fallen onto, and been completely absorbed by, a thick Sunday edition of the Chicago *Tribune*. Days were spent in recovering the 'newspaper extract' by dissolving the paper in perchloric acid.)

"After lunch we discussed the French decision to install light-water reactors and the USAEC-CEA fast reactor exchange. They said that in spite of the technical success of the French gas-graphite reactors, economic considerations had led them to abandon the gas-cooled concept. Therefore no more of that type would be built beyond those now under construction (St. Laurent - 2 and Bugey - 1). They said that France would now go to light-water reactors for their domestic power program, although they were not ready to say whether they would build PWR's or BWR's.

"In our discussion of US-French collaboration on fast reactors, we explored possibilities of making the exchange more useful to us. Friedman noted that lease of enriched fuel for the Rapsodie program was made on the understanding that this was a research project, the results of which were to be made available to us. If they held back information on the basis that it was commercial then we couldn't continue to lease and they would have to purchase the fuel. They said they might do that.

"The French expressed interest in an arrangement similar to the US-UK fast reactor exchange as well as having an opportunity to sell technology to US private industry under arrangements similar to that worked out between the United Kingdom and Atomics International. As regards the latter, we told them that this was something they were free to negotiate on their own with private industry in the United States."

After our discussions at the CEA headquarters, we visited the Institute of Nuclear Physics of the University of Paris at Orsay, where the French were doing important pioneering work with their heavy ion accelerator in the search for superheavy elements, as well as research on the physics and chemistry of the transuranium elements. Collaborating with them in the research under way were scientists from other nations, several of whom had studied in the United States.

Marc Lefort, Director of the Heavy Ion Laboratory of the Institute, met us after our meeting and escorted us to Orsay:

"We were met by Professor Georges Bouissières, the Director of the Radiochemistry Division, and Professor Michel Riou, Director of the Nuclear Physics Division. We were first taken to a meeting room where Lefort explained the design of the linac-cyclotron combination.

"Lefort mentioned that Yuriy Tsolakovich Oganessian from Dubna is in residence for a year at Orsay and had brought a supply of ^{86}Kr from the USSR for use in the cyclotron.

"For making superheavy elements, the krypton beam enters one of two reaction chambers. An electrostatic deflector in the chamber is to be used to separate superheavy ions from the krypton, thus the full beam will not enter a magnetic time-of-flight mass spectrometer which analyzes the mass and energy of the superheavy ions formed. The existing ion source limits the krypton beam to about 10^8 particles per second, which is not sufficient to give a reasonable yield of superheavy elements. Oganessian will redesign the ion source to increase the final beam intensity by a factor of three to four. Another improvement being made is construction of a new platform for the ion sources, the present one being somewhat unsatisfactory in its high voltage insulating properties.

"We were then taken on a tour of the cyclotron laboratory, where we first saw the existing ion source and the changes being made to the platform. Dr. C. Bieth, the man in charge of the machine, escorted us through the building.

"We also saw the work being done by Dr. N'Guyen Long Den.

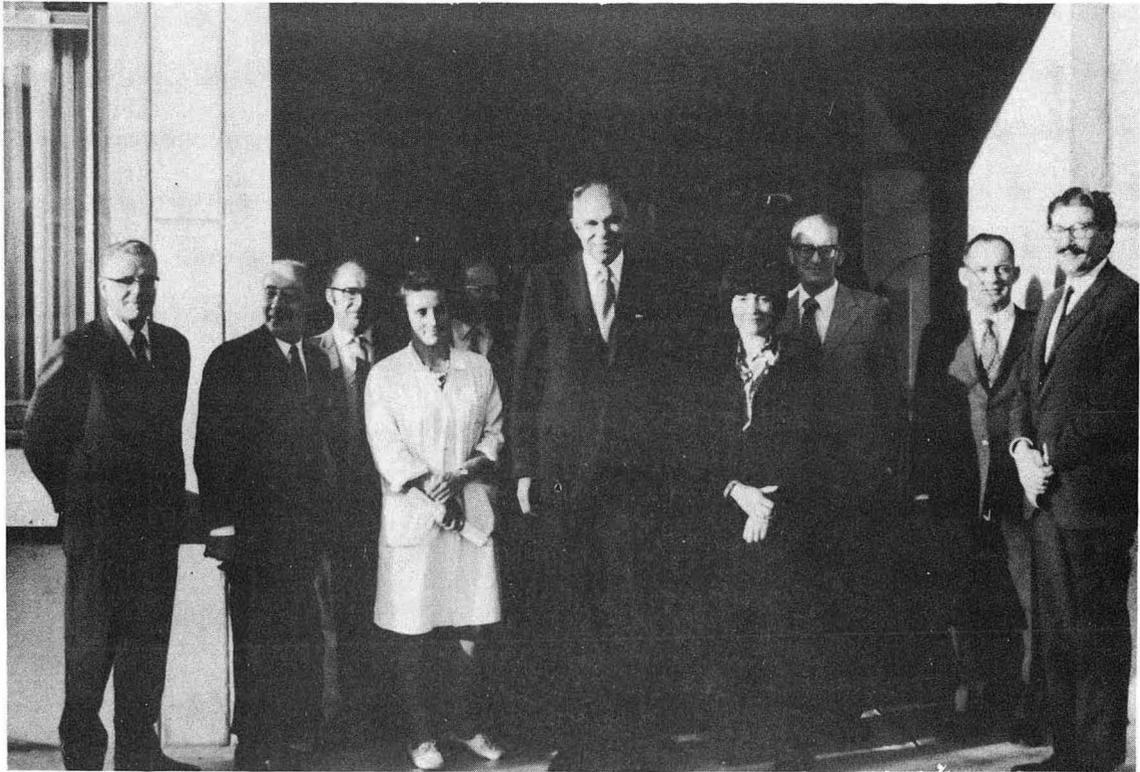
"Next we returned to the conference room where Dr. François David briefed us on his research on the measurement of oxidation-reduction potentials of the 4f and 5f elements, using dropping mercury polarography.

"We were then briefed by Dr. Monique Pages, who had worked with Burris Cunningham at Berkeley. She is doing work on the chemistry of actinide compounds.

"Following the briefings we were served champagne and cookies, at which time we were joined by Tony Turkevich, who is on sabbatical at Orsay from the University of Chicago. During this visit we also met Roger Mayer (Administrator, IPN) and H el ene Langevin.

"Recalling that Al Ghiorso of Lawrence Radiation Laboratory wants Oganessian to come to Berkeley for a year, I tried to reach Oganessian by telephone. He had left the lab for the day so I asked the lab people to try to reach him with a message that I wanted to talk to him.

"After the visit at Orsay, we rode back to Paris. Here I met Helen in our hotel. She had had lunch at the Goldschmidts, where my long-time colleague Iz Perlman and his wife Lee were also present. Bert Goldschmidt joined them after leaving the Hirsch-Giraud luncheon early.



XBC 758-6340

*Visit to Orsay, Institute of Nuclear Physics (IPN), September 17, 1970.
(Left to right) Georges Bouissières, Michel Riou, Marc Lefort, Hélène Langevin, Roger Mayer, Seaborg, Monique Pages, Anthony Turkevich, Joseph Lafleur, Abraham Friedman.*

"After lunch Helen and Robbie Bloom visited the Louvre with Joan Lafleur and Ada Rousso, and later went up the Eiffel Tower."

That evening there was an opportunity for discussion with François-Xavier Ortoli, Minister for Industrial and Scientific Development, as well as further conversations with CEA people and others concerned with nuclear developments, at a dinner which the American Chargé, Minister-Counselor Perry H. Culley, and I co-hosted at the Ambassador's residence:

"Helen and I rode to the US Ambassador's residence with the Lafleurs, with Friedman and the Blooms following in another car. Present at the dinner, in addition to the Culleys and the Ortolis, were Pierre Aigrain (Delegate General for Scientific Research and Technology) and Madame Aigrain, the Goldschmidts, Jean Couture (Secretary General for Energy), Pierre Huet (President ATEN, Association Technique pour l'Energie Nucléaire) and Madame Huet, Madame Bernard Lacoste (Office of Directorate for External Relations and Programs, Commissariat à l'Energie Atomique), Mrs. Harry Parker (wife of the Assistant Manager, Technical Operations, USAEC Richland Operations Office), Mrs. George Lohse (wife of the Director of Waste Management, Idaho Nuclear Corporation); from the Embassy, Mr. and Mrs. Edgar L. Piret (Counselor for Scientific Affairs), Mr. and Mrs. Joseph D. Lafleur, and Mr. Samuel Rousso (Assistant Scientific Representative, USAEC, Paris). Before dinner I called Iz Perlman at his hotel and said good-bye to him - he and Lee are driving south to Marseille tomorrow en route to Israel. After dinner, Culley and I extended a word of welcome to our guests. I recalled Goldschmidt's stay at the Met Lab in 1942, including his witnessing of the historic events of August 20 (first view of a compound of plutonium) and September 10 (first weighing of a compound of plutonium), Helen's and my visit to Paris in 1951, my visit to Orsay today, the long and fruitful cooperation of the United States and France in the peaceful uses of nuclear energy through good days and bad. I ended with a toast expressing the hope for such continued cooperation. Ortoli responded with some friendly remarks.

"After the dinner we rode back to our hotel. Helen and I took about an hour's walk down the Champs Elysées and other areas. When we returned to our hotel, we learned that Oganessian had dropped by during our walk. He called me in our room about 15 minutes later.

"I extended Ghiorso's invitation to come to Berkeley. Oganessian said he would like to but he has a year's contract to work at Orsay which he just started 10 days ago - he would like to come to Berkeley starting in September 1971. (This

turned out to be impossible.) He expressed doubt that they would be able to do very much with the Orsay heavy ion cyclotron due to the lack of beam intensity. He told me about a number of experiments attempted and planned for the transuranium elements at the Dubna cyclotron.... (We had a lengthy discussion of this and related matters, dwelling particularly on apparent inconsistencies between certain experiments Ghiorso has conducted and work underway at Dubna.)

"Oganessian said that in the case of element 106 they were using volatile silicon compounds in the ion source such as the chloride or fluoride. Apparently these experiments are to be carried out soon by the Flerov group in Oganessian's absence. I suggested that he send all of the information that he had given me to Ghiorso and he said he would do so immediately. He said he would write Ghiorso a letter tomorrow morning.... He expressed great admiration for Ghiorso and said he would be honored to work in his exciting and imaginative laboratory. He told me that Flerov expects to shut down to start the cyclotron modifications in February 1971 and they expect that this will take one to one and a half years."

The next day, on September 18, we flew to Grenoble, in southern France, to visit the two major scientific centers there: the Max von Laue-Paul Langevin Institute and the Centre d'Etudes Nucleaires de Grenoble (CENG). Both of these places conduct important research in the nuclear sciences. The principal facility at the former is a high-flux reactor, similar in design to the High Flux Beam Reactor (HFBR) at the USAEC's Brookhaven National Laboratory. When I was there in the fall of 1970, this was still under construction; after completion in 1971, it was the highest flux reactor outside of the United States. This Institute is another example of the effectiveness of international cooperation in science. It is jointly funded by France and Germany; and at the time of my visit, scientists were there also from other countries, including Professor Lenard Pal, the director of Hungary's nuclear energy program (whose laboratory I had visited a year earlier). My visits to these centers increased my understanding of their programs and potentials, and strengthened my contacts with the scientists there:

"Friday, September 18, 1970 - Grenoble

"Our group, including Lafleur... landed at Grenoble at about 10:30 a.m. We were met by Gerard Mitault of the External Relations Department of CENG. On the way to the outskirts of Grenoble, we drove through a valley with the Vercors Mountains on our right (south) and the Chartreuse Mountains on our left. The Chartreuse Mountains in particular are striking, with bare rock cliffs rising almost vertically.

"We were taken directly to the Laue-Langevin Institute, where we were met by Professor Heinz Maier-Leibnitz, the Director of the Institute, and his deputy, B. Jacrot. They first took us on a tour of the High Flux Reactor being built

for the Institute. The reactor is similar in nature to the HFBR at Brookhaven, and is about 50% completed. It is housed in a huge containment shell 60 meters in diameter and 40 meters high. Most of the reactor is above ground, and one unusual feature that we saw was an elevated, concrete shielded canal for transferring spent fuel elements.

"We then went to another building where we were briefed by Maier-Leibnitz, Jacrot, Jacquemin (Chief of Services and Operation Team), and Droulers (Chief of Operation), who described the reactor and the administrative set-up.

"Double containment shells house the reactor, with an overpressure being maintained between the shells. If the core should rupture, the containment can be maintained gas-tight for about one day.

"The core is similar in design to the HFBR core, except that there is no flux trap.... Total cost of the reactor proper will be 240 million francs; an additional 48 million francs will be spent on equipment and 40 million on the support activities of the Institute during construction. The French and German governments are dividing the costs equally, and there will be equal numbers of staff from each country.

"The principal difference between the reactor and the HFBR is that it will have a hot source of neutrons (0.5 Å) and a cold source (liquid helium) and neutron guides permitting experiments on the cold source and some others to be made under very good conditions.... NUKEM and SERCA are each fabricating half of the cores, which will last about 42 days in the reactor. The cores will probably be reprocessed at Eurochemic.

"Principal concern in maintaining the integrity of the heavy water has been given to leaks from the heavy water tank into the building. No one seems to be too worried about leakage into the light water.

"The project was originally conceived under OECD auspices, but was finally developed as a Franco-German undertaking, receiving approval from both governments in 1966. The Institute, a civil 'Society,' is owned as follows: CEA - 25%, CNRS (Grenoble) - 25%, GFK (Karlsruhe) - 50%. The agreement stipulates that other countries can 'buy into' the Institute, but this would be a laborious process.*

* In the fall of 1972, negotiations between the United Kingdom's Science Research Council (SRC) and the French and German representatives reportedly led to an agreement by which the UK would buy a one-third stake in the Institute at a cost of \$24 million, spread over the next ten years, and would make an annual contribution of about \$4.8 million to the Institute's operating expenses.

Outside scientific cooperation is encouraged. There will be no selling of irradiation space.

"Annual operating costs are estimated as follows:

	<u>Personnel</u>	<u>Materials</u>	<u>Total</u>
Reactor	3.3	16.7	20 M.Fr.
Technical services	2.4	2.6	5
Administration	1.5	2.5	4
Scientific			<u>29</u>
			58 M.Fr.

"From 70 to 80 people are required to run the reactor. An estimated 100 to 200 scientists will be in residence, of which about 70% will be from outside the Institute.

"Maier-Leibnitz is director of the Institute (he will remain there only until the reactor is completed) but he does not direct the construction. A Scientific Council will decide which experiments are to be conducted, and a Steering Committee made up of representatives of the two countries decides all policy issues. The Institute is separate and distinct from the Grenoble Centre, with which it has formal contractual relationships.

"Upon conclusion of the briefing, we were driven to the CEA Guest House (which some refer to as 'the Castle') located in the hills above Grenoble, where a luncheon for our party was given by Professor Louis Néel (Director of CENG) and Maier-Leibnitz. Others present were Jacrot, François Rossillon (Reactors), Blin (Metallurgy), Cordelle (Electronics), Mitault, and Donvez (External Relations)."

(When the 1970 Nobel Awards were announced that winter, Professor Néel was given the Physics prize.)

"Following lunch, we were driven back to the city of Grenoble to the CENG, where I gave a talk, 'Recent Developments in Transuranium Research.' We were then taken on a tour of some of the facilities by the CENG personnel who had been at lunch. We saw the 30 MW Siloé reactor in operation. It is of the swimming pool type, very modern and very crowded with experiments. It looked like an excellent facility. The power rating had been increased by a factor of three by use of a novel convection flow arrangement for the cooling water. Thus the pool is remarkably small in size for a reactor of this power.

"We were next shown a variety of equipment by R. Allemant that has been designed for materials testing in reactors and which is offered for sale by CEA.... Here

we met E. Roudaut, J. Jacobe, and P. Convert.

"We then left the Siloé reactor building and visited another laboratory building where photographic processes were being developed for making microelectronic circuits. Following this, we were given a short briefing by Cordell on the mechanisms used by CENG to perform work, both nuclear and non-nuclear, for French private industry.

"Since two hours remained before our dinner engagement, I asked Mitault that we be driven to some place in the mountains where we could go for a hike. The word 'hike' was unfamiliar to him and it took some negotiation in French and English before we were able to explain what we wanted. Then we were driven to the hills near the Guest House, and we set off over a trail that circled around and ultimately came back to where we had left the car.

"On return to the Guest House, I met Helen, who had spent the day as follows: She and Robbie were escorted by Mrs. Lambert, a secretary of the Deputy Administrator of Grenoble Centre, to the Musée Dauphinois, which was housed in an old monastery and fortress. This is a museum of archeology and ethnology of the Grenoble region. It is newly opened and contains some interesting fossils and minerals. They then drove out in the mountains to a restaurant, Colombié, where they had a good lunch of frogs' legs and chicken Colombié. From there they were driven on up the mountain to the Monastère de la Grande-Chartreuse. There is a museum showing the way of life of the monks of that monastery – the Order of San Bruno – who take the oaths of both silence and solitude.... The mountains there are very high with rocky surfaces rising sheer from meadows.

"Helen, the Blooms, and I were driven to the nearby home of Maier-Leibnitz. Dinner was prepared by Professor Maier-Leibnitz, who has a hobby of cooking. The meal included soup with dumplings and Guinea hen, both very good. We had an evening of interesting and amusing conversation; Mrs. Maier-Leibnitz is very lively, as is he...."

The next day, *en route* to Geneva, we concluded our 1970 stay in France with a stop at Chamonix for a cable ride part way up Le Brevent, across the valley from Mont Blanc.

Upon my return to Washington, I reported to the President (in a letter dated October 13, 1970) as follows regarding my visit to France:

"Following my arrival in Paris, I met, on September 17th, with the outgoing Administrator General of the French Atomic Energy Commission, Robert Hirsch; the new Administrator General, André Giraud (whose appointment was to be announced

the following week); Dr. Bertrand Goldschmidt, the French Atomic Energy Commission Director for International Activities and Plans, and their representative on the UN and IAEA Science Advisory Committees; and other principal officers of the French Atomic Energy Commission. They discussed with me their decision to develop American type water reactors, their program of research in fast reactor technology, and the status of technical cooperation between our two countries in nuclear science and technology. Our cooperation with French scientists in atomic energy began in 1942 when Dr. Goldschmidt worked in my group in Chicago on the separation and chemistry of the then newly synthesized element plutonium. In 1956, we signed an Agreement for Cooperation with France. This cooperation with France has continued even through periods of political stress between our countries, and is today as useful and effective as ever.

"I then visited the research laboratories at Orsay, outside of Paris, where important pioneering work is being done with their heavy ion accelerator on the search for super-heavy elements as well as research on the physics and chemistry of the transuranium elements. I was interested to find there scientists from the United States, France, and the USSR - all collaborating on these important researches - most of whom had studied in the United States. The laboratory at Orsay is one of the few in the world developing accelerators capable of application in the search for new superheavy elements - the others are in Germany, in the Soviet Union's international laboratory at Dubna, and in the USAEC's Lawrence Radiation Laboratory at Berkeley where essentially all of the transuranium elements have been discovered. Following my visit to Orsay, I met with the principal officers of our Embassy in Paris and with the French Minister of Science, François X. Ortoli, as well as with other French Government and industry leaders in science and technology.

"On September 18, I visited the two major scientific centers in Grenoble in the southeastern part of France - the Institut Max von Lauë-Paul Langevin and the Grenoble Nuclear Research Center. Both of these facilities are carrying out important research in the nuclear sciences. The principal facility at the Institut Max von Lauë-Paul Langevin is a high-flux reactor, similar in design to our own Brookhaven High Flux Beam Reactor, and, when completed next year, will be the highest flux reactor outside of the United States. Here again is an example of the effectiveness of international cooperation in science. The Institute is jointly funded and operated by France and Germany. Its Director is the world famous German physicist, Professor Maier-Leibnitz, and the Deputy Director is the French physicist, Professor Jacrot. The international character of this laboratory at the time I visited was evident from the number of scientists visiting from other countries,

including Professor Lenard Pal, the Director of the Hungarian nuclear energy program (whose laboratory I had visited last year). Following my visits to the laboratories at Grenoble, I gave a scientific lecture on the superheavy elements to scientists from the Grenoble Nuclear Research Center, the Institut Max van Lauë-Paul Langevin, and the University of Grenoble."

In March 1971, six months after our meeting in Paris, CEA Administrator General André Giraud came to see me in Washington, accompanied by Goldschmidt and Villaros; also present were Commissioners James Ramey, Wilfrid Johnson, and Clarence Larson, several principal USAEC staff members, and Robert Loftness and James D. Phillips of the State Department.

Shortly before Giraud's trip to the United States, there had been two significant developments. First, the French had concluded an agreement with the USSR providing for the latter to supply uranium enrichment services for the core of the projected Fessenheim-1 850 MWe-PWR plant, the first to be constructed under France's new plan for powerstations using light-water reactors. Secondly, in a press conference at Pierrelatte on March 11, Giraud had announced the French decision to go ahead with a feasibility study of a gaseous diffusion uranium enrichment plant to come into operation by 1980, to meet the future enriched uranium needs of Western Europe for nuclear power production. After completion of the study, France intended to proceed with plant construction, preferably in cooperation with other nations, but if necessary alone. We were naturally interested in obtaining Giraud's comments on these and related matters in our meeting on Wednesday, March 17:

"Giraud discussed the French decision to adopt enriched uranium water reactors and emphasized the change in emphasis on applied research and engineering development involving industrial aspects of nuclear energy as opposed to previous emphasis on basic research.

"The CEA Administrator General then led into some remarks concerning the NPT and the French position which he described as philosophically consistent with the NPT even though France is not a signer. I asked whether he thought that an accommodation could be reached between Euratom and IAEA, and Goldschmidt replied that he very definitely thought so. I made reference to the fact that France had been almost a lone dissenter in the recent solution to the problem of financing IAEA safeguards under the NPT, and both Giraud and Goldschmidt said this is because they thought there should be more recognition of the differences between nuclear and non-nuclear nations.

"Giraud then went on to the French decision to build a uranium gaseous diffusion enrichment plant, either alone or, preferably, in collaboration with other European countries and possibly also with the United States. He said that this



XBB 761-7002

Seaborg and CEA Administrator General André Giraud. USAEC Chairman's DC office, March 17, 1971.

would be an industrial enterprise with private financing except that the French portion might include some state financing. He said their estimated cost for separative work would be about \$28.70 per kilogram (compared to the new US charge of \$32.00). He indicated that the main reason for undertaking this expensive enterprise was to assure a source of supply because the United States was not taking proper steps to insure such a supply. He said that a new enriching plant would be required in the United States by 1978, which date might not be met. I said that we wouldn't agree with the 1978 date. We have made a careful study, which takes into account present unused capability in our enrichment plants, some pre-production, increased tails assay, plutonium recycle starting in 1974, Cascade Improvement Program (CIP) starting at a time when it can be justified (we don't want to start CIP too early, which would be wasteful), and have come to the conclusion that we would need a new enriching plant no sooner than 1982. This seemed to impress Giraud, who said that however it would be better for them to start their work now in order to be sure, with the option of delay later on, rather than start too late and fail to meet their objective if the capacity was needed.

"Giraud then went on to talk about their purchase of uranium enriching services from the Soviet Union. He said that the price is below \$28.70 per kilogram of separative work, they have a large choice of values for the tails, the Soviets are not demanding any safeguards and the transaction is direct with France and not through Euratom.

"We then went on to discuss the problem of technical information exchange between the CEA and the USAEC. Abe Friedman expressed our view that the French could be more forthcoming in the exchange of fast reactor technology. Giraud said that although he thinks France is ahead in the fast breeder development now, he realizes that they cannot corner the world market and will need to cooperate with the United States later; therefore, he thinks we should work out some kind of an exchange of information agreement on the fast breeder that allows France to give the United States information now, while recognizing that later the United States will have information that it will pay France to have."

With respect to the renewed CEA-USAEC technical exchanges, over a year and a half passed between the second "annual" CEA-USAEC staff meeting in Paris in the fall of 1969 and the third, which took place in Washington in June 1971. Detailed discussions were held regarding activity in the various fields involved and the conclusion was that in general our exchanges were developing satisfactorily. In connection with fast reactors, however, the CEA and AEC representatives merely reviewed the overall progress to date in their respective programs and their general future plans. The decision was made to defer additional discussions in this field until after

the Fourth Geneva Conference on the Peaceful Uses of Nuclear Energy in September 1971. Nevertheless, it seemed fairly clear that the French were not prepared to engage in an exchange that would be of real use to us. For one thing, they seemed to fear that any FBR technology they supplied to the USAEC might ultimately work to their disadvantage *vis-à-vis* US industry. Furthermore, they had initiated arrangements to make their technology available for use in Japanese and Indian fast breeder projects; and they might well be reluctant to provide the same technology to the United States without charge.

Not quite a year from the day I left France in 1970, I was back there again, after attending the Fourth Geneva Conference. Though schedule pressures allowed me less than 24 hours between arrival in Paris after a brief Luxembourg stay and departure for Bucharest, the stop permitted a return visit to the Institute of Nuclear Physics at Orsay, a memorable dinner hosted by CEA Administrator General Giraud, and a glimpse of some favorite Paris scenes.

Abe Friedman, Stan Schneider, Justin Bloom, Helen, and I arrived in Paris at about 1:50 p.m. We were met at the airport by USAEC Scientific Representative Joe Lafleur:

"Friday, September 17, 1971 - Paris and Orsay

"We were driven to the Institute of Nuclear Physics at Orsay, where we arrived at about 3:30 p.m. We were met by Marc Lefort who took us to meet Dr. Maurice Jean, the Director of the Institute of Nuclear Physics. A number of others then came in to meet with us and tell us about their work. These included Oganessian, who will return to Dubna in a couple of months, Monique Pages, Robert Guillaumont, Roland Muxart, François David, Georges Bouissières, Jean Péter, and Y. LeBeyec.

"They each gave me a number of reprints as they described their work. In the course of our talk I told them about my visit to Spitsyn's Institute and the work there on the plus two states of fermium, einsteinium and californium, and the plus seven states of neptunium and plutonium. I also described the exciting news of the Los Alamos discovery of plutonium-244 in nature, that I had announced just a few days ago in Geneva.

"Lefort described his experiments bombarding thorium with krypton beams ... catching products in a helium jet to look for spontaneous fission and alpha particles.

"A breakdown of the machine in July has set back their whole program.

"Guillaumont has looked for Peppard's tetrad effect in the lanthanides with different liquids and found a similar but not identical effect.

"David described polarographic work on lanthanide elements to test the method of looking for plus two oxidation states. He also showed us his extrapolations of chemical properties to the superheavy element region and gave me a complete set of curves summarizing this work.

"Madame Pages described her work on new neptunium compounds, heptavalent neptunium and plutonium compounds, anti-ferromagnetic neptunium compounds, and lanthanide and actinide elements in liquid ammonia, and gave me reprints covering this and other work.

"Muxart described his work on protactinium (V) oxide and gave me reprints covering his protactinium work including a good survey article.

"I told them about the plans Joe Katz and I have to revise *Chemistry of the Actinide Elements* with the help of Bob Penneman.

"Lefort and Madame Pages and possibly Oganessian are coming to the Argonne Symposium on the Transplutonium Elements next month.

"Jean gave me a Madame Curie medal commemorating the 100th anniversary of her birth in 1967. I gave him an AEC 25th anniversary medal and Lefort an autographed copy of *Man and Atom*.

"I talked to Oganessian about his possible visit to work at the SuperHILAC and he suggested that a time such as July 1972 might fit his schedule. (This again did not turn out to be possible.) He wants to return to Dubna for a while before he goes to Berkeley.

"We said good-bye to the group, and rode back to Paris to the Madeleine Palace Hotel. (We had a rather wild driver.) We changed clothes very quickly for dinner.

"I rode with Friedman and Pierre Villaros, French Atomic Energy Attaché in Washington, to the French CEA building for a press conference. The conference was held in a room equipped for simultaneous translation. I sat on the stage with Jacques Yvon (Francis Perrin's successor as CEA High Commissioner), Bert Goldschmidt and Friedman, who joined us there soon after the press conference started. Yvon introduced me. There were questions on the Fourth Geneva Conference, my visit to the Soviet Union and the workmanship on their reactors, uranium enrichment and comparison of the gaseous diffusion and gas centrifuge methods, US policy and pricing on uranium enrichment, and the discovery of plutonium-244 in nature. I clarified my views on predicted schedules for proof of scientific feasibility and attainment of practical fusion reactors.

"Following the press conference we rode to La Tour d'Argent restaurant where we joined Helen, Robbie Bloom and Renée Schneider. Robbie had come to Paris following her visit to Italy and Renée had come by train from Geneva on Thursday. Our hosts were André and Claudine Giraud. The other guests were the Goldschmidts, the Renous, Mr. and Mrs. Anatole Abragam, Mr. and Mrs. Claude Frejacques, Pierre Villaros, the Lafleurs, Mr. and Mrs. Edgar Piret, and Abe Friedman.

"The dinner took place in a special room with a marvelous view of Notre Dame, the Seine, and the apartment house across the river where President Pompidou lives. The view of Notre Dame, upon which light shone to produce a beautiful effect, was spectacular. The food was very good. After dinner Giraud rose and made some very nice welcoming remarks and I responded with recollections of my 1961 visit to Paris (which makes the present 1971 visit particularly appropriate at the end of my ten years as Chairman), comments on the close relationship between the USAEC and the French CEA during the ten years even at times when the governmental relationship was not the best, and – after I had described Helen's move to California last month during which she transported our snakes with her on the airplane – an invitation to Mr. and Mrs. Giraud to visit us in our Lafayette, California, home.

"I presented Giraud with an inscribed pen set mounted on a piece of wood plastic produced by irradiation.

"In the course of the evening Giraud told me, and also Helen, that I had been selected to receive the French Legion d'Honneur which will probably be presented to me in a ceremony at the French Embassy in Washington next February or March. I presented autographed copies of *Man and Atom* to the Girauds and the Goldschmidts.

"Helen and I rode back to the Madeleine Palace Hotel with Mr. and Mrs. Edgar Piret."

Later on that trip, at the 15th IAEA General Conference in Vienna, I saw Bertrand Goldschmidt several times. On one occasion (under the direction of the IAEA's TV Director Hannant) he and I participated with Sigvard Eklund in taping a TV program in recognition of the end of my relations with the Agency as USAEC Chairman. During our conversation, Bertrand spoke again of the early days in 1942 and our collaboration then. It seemed particularly fitting, at the conclusion of my existing IAEA connection, thus to recall one of my earliest international associations in the field of atomic energy.

On October 8, 1971, after I had returned to Washington, I wrote a letter to the President, reporting on my visit to France:

"On September 17, I flew on to Paris and drove to the Institute of Nuclear Physics at Orsay, where a young and highly competent research team is carrying out interesting and important work on the chemistry and physics of the trans-uranium elements. I was interested in learning of the progress in that laboratory's search for superheavy elements since my last visit there precisely one year ago. Although they had not made the progress they had expected, they had nevertheless done creditable research in this field. I told them about the important discovery, made by a group of scientists from the AEC's Los Alamos Scientific Laboratory and the Knolls Atomic Power Laboratory in Schenectady, of the existence in nature of plutonium-244. I had first announced this discovery at the Geneva Conference a few days earlier and it was probably one of the most important scientific announcements at the Conference. It required painstaking research and the most highly sophisticated analytical instruments available to demonstrate the existence of this heavy element in nature. Prior to this work, it was believed that uranium was the heaviest natural element. Furthermore, the calculations based on the existence of this isotope of plutonium in nature confirm the date of the creation of the elements on earth as being no more than about 5 billion years ago.

"In Paris, I held a press conference organized by Professor Jacques Yvon, High Commissioner of the French Atomic Energy Commission, following which I met with the Administrator General for the French Atomic Energy Commission, André Giraud, and several other senior officials and scientists in the French atomic energy program."

The nuclear relationship between the United States and France during the 1960's has been one of evolution, attended by some uncertainty and friction but also by beneficial cooperation and, always, profound mutual respect. The French will unquestionably continue to be among the leaders at each advance of nuclear science, as they have been heretofore. In one recognition of their past accomplishments, I was proud to speak for the United States at a 1968 ceremony honoring four scientists whose contributions played a significant role in early research on nuclear fission: Frédéric Joliot and Hans Halban, both deceased, Lew Kowarski, and Francis Perrin. Kowarski and Perrin were present at the ceremony held on June 11, 1968, in the Jefferson Room of the State Department; members of the Joliot and Halban families (Hélène Langevin, Joliot's daughter, and Peter Halban, Halban's son) attended to accept the posthumous awards. Also present were USAEC Commissioners James Ramey and Gerald Tape, as well as Ambassador Lucet. I presented citations, a plaque, and a financial award in recognition of experimental research performed by Drs. Joliot, Halban, and Kowarski in 1939 and 1940,



XBB 732-1254

Presentation of AEC Award to French scientists, US State Department, June 11, 1968. (Left to right) Commissioner James Ramey, Lew Kowarski, Seaborg, Francis Perrin, Peter Halban, H el ene Langevin, Ambassador Lucet, Commissioner Gerald Tape.

as well as theoretical considerations put forward by Dr. Perrin. The joint citation I read declared:

"....Their discoveries concerning neutron emission in the fission process, and their determination of the critical cross-sections of nuclear fuels and moderators served to help establish the possibility of a self-sustaining chain reaction. Their dedication to their task in the face of wartime adversity resulted in the successful conduct of an important experiment at Cambridge, England, in 1940, which provided experimental evidence that a homogeneous heavy water uranium oxide mixture would support a chain reaction."

The pace of nuclear science development since the establishment of *the possibility* of a chain reaction may give us some idea of the tremendous strides to be expected by the turn of the century. I am hopeful that US-French cooperation can play an important part in those future advances.

CHAPTER 4

GERMANY

After France, the Federal Republic of Germany has the largest civil nuclear program in continental Europe and one of the largest in the world. International cooperation has been a primary factor in its achievement of this status.

With the exception of nuclear explosives development, which the nation has committed itself not to undertake, every significant area of nuclear research and application is represented at an advanced level in Germany's laboratories and in its nuclear industry. Germany has been among the leaders in turning to nuclear power generation, both in utilization of proven reactor types and in the development of advanced and breeder reactors. Several nuclear power stations (one of which, at Gundremmingen on the Danube, was constructed under the US-Euratom Joint Reactor Program) are operating successfully, many more are under construction or planned, and the German nuclear power industry has already achieved a strong position on the international market. Keenly aware of the benefits of international collaboration, Germany has cooperated with other countries both within Euratom and in other multilateral nuclear organizations and on a bilateral basis, especially with the United States.

The United States and Germany have collaborated in civil nuclear applications since soon after the start of our Atoms-for-Peace program. Formal Agreements for Cooperation with the Federal Republic of Germany, signed in 1956 with respect to the Republic itself and in 1957 with respect to West Berlin, were allowed to expire in 1967 in accordance with our "fold-in" policy and our decision to provide special nuclear materials for Euratom members in future through the Euratom Supply Agency; but our cooperative activities continued uninterrupted. In addition to material supplies and provision of a \$350,000 grant toward the cost of a research reactor in Munich, these activities have embraced collaboration and information exchanges in important programs such as the study of pebble-bed gas-cooled reactors (the German AVR project at Jülich); fast breeder research project including the Southwest Experimental Fast Oxide Reactor (SEFOR) project in Arkansas, in which the FRG has participated on its own behalf and on behalf of Euratom; and maritime reactor studies, involving the exchange of information pertinent to the US nuclear merchant ship *Savannah* and Germany's *Otto Hahn* project.

On the whole, US-German cooperation in the nuclear field has proceeded smoothly and to the satisfaction of both sides. The mutual value and steady progress of our joint activities was facilitated during the sixties by the meetings my colleagues and I had with German scientists and officials, both in Germany and in the United States; for these meetings, together with visits to laboratories and other installations, provided opportunities to resolve questions and settle details before problems could escalate into serious difficulties.

My first contact with a German official was on March 11, 1961, at a stag dinner given in honor of West Berlin Mayor Willy Brandt by Ambassador Grewe at the German Embassy. During a pleasant evening of conversation I had the opportunity to have a long talk with Mayor Brandt and was impressed by his progressive and enlightened views concerning the need for international cooperation and the cooperative role that he would like to see Germany play.

Although I had no chance to tour German facilities until over two years after assuming my USAEC responsibilities, there were opportunities for discussing mutual nuclear energy interests during visits by German officials to the United States. One such occasion of particular significance to our cooperation was a visit to the United States in April 1962 by the Federal Minister for Atomic Energy, Dr. Siegfried Balke. On learning of Minister Balke's forthcoming trip, I wrote inviting him to meet with us at USAEC Headquarters on April 18. During conversations at that time, preliminary plans were laid for US-German cooperation in the field of fast breeder reactors.

In order to complete these plans, a German working group, including representatives of the Ministry and scientists from the Karlsruhe Reactor Center, came to Washington in late October 1962 to work out details with their US counterparts. A representative of Euratom also attended these meetings, as the projected cooperation was envisioned as part of the program in this field being developed by the United States and Euratom. Precise areas of collaboration were decided on, with agreement on such matters as exchange of personnel between our Argonne National Laboratory and the Karlsruhe Center. The way was thus paved for our long-term cooperation in several specific fast breeder research areas, as well as German participation (including a substantial financial contribution) in the SEFOR project.

Minister Balke himself returned to Washington as these talks were completed. We saw each other and had some discussion the evening of his arrival on Friday, November 2, at a stag dinner in his honor at the German Embassy. The following morning, at USAEC Headquarters, final agreement was reached on US-German collaboration in the important fast breeder area.

In December 1962, Dr. Balke was succeeded by Dr. Hans Lenz, whose appointment as Minister for Scientific Research (rather than of "Atomic Energy" alone) seemed to reflect growing recognition of the importance to national policy of science in general. (Balke continued his connection with the German atomic energy program and I saw him in a number of subsequent occasions, including the visit to the US Nuclear Ship *Savannah* in Sweden.) Minister Lenz visited the United States late in the spring of 1963 and came to see me in my office on June 1, accompanied by Dr. Joachim Pretsch (Head, Subdivision of Nuclear Engineering) and Dr. Hans Sauer, of the Atomic Energy Section of the Ministry, and others. While schedule pressures



XBB 769-8553

Hans Balke with Seaborg at Cointrin Airport in Geneva just before take-off for Sweden to visit the NS Savannah, Sept. 3, 1964.

made it impossible to have as long a time together as we both desired, our meeting was useful to both sides. On return to Germany, the Minister wrote expressing his appreciation for the opportunity afforded by this meeting for personal acquaintance and direct exchanges of view, and stating the hope that it would be possible "to continue and intensify our conversation in a not too distant future."

This hope was in fact fulfilled just a few months later, in the fall of 1963. I have already mentioned, in discussing our collaboration with Euratom, my visit then to the Federal Republic's large government-supported laboratory at Karlsruhe.* I was favorably impressed with what I saw of the work under way at the well-designed facilities there -- for example, the 12 MW research reactor and the 50 Mev cyclotron. After our Karlsruhe visit, my group and I went to Bonn for brief talks there:

"Saturday, September 28, 1963 -- Strasbourg to Bonn

"We were driven to Strasbourg, where we took a MATS Convair to Bonn -- landing at the Cologne Airport. We were driven to the US Embassy in Bonn, where we met with Ambassador George McGhee. Then we went to the Ministry for Scientific Research, where we met with Minister Lenz, Professors Heinz Maier-Leibnitz, Fritz Strassmann, Dr. Pretsch, Dr. Wolfgang Finke, and others to discuss German and US nuclear power programs. We attended a luncheon at Redoute given by Minister Lenz. I responded to a toast given by Lenz. Our group visited the birthplace of Beethoven on Bonngasse, in Bonn."**

In 1964, after the Third "Peaceful Uses" Conference in Geneva and meetings with Euratom officials in Brussels, I had time for a brief visit to Berlin before going on to the IAEA General Conference in Vienna:

"Saturday, September 12, 1964 -- Berlin

"Helen, Dan Wilkes, Arnie Fritsch (my Special Assistant) and I toured West Berlin. Saw the Berlin Wall at several points, the Brandenburg Gate, the Kaiser-Wilhelm Institute (Otto Hahn's laboratory) in Dahlem, Wannsee, the Reichstag Building, and many other points of interest. Saw the Nefertiti at the Museum, which is at Berlin Free University."

*See Chapter 2, p. 18. .

**My report to the President upon my return to Washington may be found in Chapter 2, pp. 18-20.



CBB 769-8553

Seaborgs at Brandenburg Gate, Berlin, Sept. 12, 1964.

Another trip to Germany and the important Jülich Research Center came in the spring of 1966, between my stop in Paris and meetings with Euratom officials in Belgium:

"Thursday, March 10, 1966 – Paris to Wiesbaden and Bonn

"Arnie Fritsch, Larry O'Donnell (Assistant for Military Arrangements, USAEC Division of International Affairs) and I flew to Bonn where I gave my talk, 'Atoms for Peace – A Milestone in International Cooperation,' to a large group of German scientists, industrialists, members of Bundestag, etc., at the 'Parliamentary Evening' of the German Atom Forum at the Hotel Königshof. I was introduced by Atom Forum President Karl Winnacker. Dr. Strassmann was present, also Minister of Science Gerhard Stoltenberg (who replaced Lenz), who spoke a sort of tribute after my speech. Then Fritsch and I sat with Stoltenberg, Winnacker, Alfred Boettcher (Technical Director, Jülich Research Center), Wilhelm A. Menne, and others, at the buffet supper. I found Stoltenberg quite pleasant to talk to. Boettcher doubts the value of the Heavy Water Organic Cooled Reactor (HWOCR)."

The German Atom Forum's invitation to speak at its "Parliamentary Evening" had been most welcome and had, in fact, been a principal reason for scheduling my trip to Europe at this time. The occasion offered an excellent opportunity for stressing certain US policies to a wide-spectrum and influential group. I began my talk by paying tribute to German achievements in the nuclear field, with special mention of the 1939 discovery of nuclear fission by Otto Hahn and Fritz Strassmann; I spoke of the moving experience of my 1964 visit to Hahn's famous laboratory in Berlin. Then, during an overall review of the US "Atoms-for-Peace" program and particularly our cooperation with Germany, I explained our current policy regarding fuel supplies for power reactors. I stressed the advantages of toll enrichment and the long-term availability of US enriched uranium for foreign customers at non-discriminatory prices. Turning to other aspects of international nuclear cooperation research activities, I moved finally to the part I most wished to underline – our support of safeguards administration by the IAEA. With the aim of fostering wider acceptance of this policy, I clarified the reasons for our position, saying in part:

We have always believed that international control in the sensitive area of nuclear cooperation is preferable to bilateral control. The controls must do more than convince a nation which supplies assistance to another that the materials supplied will be used only in accordance with the agreement. Indeed, that is the least of their objectives, since the degree of trust implicit in the transaction in the first place leaves little need for further proof to the supplier that the nuclear materials he has supplied for peaceful purposes are not diverted to military purposes. What is required is a

control system which the world at large accepts as evidence that arrangements for cooperation in peaceful uses of nuclear energy are not contributing to the spread of military uses.

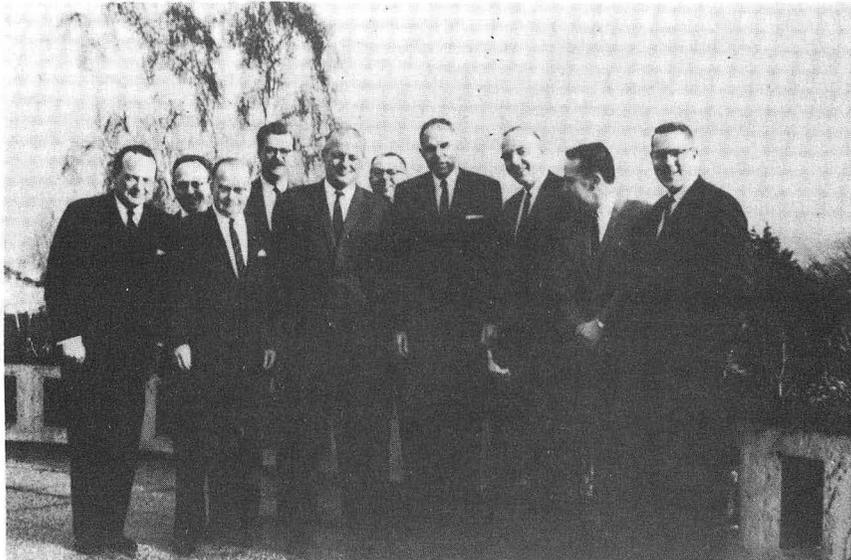
The final goal must be a single comprehensive and effective international safeguards system receiving the support of the whole world through acceptance of its application — including not only the United States and the Soviet Union but also a United Europe. Such a goal does not mean that we have lost trust in the Euratom safeguards system — which I believe to be a good one and which the United States Government considers effective. It means simply that eventually we all must face the reality that the broadest internationally administered effective safeguards system is the best way to ensure that the peaceful atom remains peaceful.

Aside from enabling me to explain policies to a key audience, the "Parliamentary Evening" permitted me to meet many Bundestag members and assess their views. I found them clearly aware of the importance of progress in atomic energy and science in general. The German Government seemed definitely committed to an increase in expenditures in these areas.

I spent the night at Ambassador McGhee's residence and had useful conversations there the next morning before setting out for Jülich:

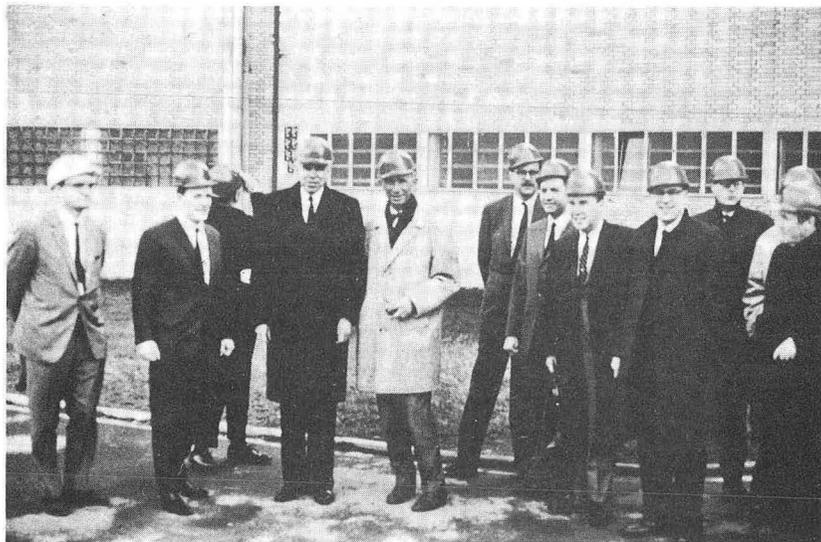
"Friday, March 11, 1966 — Bonn, Jülich

"I had breakfast at Ambassador McGhee's residence with McGhee, Gerhard Stoltenberg, Joachim Pretsch, Martin J. Hillenbrand (Deputy Chief of Mission, US Embassy, Bonn), Peter Rutter (First Secretary, US Embassy), Arnie Fritsch, Larry O'Donnell, Theodore Iltis (USAEC Scientific Representative, Brussels), and William W. Williams (US Embassy, Scientific Officer). I explained our decision on barter to Stoltenberg (approved two and disapproved two German requests for barter). We discussed the fast breeder program. Pretsch asked if we would like to see the gas centrifuge program at Jülich Research Center, and when Fritsch and I said we would, he obtained the approval of Stoltenberg. We drove to Jülich Research Center — Pretsch and Fritsch in my car — arriving about 10:30 a.m. We had a bus tour of the Center under the direction of Dr. Alfred Boettcher, after a meeting with Boettcher, Dr. Alexander Hocker (Administrative Director), Dr. Josef Fassbender, Professor Dr. Wilfrid Herr, Dr. -Ing. Hans Grosse, Dr. Tasso Springer, Dr. Ernst A. Niekisch, Professor Dr. Rudolf Schulten, Professor Dr. Wilhelm Fucks, Dr. Francois Waelbroek, Dipl.-Ing. F. Schweiger, Dipl.-Ing. J. Kolditz, Werner Hugg, Hans Ihle, Pretsch, Fritsch, Martin B. Biles (USAEC Scientific Representative, Paris), Williams and Iltis. Boettcher asked my views on the Molten Salt Reactor



CBB 769-8556

US Embassy residence, Bonn, Germany, March 11, 1966 (left to right) US Ambassador to Germany George McGhee, Martin J. Hillenbrand, Joachim Pretsch, William W. Williams, German Minister of Science Gerhard Stoltenberg, Peter Rutter, Seaborg, Arnold R. Fritsch, Larry O'Donnell, Theodore Iltis.



XBB 769-8558

Tour of Jülich Research Center, March 11, 1966. (Left to right) F. Schweiger, C.-B. Von der Decken (leader, Experimental Group, Brown Boveri/Krupp Reaktorbau G.m.b.h., Jülich), Seaborg, Alfred Boettcher, W. W. Williams, H. Ihle, L. O'Donnell, T. Iltis, J. Kolditz, and Werner Haugg (Northrhine-Westfalia government representative responsible for the Kernforschungsanlage Jülich).

(favorable, but no decisions yet) and why we favor HWOCR (good for scale-up to large dual purpose plants). We visited the Pebble Bed Reactor project, AVR [concerning which the USAEC had entered into a technical exchange arrangement in August 1965.] Fritsch and I toured the gas centrifuge lab with Pretsch and the assistant director. It is separate from Jülich Research Center and under the Federal Government."

Just two months after my trip to Germany I had another meeting with Federal Minister for Scientific Research Stoltenberg, who came to see us in Washington on May 11, 1966, accompanied by Dr. Joachim Pretsch and others. After I had welcomed the Minister privately, he and his group were given special briefings by principal USAEC staff concerning the relationship of the AEC to the executive and legislative branches of the US Government, the US high energy physics program, and present and future trends in the US civilian power reactor program. Following this there was a meeting with the Commission:

"At 11:45 a.m. I presided over the Commission meeting with Gerhard Stoltenberg, Joachim Pretsch, Max Mayer (in charge of the Ministry's Space Research Program), Karl Tremml (Stoltenberg's personal assistant), Wolfgang Opfermann of the German Embassy, and William W. Williams, to discuss (1) review of US-German cooperation in the civil uses of atomic energy; (2) continuation of cooperation under US policy on 'fold-in' of agreements with Euratom Member States; (3) application of safeguards and US position; and (4) future of nuclear power in Germany and the United States.

"At 12:30 I hosted a luncheon in the State Room at the Mayflower Hotel in honor of Dr. Stoltenberg. USAEC Commissioners James Ramey, Gerald Tape, John Palfrey and USAEC staff members were present. Others attending, in addition to Stoltenberg and his group, included Baron Herbert von Stackelberg and other principal members of German Embassy, representatives from the JCAE, officials from the State Department, and other US government agencies, and Bill Williams."

Between my March 1966 trip and September 1968 I had no opportunity to visit German nuclear facilities. However, in the fall of 1966, in Vienna, I had the privilege of presenting the Enrico Fermi Award to the great German nuclear scientist Otto Hahn, whom I had known personally since 1955, and to Fritz Strassmann, who collaborated with him in the discovery of the nuclear fission of uranium:

"Friday, September 23, 1966 - Vienna

"Then we went by buses to the Hofburg to attend the Fermi Award Ceremony. I presided, beginning the ceremony by escorting Chancellor Josef Klaus of Austria through the

Festsaal to the stage. I introduced those on the stage – Klaus, State Minister Karl Gruber, US Ambassador James Riddleberger, US Ambassador (to IAEA) Henry Smyth, US Atomic Energy Commissioners James Ramey and Samuel Nabrit, and Otto Frisch, who represented Lise Meitner (his aunt), longtime collaborator of Hahn and important contributor to the discovery of uranium fission. I then called on Donald Hornig, Presidential Science Advisor, who gave a message from President Lyndon Johnson. I then made my statement regarding the work of Hahn, Strassmann, and Meitner, followed by presentation of the Fermi Award to Hahn and Strassmann, in that order. Hahn made his response and then Strassmann made his. I brought it to an end with reference to Meitner (whose health prevented her attendance) and said I would present the Award to her in Cambridge. The ceremony was filmed. We then had a little reception for Hahn and Strassmann in the room behind the stage, where a few people could meet them. I presented to Hahn an advance copy of his autobiography published by Scribner's, to which I wrote the introduction."

At dinner that evening, the momentous discovery days of the winter of 1938-39 were recalled:

"I had dinner with Hahn, Dr. and Mrs. Strassmann, Frisch, Miss Mary Rehber (Hahn's secretary), and the Rector of Bonn University. Frisch and Strassmann told me how the famous communication with Meitner, who was in Stockholm, came about in December 1938. Frisch was with Meitner in Stockholm December 22-27, and together they deduced the liquid drop explanation, correlating the energetics with masses and coulomb repulsive energy (both about 200 Mev), which Meitner communicated to Hahn and which aided them in their famous January letter to *Naturwissenschaften*. A few weeks later Frisch demonstrated the large fission pulses in an ionization chamber using an approximately 100 mg radium-beryllium neutron source."

The following month I made a special trip to England to present the Award to Lise Meitner:

"Sunday, October 23, 1966 – Cambridge

"Arnie Fritsch, Carl Malmstrom (USAEC Scientific Representative in London), and I were driven in a hired car to Cambridge, where we had lunch in the Old Guest Room of Trinity College with Dr. and Mrs. Otto Frisch; Lise Meitner's cousin, Mrs. Lemberger; her sister-in-law, Mrs. L. Meitner-Graf; her nieces, Dr. Frida Lim and Miss Ilse Lim; her nephew and his wife, Mr. and Mrs. Philip Meitner; her friend and doctor, Dr. Josephine Stross; Professor and Mrs. Harry J. Emeleus; Professor and Mrs. Hawthorne, Dr. and Mrs. Alfred G. Maddock, and Sir Geoffrey Taylor.



XBB 769-8559

Fermi Award Ceremony, Hofburg Palace, Vienna, Austria, September 23, 1966. (Left to right) Otto Hahn, Seaborg, Fritz Strassmann, James T. Ramey, Donald F. Hornig, Henry D. Smyth, Austrian Chancellor Josef Klaus, US Ambassador James W. Riddleberger, Austrian State Minister Karl Gruber, Samuel Nabrit, Otto Frisch (hidden).



XBB 769-8560

Presentation of Fermi Award to Lise Meitner, home of Max F. Perutz, Cambridge, England, October 23, 1966. (Left to right) Otto Frisch, Lise Meitner, Seaborg.

"Then I went to the home of Dr. Max F. Perutz, where I presented the Fermi Award to Lise Meitner in the presence of her relatives. She was seated during the ceremony and seemed to appreciate the honor very much. It was a moving scene with the members of her family hovering nearby, very solicitous but also very proud of the honor being bestowed upon her.

"Then we went to Cavendish Laboratory, where I made a statement, after being introduced by Sir Nevill Mott, concerning Lise Meitner's work, and Dr. Frisch read her acceptance remarks. This ceremony was filmed. Present, in addition to relatives and those present at lunch, were Lord and Lady Alexander Todd, Dr. and Mrs. Egon Bretscher, Dr. Richard Keynes (Vice President of the Royal Society), Professor and Mrs. Alfred Pippard, and others, to make up a full room. This was followed by a tea. Then I was interviewed by BBC on the entire 1966 Fermi Award procedures and ceremonies. I then saw the original apparatus of Rutherford, Aston, Cockcroft, Maxwell, etc., in the excellent museum in the corridors of the Cavendish Laboratory, and the pictures of the many historic occupants of the Laboratory on the walls of the Laboratory corridors."

During these years there were opportunities for worthwhile discussions in Washington, as well as abroad, regarding nuclear matters of mutual interest to the United States and Germany. For example, between the award presentations in Vienna and Cambridge, I was visited at USAEC Headquarters by Dr. Heinrich Mandel of the Rhine Westphalia Electrical Works (RWE), the firm responsible for construction and operation of the Gundremmingen nuclear power plant (one of the three plants built under the US-Euratom Joint Reactor Program, and as such one of the first enriched uranium power facilities in Europe). Dr. Mandel, accompanied by Professor K. Jaroschek of the Institute for Heating Technology, located in Darmstadt, and Dr. Alex Warrickoff of the nuclear fuel company NUKEM, had come to the United States to confer with USAEC and industry officials regarding fuel supply and other aspects of nuclear power. After meeting with the group in my office on October 12, 1966, I hosted a luncheon for them at the Mayflower Hotel. The composition of the gathering on that occasion reflected recognition of the growing importance of nuclear power here and abroad and respect for our guests' role in that growth in Germany. Those present included Mr. Wolfgang Opfermann of the German Embassy; my fellow Commissioners and principal USAEC officials; Ambassador Henry Smyth and Donovan Zook of the State Department; Messrs. John Conway, George Murphy, and Leonard Trosten representing the Joint Committee on Atomic Energy; Mr. Charles Johnson of the White House staff and Mr. Fred Schuldt of the Bureau of the Budget. In my welcoming remarks, I addressed Dr. Mandel as "one of the true industrial pioneers of nuclear energy in Europe." I went on to speak of the group's aims in visiting the United States at that time, and concluded by stressing what I regard as an important "spin-off" contribution of nuclear energy: "I believe that among the many

incidental benefits of nuclear energy is the creation of new and extremely close forms of cooperation between many nations, and we deeply value our cooperation with your Government and with the aggressive and progressive industry of which you are a distinguished representative."

My attempts to persuade Germans that their country sign and ratify the Non-Proliferation Treaty was a recurring theme. Central to this was the application of the nuclear safeguards provision (Article III), a matter of concern because of their fear that these would hinder their development of nuclear power through the revelation of national trade secrets; of special concern was their fear that such safeguards might be discriminatory because they would not apply to France in view of her exempt role as a nuclear weapons power. Typical of these discussions is one held in my office on March 21, 1967:

"At 2:25 p.m. I met with Dr. Karl Wirtz (Nuclear Research Center, Karlsruhe), Dr. Gernot Heyne (German Foreign Minister for Scientific Research), Berndt von Staden (Counselor, German Embassy), Myron Kratzer, and Allan Labowitz to discuss Article III of NPT. Wirtz suggested it be dropped and I retorted by saying this would make the NPT worthless."

In the fall of 1967, in September, Stoltenberg came to see us again in Washington. His concern this time was primarily with the long-term supply of enriched uranium. Noting that two nuclear power plants had recently been ordered in Germany on a wholly commercial basis, he pointed out that developments indicated a sharp increase in Germany's need for enriched uranium. He observed that Germany had a very strong coal lobby and that in developing Germany's future energy program, it was essential to give careful consideration to long-range fuel needs.

I informed the Minister that approval had just been obtained within the US Government to proceed with the presentation to Congress of legislation for an increase of 145,000 kgs of U-235 in the ceiling for the European Community, and observed that this was a significant amount of material which would cover Community needs for reactors installed by the mid-1970's. (As I mentioned in connection with Euratom, Congress did pass this legislation, which, after signing by the President, became law on December 14, 1967.) The Minister agreed that this should provide for the immediate future, but felt that they should look farther ahead, and he mentioned that Euratom and others were giving attention to the need for additional diffusion plant capacity to be located in Europe.

In response, I assured Stoltenberg that our diffusion plant capacity was sufficient for US and all free world needs until at least 1980. I went on to say that improvements in production techniques as a result of research efforts were expected to increase that capacity, that developments in the fast reactor field might reduce the demand for enriched uranium, and that these factors gave Germany and others some time

to make a decision that could take into account future economic and technological developments. Minister Stoltenberg agreed that this was indeed the case. He believed that studies of a European capability should proceed but that it was too early to make a decision on construction.

At the time of this visit by Stoltenberg, the USAEC and other US government elements were known to be studying the feasibility of involving private industry in the ownership of the gaseous diffusion plants. The Minister inquired about this. In response, it was noted that our studies had not progressed to the stage where a decision was imminent, that even if a decision were to be made now it would take some years to effect a turnover, and that, in any turnover, arrangements would be made to have industry honor any supply commitments of the US government. The Minister remarked that this last was an important point.

Other conversations in Washington with Germans concerned with various aspects of their country's nuclear activities include two that took place in the spring of 1968. One was with Walther Casper, Chairman of the Board of Urangesellschaft, who came to see me on March 27, 1968, to discuss matters of concern to his consortium of four German companies with mining and prospecting interests. The second conversation, somewhat broader in scope, occurred less than a month later, on April 17, 1968, when Dr. Carl Von Weizsacker, a member of the Federal Republic's Committee for Research Policy, visited me. Dr. Von Weizsacker wished to obtain my informal views on several major research policy questions facing the FRG particularly with respect to the 300 BeV accelerator project proposed for construction under the aegis of CERN -- the European Organization for Nuclear Research (at Geneva). He asked my opinion as to whether the undertaking of such a sizable project represented the best use of the funds available in Europe for research and development, considering the plans that the United States itself had in this area.

I expressed the view that construction of the proposed 300 BeV accelerator would probably represent one of the best uses of research funds from the standpoint of fostering scientific cooperation in Western Europe. I also said that deferral of action with the idea of perhaps constructing a 1000 BeV machine at some future time, possibly within the context of a worldwide cooperative venture, would deprive European scientists of the opportunity to participate in the exciting current field of high energy physics. Dr. Von Weizsacker agreed but said the main difficulty related to limited funds.

It seems appropriate to mention here that CERN did eventually decide to proceed with the accelerator. After almost three more years of debate and delay, caused principally by the problem of financing

this \$250-\$300 million project but also by the difficulty of reaching agreement on a site, CERN members finally gave the go-ahead for construction in February 1971. The Federal Republic of Germany was the largest contributor, pledging 23% of the funds required. The compromise location selected was on the French-Swiss border, contiguous to the existing CERN laboratory.

Von Weizsacker and I discussed certain other questions, such as the advisability of Western Europe's developing a computer capability (which I considered desirable) and the views that he and other leading nuclear scientists of Germany held with respect to the latest draft of the Non-Proliferation Treaty. Knowing that there had been some concern lest this treaty, as previously drafted, might harmfully restrict research in the peaceful uses of atomic energy, I was glad to learn that German scientists' reservations in this respect had been put to rest by the draft revisions.

Another trip to Germany was possible for me in the fall of 1968, en route to the twelfth IAEA General Conference. After discussions first with Euratom people in Brussels, Myron Kratzer (USAEC Director of International Affairs), Arnie Fritsch, Ted Iltis, and I flew to Cologne the evening of September 19, 1968:

"Friday, September 20, 1968 - Cologne, Jülich

"Helen and I had breakfast in our suite in the Arera Hotel, Bad Godesberg, overlooking a marvelous view of the Rhine. Unfortunately, it was a rainy day. Petersberg (where Queen Elizabeth stayed) was visible on a hill across the river. The car ferry across the river was just below our hotel.

"Fritsch, William Williams, Kratzer, Iltis, and I rode to the Jülich Research Institute. On the way, Williams showed us a copy of a Foratom report showing the advantages of Europe building a gas centrifuge plant for uranium enrichment for reactor fuel.

"We were met at Jülich Research Center by Dr. Alfred Boettcher (Technical Director) and Dr. Alexander Hocker (Administrative Director). We went to the conference room, where we met with Rudolf Schulten (Head of Institute of Reactor Development), Hans-Jochen Stöcker (Deputy Director, Institute for Reactor Materials), H. Kramer (Project Division), Werner Haugg and Walter Schrock-Vietor (Director, Project Division). We were briefed on the AVR by Schulten. The AVR (Pebble-bed reactor) develops temperatures as high as 850°-980° C, with steam temperatures of 550° C. The follow-up reactor, THTR, will have a capacity of 300 MWe and is to be started perhaps next year. It will operate at a temperature of 750° C

with helium cooling, and the fuel will be either low-enriched uranium or the thorium-uranium cycle.

"Stöcker, who spoke next, told a story about how he wrote me (about 1949) and I accepted him for work in my laboratory at Berkeley, but he couldn't raise the travel money so he didn't come (he went to France) — he took this occasion to thank me. He explained the fuel elements utilized in these reactor concepts. He compared the sphere (AVR-THTR) and prismatic (HTGR) fuels, using charts, which he gave us, and samples of the AVR and THTR fuels, which he showed us. Irradiation tests at integrated fluxes of up to 5.3×10^{21} have been conducted. NUKEM manufactures the fuel spheres. A group of utilities are apparently interested in proceeding with the construction of the THTR.

"Kramer described the plan for the next five years. He explained the advantages of the direct cycle helium turbine compared with the indirect cycle turbine (10-15 percent less capital cost). He estimated costs of 3.0-3.5 mills per kilowatt hour (helium turbine). They hope to have bids in 1974 for the first commercial station, which would go into operation in 1980. The plant would have 46-48 percent thermal efficiency, and will use cooling towers.

"Using slides, Boettcher described a computer program to optimize the economics of the German electrical grid including various types of reactors. HTR (ST), with steam turbine, is about equal to the fast breeder with oxide fuel. Eventually, HTR (HT), with helium turbine, and fast breeder with carbide fuel, which are about equal, will take over. The HTR's would be on thorium fuel cycle. With a closed plutonium market, the HTR (HT) runs way ahead of the fast breeder-carbide fuel. He also presented slides of computer results on the USA grid to the year 2020, including fast breeder, water-cooled reactors, molten salt reactor, conventional fueled plants, and HTR. The molten salt reactor came out very well. We should make such comparative analyses in the United States! The steam-cooled fast breeder is dropping out of favor in Germany. The gas-cooled fast breeder with helium turbine has good potential (oxide or carbide fuel). The General Atomic HTGR and gas-cooled fast breeder seem to be designed for too low temperature to make it feasible to operate a helium gas turbine. Boettcher will give a paper on this at the AIF-ANS November meeting.

"After the briefing, we visited the AVR. Claus-Benedict Von der Decken and H. J. Hantke (Brown-Boveri-Krupp) of the AVR group joined us. Ed Nephew of ORNL also joined us. We rode on a bus to the AVR reactor site. Peter Hartmann (Manager of the ARV Group) gave us written material and briefed us on the history

of the AVR. Schulten briefed us on the AVR. Hantke continued the briefing, describing startup and characteristics of AVR operation.

"We then went across to the AVR itself (shut down at the moment for some repair to fuel-handling machinery), where Hantke showed our group around -- also with us were Hartmann, Von der Decken and some of the others.

"We then rode in to Jülich where we had lunch at the Hotel Kaiserhof. Present at the lunch were our group (Fritsch, Kratzer, Iltis, and Williams), Boettcher (our host), Schulten, Hocker, Stöcker, Haugg, Kramer, Schröck-Vietor, Hartmann, Hantke, Von der Decken, and Nephew."

In my talks with the scientists at Jülich, during the visit described above, I was particularly impressed by their strong interest and program in high-temperature gas-cooled reactors, paralleling US efforts. The German assessment of future trends in reactor development was most enlightening, as it provided additional justification for the position that we were then evolving, of supporting active programs in the areas of both high-temperature gas-cooled reactors and molten salt reactors while continuing to concentrate primarily on liquid-metal-cooled fast breeders.

On returning to Cologne, we took advantage of a few free hours for some sight-seeing:

"I met Helen in the Wiesel Restaurant (across from the Dom, the Cologne Cathedral), where she was finishing lunch with Mrs. Edwin G. Moline (wife of the US Minister of Economic Affairs) and Mrs. Williams. During the morning, she had visited Remagen (where the Allies crossed the Rhine during World War II); an old church at Schwarzerheinbach across the river from Bonn, the Doppelkirche (with excavations beneath) where the men and women were segregated; the Rheinische Landesmuseum in Bonn (containing Neanderthal man); and the Beethoven House in Bonn.

"All of us, joined by Nuel Pazdral (Williams' assistant) toured the Cologne Cathedral under the guidance of Sue Maitek. The Cathedral was started in 1248 and the building continued, intermittently, for over 600 years. It was largely spared from World War II bombing and is one of the best huge cathedrals in Germany. After the tour, we visited the neighboring Roman-German Museum in which we saw a mosaic floor dating from about 50 A.D., which was uncovered in 1941 during the construction of a bomb shelter. We then walked to a portion of a Roman wall.

"Fritsch, Williams and I flew to Hamburg to visit DESY (the Deutsches Elektronen Synchrotron) and the nuclear ship

Otto Hahn. We were met by Commander and Mrs. Patrick Maveety. Mrs. Maveety stayed to meet Helen and Iltis on a later plane.

"I called Tape in Washington and learned that the appointment of Frank Costagliola as USAEC Commissioner had been announced this afternoon. I received a State Department cablegram saying that I should postpone my visit to Lisbon -- apparently Kaulza de Arriaga (head of the Portuguese AEC) is a possible successor to Antonio Salazar (who reportedly is near death) and my visit at this time might be interpreted as US support for Kaulza." *

The next morning I visited DESY, a large 7 BeV electron accelerator in Hamburg, and from there went on to Kiel to board the nuclear ship
Otto Hahn:

"Saturday, September 21, 1968 -- Hamburg, Kiel

"Helen and I had breakfast in our room at the Vier Jahreszeiten Hotel. We rode with Cdr. Maveety to DESY, with Fritsch, Iltis, and Williams following.

We were greeted by Dr. M. W. Teucher (Associate Director of DESY), and others, and then went into a conference room. Jeanne, four-year-old daughter of Dr. C. C. Ting, presented Helen with a nice bouquet of flowers. Those present included: Dr. Teucher, Dr. C. C. 'Sam' Ting (MIT physicist), Dr. H.-O. Wüster (Board of Directors, DESY), Dr. Sohngen and Dr. Hermann Kumpfert (Synchrotron Operations and Improvements), Dr. G. Weber (electron scattering experimentalist), Eugene Engels and Mervin Wong (Harvard), Sanders and Cohen (MIT graduate students), Gerald Bennett (Brookhaven), Bienlein, Joos, Managing Director Berghaus, and Woloshek.

"We were told that DESY has a capital investment of about \$40 million and an operating budget of about \$11.5 million. There are 147 scientist members of the DESY staff, plus about 40 visiting scientists. The total staff numbers 858. After an historic account and a general description of DESY, we took a tour of the facility and its experiments, under the guidance of Teucher, with the entire group who had been in the conference room accompanying us. Among the programs we saw were: Weber's electron-proton scattering experiments; Ting's photoproduction of electrons and positrons to test basic electromagnetic theory;

*Salazar died July 27, 1970, but was actually superseded in 1968 by Marcello Caetano.

Wong's streamer chamber detection of the products of 4 to 7 GeV photons; Weber's experiment to determine the form factor (charge distribution, if any) of the neutron and the characteristics of the reaction $e^- + p \rightarrow e^- + p + \pi^0$; the new 360 Mev injector for DESY; and Dr. Kumpfert showed us the Klystron testing area.

"At the end of the tour, as we were taking our leave, Hans Schmerenbeck (Technical Manager, Der Gesellschaft für Kernenergieverwertung in Schiffbau und Schifffahrt mbH at Hamburg and Geesthacht, GKSS) joined us to accompany us to the nuclear ship *Otto Hahn* at Kiel. On our way, we drove past the Freilicht Museum (reconstructed old houses from all over Germany), just south of Kiel.

"At the *Otto Hahn*, we were met by Gerhard Theune (Captain of the *Otto Hahn*), Dieter Ulken (Director of the Institute for Technical Installations of the GKSS), Heinrich Fock (Chief Engineer of the *Otto Hahn*), and Klaus Dieter Henning (Safety Officer of the *Otto Hahn*).

"We all sat in the lounge, which contained a fine portrait of Otto Hahn (his last, and hung just yesterday), and talked a while. In the main dining room, we had an excellent two-hour lunch. Following lunch, we returned to the lounge for coffee and a technical briefing. We were told the *Otto Hahn* cost \$14 million (the original estimate); the GKSS people think that if they were to build three or four such nuclear cargo ships, at about 40,000-50,000 horsepower, they would be economically competitive. They are considering a boiling-water reactor. The *Otto Hahn* has an advanced pressurized-water reactor with internal steam generation. We then toured the *Otto Hahn*, including the reactor area inside the secondary containment, the control area, the machinery and propeller shaft area, and the bridge area."

My tour of the *Otto Hahn* and discussions with scientists and others involved in this program were most useful. In 1965 the USAEC had entered into an arrangement with the GKSS under which we agreed to lease (through Euratom) the nuclear fuel materials for the *Otto Hahn* and both sides agreed to exchange information on nuclear maritime concepts and, specifically, on the US ship *NS Savannah* and the German *Otto Hahn*. I was naturally very glad of this chance to inspect their ship, an ore carrier with an improved propulsion plant about half the size of the *Savannah*, and to exchange opinions with the Germans regarding the potential value of this use of nuclear energy.

In our talks, it was apparent that the German view was not unlike ours. As indicated above, they felt that if it is to be economic in the long run, then eventually a commitment should be undertaken to construct at least four ships, each powered by a reasonably large (about 50,000 shaft horsepower) nuclear power plant in order to maximize the



XBB 732-1131

Visit to Nuclear Ship Otto Hahn, Kiel, Germany, Sept. 21, 1968. (Left to right) Hans Schmerenbeck, Seaborgs, Captain Gerhard Theune, William W. Williams, Dieter Ulken.

advantage of the nuclear power source. Pending a time when such a commitment may become feasible, however, the Germans are continuing their research and development efforts in this area and are seeking to promote wide interest in the nuclear ship concept and collaboration with other nations active in this field, such as Japan. (They have held several "Symposia on Nuclear Ship Propulsion" in Hamburg, under the joint sponsorship of the IAEA, the Inter-Governmental Maritime Consultative Organization, and the German government and industry.)

At the time I visited the *Otto Hahn*, final tests were nearing completion prior to the ship's nuclear-powered operation. Her first cruise under nuclear power took place just a month later, in October 1968. It was a matter of deep regret to all that the man for whom the ship was named could not be on board for the event; Otto Hahn had died in July.

"After taking leave of the ship, we rode back to Hamburg.

"Helen and I had dinner at Mellingburger Schleuse, a charming, rustic restaurant on the outskirts of Hamburg, with Fritsch, Mr. and Mrs. Maveety, and Bill Williams. Following this, we visited the Reeperbahn."

The day after our trip to Kiel offered an opportunity for more sight-seeing before a press conference and my onward flight to Vienna:

"Sunday, September 22, 1968 - Hamburg

"Helen and I had breakfast in the Vier Jahreszeiten Hotel grill, after sleeping late. Pat and Darle Maveety came by and drove us around to see the sights of Hamburg.

"We drove by St. Peter's Church, which is on the site of Hamburg's first church built in 811, on a high point in the area. We drove down Schönaussicht where we had good views of the towers of Hamburg (church spires, etc.) across the outer Alster. We saw the Rathaus, with the traditional Ratskellar. We saw old houses bearing such dates as 1641, 1698. (Most of Hamburg was destroyed by a fire in 1842 and much was destroyed in World War II, but some areas, such as this, have remained intact.) We drove through the Fish Market area and viewed the boat docks on the Elbe River. We then visited the Altona Museum, where we saw the old German houses (combination living quarters and barn), old German household goods, archeological materials and digs from nearby areas showing material dating as far back as 10,000 BC, anthropological exhibits, models of boats, stuffed animals, etc. We drove out on the Elbechaussee, a nice road along the Elbe, and back. We saw the huge statue of Bismarck. Pat Maveety then dropped Mrs. Maveety off at their home and drove us to the airport.

"I went with Maveety to the Pan American lounge to participate in a news interview. The newsmen were Herbert Schrader (*Hamburg Abendblatt*) and T. von Randow (*Die Zeit*). Fred Irvin, Public Affairs Officer of the US Consulate, and Gerhart Leckel of the USIS were also present. The questions and answers were tape recorded, including questions about the possibility of still heavier transuranium elements (I described the prospects for element 114), budget cuts in US science (I said that so far it wasn't bad for AEC), effect of budget cuts on 200 BeV accelerator (I said not too bad), need for 300 BeV accelerator in Europe if US builds 200 BeV (I said high energy physics can profitably use both), the future of the peaceful uses of nuclear energy (I described nuclear electric power program in the United States, nuclear desalting, the Nuplex concept, use of radioisotopes in medicine, agriculture and industry, use of radiation for food preservation, nuclear energy in space including nuclear rockets and nuclear auxiliary electric power and the peaceful uses of nuclear explosives), should Germany sign the Non-Proliferation Treaty (I said yes, it is to the advantage of nuclear and non-nuclear weapon states, and the NPT should be followed by nuclear arms cutback by nuclear weapon states), and the role of the IAEA (I emphasized its impending role in NPT safeguards)."

Upon my return to Washington, I wrote the President on October 4, 1968, to report on this trip, and included the following comments on the Federal Republic of Germany:

"The following two days, September 20 and 21, I visited the Jülich Research Center, the Deutsches Electron Synchrotron (DESY), and the nuclear ship *Otto Hahn*, all in West Germany. During my visit to Jülich, near Cologne, I was particularly impressed by their strong interest and program in high temperature gas-cooled reactors, paralleling efforts in our country. Their assessment of the future trends of reactor development was most enlightening and provided additional corroboration to the position which the AEC is slowly evolving of supporting active programs in the high temperature gas-cooled reactor field and the molten salt reactor field while continuing with the development of a main-line effort on liquid metal cooled fast breeder reactors.

"My visit to the DESY in Hamburg, a large 7 BeV electron accelerator, clearly showed that Germany is prepared to support high energy physics in this area in the same proportion as we are supporting it with our Stanford Linear Accelerator and the Cambridge Electron Accelerator complexes in the United States. My final visit to the nuclear ship *Otto Hahn* at Kiel was most useful. This developmental ship is an ore carrier

with an improved propulsion plant about half the size of our NS *Savannah*. The German view regarding nuclear maritime propulsion is not dissimilar from ours. They feel if it is to be economic, a commitment must be undertaken to construct at least four ships, each powered by a reasonably large (about 50,000 shaft horsepower) nuclear power plant in order to maximize the advantage of the nuclear power source."

With its large, and constantly expanding, nuclear power construction program, Germany (like its neighbors within the European Community) has become increasingly concerned with the matter of fuel supply. This concern was reflected in a meeting I had in Washington on November 12, 1968, with Mr. Friederich Hammerling, a member of the Board of Directors of the German firm Allgemeine Elektrizitäts Gesellschaft (AEG--an affiliate of the US General Electric Company), Dr. Hans Joachim Brüchner (head of AEG's Atomic Energy Functions), and Arthur L. Fern of the German Embassy. Dr. Abraham Friedman, Deputy Director of the USAEC's Division of International Affairs, and my Special Assistant Julie Rubin were with me. After some preliminary discussion, which included a review of the AEG-GE relationship and the German power reactor construction program, Mr. Brüchner asked that we consider liberalizing our fuel supply policy. He felt that we should be willing to provide up to 15 years' inventories of enriched fuel rather than five years' (as stipulated in a newly announced policy). I indicated that we would consider extending the period if we received a formal request for material beyond the five-year limit. Mr. Brüchner then suggested liberalizing our toll enrichment policy; by this suggestion, it presently appeared, he meant our being willing to share in joint capital financing of an enrichment facility in Europe or arranging to provide the technology so that the Europeans could build their own plant. My answer to this recommendation was that we were already reviewing our policy in this area. I made it clear that the positions taken by other nations toward the NPT would influence our policy in this regard.

Among other important matters that arose in these years, with respect to our cooperation with Germany in the nuclear field, was the question of possible use of "offset" funds to purchase nuclear-related services and materials in the United States. These "offset" funds were US dollars deposited by Germany in the United States for the purchase of military equipment to offset the dollars expended by the US military in Germany in the operation and maintenance of our military installations there. A formal US-German agreement on the use of offset funds was terminated in 1967. In view of the large amounts of these funds still available by the end of 1968, various US Government agencies, including the USAEC, were asked to explore the feasibility of entering into a new agreement to provide for their use for the purchase of non-military equipment and services. The nuclear field appeared to offer various possibilities, and one of these was among the subjects in a brief discussion in March 1969

with Ambassador Rolf Pauls, who on January 31 had presented his credentials as Germany's new chief of mission in Washington. He was accompanied by Wolfgang Opfermann, I by Myron Kratzer and Julie Rubin, at our meeting in my office on March 26, 1969:

"Ambassador Pauls expressed appreciation for the opportunity to meet briefly with me. I mentioned my trip to Germany last year in which I visited the Jülich Laboratory and also noted my inspection and very pleasant luncheon on the *Otto Hahn*. The Ambassador appeared quite interested in my visit to Germany and immediately requested that I plan on a return trip soon.

"The possibility of using offset funds in connection with heavy ion accelerator work that may be of interest to Germany was briefly mentioned and this seemed to be of particular interest to the Ambassador. Mr. Opfermann seemed quite aware of my personal involvement in this scientific work and its potential mutual area of interest. I mentioned being with Professor J.H.D. Jensen (outstanding German nuclear physicist and winner of the Nobel Prize) at Nova University in Florida earlier this week in connection with our participation as members of their Advisory Committee."

Negotiations between the United States and Germany regarding the use of offset funds were conducted during the following months. Agreement was reached that a portion of these funds would be used to purchase uranium and uranium enrichment services in the United States. An early proposal to use some of the money for a project in the United States of interest to Germany (such as the heavy ion accelerator work mentioned in my conversation with Ambassador Pauls) was dropped, however.

My journal for July 14, 1969, records that I held a conversation with Dr. Hans Von Heppe (Under Secretary, Ministry for Scientific Research, Federal Republic of Germany) at the Reception for Foreign Ministers of Science at the State Department:

"During the reception I talked to Dr. Von Heppe who told me that the Minister of Science has decided to locate the German heavy ion accelerator, the Unilac, at Darmstadt. (Carl C.) Schmelzer will move to Darmstadt to supervise the construction, which will cost an estimated \$16 million and take about three years to complete."

The year 1970 took me to Germany twice. The first occasion, when I was on my way home after touring scientific facilities in Africa with a group of US scientists, enabled me to participate in a wide range of discussions, visit two important universities, and become acquainted with Federal Minister of Science and Education Hans Leussink, who in

late 1969 had succeeded (with broader duties) Scientific Research Minister Stoltenberg.

My colleagues and I followed our trip to Africa with a day of meetings in Madrid, then headed northeast to Cologne:

"Thursday, January 15, 1970 - Madrid to Cologne, Mainz, and Frankfurt

"The plane took off for Cologne at about 9:15 a.m. We were met by Mr. and Mrs. Bill Williams, Nuel Pazdral, Roderick Grant (Commercial Attaché), Mr. John Spencer DeCourcy (Assistant Agricultural Attaché), and Mrs. Gerald (Silvia) Goldstein (wife of the Economic Officer).

"Justin Bloom (my Technical Assistant) and I rode with Williams to the US Embassy Chancery (the women went to the Maternus Restaurant in Bad Godesberg for lunch after visiting the Cathedral in Cologne and Beethoven's house). Here we met Ambassador Kenneth Rush in his office, then he and I proceeded in his car to the Embassy Residence, a beautiful house overlooking the Rhine River. (This is where I had breakfast with Ambassador McGhee, Stoltenberg, etc., in March 1966.)

"Professor Dr. Joachim Pretsch (now State Secretary for Science and Director, Nuclear Research Division, Federal Ministry of Education and Science) and Professor Dr.-Ing. Hans Leussink arrived. Drinks were served, after which the four of us had lunch. I invited Leussink to visit the United States (mentioning Lee DuBridges' earlier invitation to him) and also suggested that he visit some USAEC Laboratories and installations. He indicated he would do so, saying that perhaps this would be possible this year. He told me that he knows Clark Kerr and has invited him to spend some time in Germany lecturing. (Leussink served as Rector of Karlsruhe Technical University from 1958 until 1961, and has a technical background in soil mechanics). Pretsch told me that he hopes the United States will modify its agreement with Germany to furnish more nuclear fuel--this might mitigate Germany's desire to participate in the building of the gas centrifuge plant. Pretsch seemed to have some doubts as to the wisdom of building such a plant. I asked Leussink which part of his job would occupy more of his time, education or science, and he said education probably would because the science part is already in good hands. We talked a good deal about the student unrest problem around the world, and he expressed the opinion that there is need for some reform in university administration. I described my trip to Africa and some of the observations I made there.

"Helen arrived at the Embassy soon after 2:30 p.m., as did Bloom and Charles F. Baxter (engineer in Applications

of Radioisotopes, Division of Space Nuclear Systems, USAEC, a member of our African traveling party). Helen and June Pollack (a doctor, and wife of Herman Pollack, also in our African party) had been taken by Mrs. Williams and Mrs. Goldstein (the mother of Susan who is our daughter Lynne's friend) to the cathedral in Cologne. On the way they spotted some beautiful posters, which they bought. From the cathedral they drove to the house where Beethoven was born. It is beginning to be restored, so the furnishings were in storage. They went into the house and gardens, though, and saw the room where Beethoven was born. This is the 200th anniversary of his birth, and there will be commemorative concerts. From there they went to the Maternus Restaurant where Helen had rahmragout. They serve wine in little ceramic pitchers which they give to the customers.

"We then rode to Mainz in an Embassy car. We arrived at 4:40 p.m. at Johannes Gutenberg University (the University of Mainz) where we were met by a nuclear chemistry graduate student, Herr Denschlag. He escorted us to the Nuclear Chemistry-Reactor Building, where we were greeted by Professor Günter Herrmann, Professor Fritz Strassmann, and Professor Walter Greiner (who had come from the University of Frankfurt). After having some photographs and movies taken, we were taken to the reactor area. An excellent demonstration was performed for us of a fast nuclear fission chemistry experiment; a sample was irradiated in the reactor, transported by pneumatic rabbit to the experimental area, and automatically chemically processed and counted. Induced radio-zirconium activity was shown on an oscilloscope as a function of time. The chemical separation was performed in one or two seconds. We also saw the equipment used by Herrmann to count spontaneous fission neutrons in ore and metal samples in his search for the superheavy elements in nature.

"I was interviewed by Herr Rabe of Mainz Radio and Television, with the interview being recorded on film. It was to be broadcast on TV that evening to southwest Germany and the broadcast was to be repeated over German national TV the following Sunday.

"We were then escorted to the lecture hall in the Chemistry Building, where I had been invited to deliver a lecture in honor of Professor Fritz Strassmann on the occasion of his retirement. We met Dr. Carl Schmelzer (University of Heidelberg), Dr. Kurt Giese (Federal Ministry of Science and Education), and Professor Pretsch. Following an introduction by Professor Herrmann, I gave my lecture, 'The Past and Future of the Transuranium Elements.' I then presented a copy of the 1967 Fermi Award

film to Professor Strassmann. There were one or two questions following my lecture, followed by applause from the audience-- in the form of table pounding. Herrmann later told me that this is only the second time the Lecture Hall has been filled (400 people) and that people came from all over Germany, from as far away as Munich; the other time the Hall was filled was for a lecture by Otto Hahn nine years ago. I gave out copies of my lecture to the students and also a few autographed copies of my two books, and there was a fight over them by students from Darmstadt. We went to another building for a reception given by the Max Planck Institute and Professor Herrmann. I met Alfred Klemm (whom I last saw in 1949 in Gothenburg) and H. Wanke (who showed Helen and me a moon sample being used in his moon research). I gave out autographed copies of *Man-Made Transuranium Elements* and the *Annual Review of Nuclear Science* article to Herrmann and his students. We met Mrs. Strassmann, Mrs. Schmelzer, and Mrs. Herrmann.

"We drove to Frankfurt and checked into the Intercontinental Hotel, where Helen changed quickly before going to the Consul General's home where a reception was in progress. June was already there. June and Helen were taken to a little German restaurant by the William Grenobles (USIS) and the Paul du Viviers (Deputy Consul General) for a light supper.

"Bloom and I went directly to the 21st floor to attend a dinner in the Salon Dom-Roma given by Walter Ruegg, Rector of the University of Frankfurt, at 8 p.m. Present at the dinner were Erwin Schopper (University of Frankfurt), A. V. Thumen (Chancellor, University of Frankfurt), R. Bock (University of Heidelberg), Günter Herrman (University of Mainz), Egbert Kankleit (University of Darmstadt), Peter Brix (University of Darmstadt), Carl Schmelzer, Max Barnick (Batelle-Frankfurt), Dr. Schuff (University of Darmstadt), Walter Greiner, Dr. Jurgen Schaafhausen (Farbwerke Hoechst), and James Johnstone (US Consul General at Frankfurt).

"At the end of the meal, Ruegg gave a few remarks of welcome and I responded with an explanation of how my visit to the Universities of Mainz and Frankfurt had evolved and of our trip to Africa and Spain.

"After dinner Greiner, Schmelzer, Ruegg, Johnstone, and I discussed student problems. There are laws in some 'Länder' in which students are empowered to assist in the election of the university president. A student has been elected president of the University of Berlin--they felt he is an irresponsible student. This has them very worried, especially Greiner who has been the subject of student attacks.

"I went to our rooms and waited for Helen. We then went dancing for a few minutes in the night club on the 21st floor.

"Friday, January 16, 1970 - Frankfurt

"I rode with Bloom and Baxter to the University of Frankfurt, where we were met by Greiner, who escorted us to his office in the Institute of Theoretical Physics. After some discussion there, we went to the nearby Institute of Applied Physics (next to the building in which the Stern-Gerlach experiment was performed) where we saw the work on the Helix Heavy Ion Linear Accelerator (Helac) shown us by Dr. H. Klein. He showed us slides and then the apparatus itself which operates at cryogenic temperatures and so far has been used to accelerate protons. This principle was considered by Schmelzer for use in the Heavy Ion Accelerator to be constructed at Darmstadt. [Actually a different accelerator, the Unilac, was the later choice for construction at Darmstadt.] Uranium ions can be accelerated using this Helac concept to 10 MeV per nucleon, at several charge states continuously, at large currents determined only by the ion sources, and energy resolution of 3.7×10^{-3} . This Helac is similar to the accelerator being developed by Harry A. Schwettman at Stanford, in which Al Ghiorso (of Lawrence Radiation Lab in Berkeley) is interested. Criton and Herwig Schopper at Karlsruhe are also developing this accelerator concept.

"Greiner then took us back to his Institute of Theoretical Physics where we met Ulrich Mosel, Jens Grumann, and T. Morovic, who explained their work on isomeric states in fission, and Harmut Holm, who explained his work on the effect of nuclear forces in overcoming Coulomb distortion (i.e., an effect that makes 'cold nuclei' more possible). Burkhard Fricke gave me a copy of his version of the Periodic Table in which Elements 165 and 166 are in Groups I and II, with the filling of two 9s electron shells. Elements 167-172 are formed by the mixed filling of 8p and 9p shells, resulting in a noble gas structure at 172. The 7d shell is completed at 164, so it and element 163 are noble metals. This system appears to give a good treatment of what was the anomalously early appearance of the 8p, 9s, and 9p electrons as calculated by Joseph B. Mann.

"We then rode to the Institute for Nuclear Physics where we were greeted by the Director, Erwin Schopper. We went to the lecture room where I was introduced by Greiner and gave my talk 'Transuranium and Superheavy Elements.' There was a 'standing room only' crowd of

about 200. After my lecture there were a few questions. I gave out a number of autographed copies of *Man-Made Transuranium Elements* and *Elements of the Universe*. A smaller group of Greiner's students and associates, including Herrmann and Schmelzer, stayed on in the lecture room for further discussion of heavy ion accelerators. Schmelzer described the plans for his Darmstadt machine, and I described the changes proposed for the Berkeley Hilac and the Dubna cyclotron. After the discussion, Lewis P. Fulcher (who is working with Paul-Gerhard Reinhard) described the work they are doing on the quantum electrodynamic effect on the inner K electrons which may show where they drop into the sea of negative energy states. This may lead to a new application of the Pauli Exclusion Principle leading to a new form of the Periodic Table for the region where this effect might be operative. He will send me these results when the calculations are completed in six months or so. I learned that they do their calculations on a UNIVAC 1108. I also learned that Fricke might go to the University of Melbourne in the fall (but would prefer a job in the United States) for a year or two. Mosel is leaving in February for a two-year stay at ORNL with R. A. Schmidt, and Bernd Fink is leaving in February for a stay at the Bureau of Standards to work with Michael Danos.

"I then rode with Bloom, Baxter and Greiner, to the Officers Club at the Rhein-Main Air Force Base where we were met by Tom Blair (US Consulate) who escorted us to a private dining room for our lunch. I had lunch with Greiner, Reinhard Brandt, Bloom, and Baxter. (Brandt was at the Berkeley Radiation Laboratory from 1959 to 1962, where he earned his Ph.D. degree working with Stan Thompson and Iz Perlman on spontaneous fission.) There was a spirited discussion during lunch about the student problem in Germany, with a difference of opinion between Greiner and Brandt. Greiner feels that the trend toward election of students as presidents of German universities will extend to the University of Frankfurt and lead it to serious deterioration, while Brandt thinks this is an overly pessimistic view and some of the student activity has been necessary in order to force necessary reforms in the German universities.

"Greiner and Brandt rode with Bloom, Baxter and me to our plane at the Frankfurt Rhein-Main Air Force Base. We said goodbye to Greiner and Brandt, boarded the plane and joined the other members of our traveling group, who were already aboard. During the morning some of them, including June and Helen, had visited the Palmengarten, very extensive botanical gardens founded in 1869. The plane took off from Frankfurt at 2 p.m."

The annual fall trip to the IAEA General Conference permitted a visit to Frankfurt and the Karlsruhe Center in September 1970:

"Sunday, September 20, 1970 - Geneva to Frankfurt and Karlsruhe

"Helen, the Blooms, Friedman, and I were met by Thomas Bleha, our control officer from the US Consulate in Frankfurt, Professor Otto Haxel (of Heidelberg University, one of the managers of the Karlsruhe Research Center, spending the next half-year or so as scientific director of the Center), and Mr. Woesler (head of international activities and protocol for Karlsruhe Nuclear Research Center), and proceeded to the Park Hotel in Karlsruhe. In the hotel lobby I met Mr. and Mrs. Clyde McClelland (Scientific Attaché, US Embassy, Bonn) and, later, we met Glenn Bradley (USAEC Senior Scientific Representative, Brussels) just in from Brussels.

"In the afternoon we rode to the Black Forest for a hike at the village of Herrenwies. Later we drove to nearby Varnhalt, where we had dinner in the restaurant Gasthaus Zum Adler."

In speaking of Euratom matters I quoted my account of our visit the next day, September 21, to the European Institute for Transuranium Elements at Karlsruhe.* We went on to inspect other facilities at the Center, where I had agreed to deliver the inaugural lecture of the International Seminar on Radiation Protection Problems Relating to Transuranium Elements, jointly sponsored by Euratom and the European Nuclear Energy Agency:

"We were driven to the Hot Chemistry Building, where we were met by Ochsenfeld, Franz Baumgartner (the Director of the Institute for Hot Chemistry, whom I saw at the ACS meeting in San Francisco in April 1968), and Institute scientists Günter Koch, Hochlein, and Blum. Relatively large scale processing equipment was shown to us for recovering ^{238}Pu from 200 grams of irradiated ^{237}Np . This equipment will also be used to recover heavy transuranium elements from high level waste streams which are generated at the German reprocessing plants. Walton Rodger of Nuclear Fuel Services has been one of the US experts who helped with the design of the equipment. Solvent extraction flowsheets are being developed also for processing fast breeder reactor fuels containing high concentrations of plutonium.

* See Chapter 2, pp. 42-43.

"In another laboratory containing many glove boxes for alpha activity, we saw where research is being conducted on preparing new compounds of transuranium elements, such as the cyclopentadienyls.

"Another laboratory contained process development equipment which is being operated in support of a small scale fuel reprocessing plant being built outside of Karlsruhe. One piece of equipment was a small centrifugal extractor which can handle a feed rate of 600 liters/hour. Another interesting set-up was a continuous ion exchange column in which the resin is made to flow countercurrent to the eluant. It is hoped that such an arrangement can be used for tail-end plutonium purification, although the bugs have not been ironed out yet.

"We drove next to the main administration building of the Center, where I was to give my lecture. Here I met Bob Penneman, Alexander Van Dyken, and Don Ferguson from the United States. I was introduced first by Haxel, representing the Minister of Science, and then by Dr. Pierre Recht, Director of Radiation Protection for Euratom and head of the Seminar on Radiation Protection Problems Relating to the Transuranium Elements. Einer Saeland, the Director General of ENEA, was also at the head table. I then spoke for about one hour on 'Recent Developments in Transuranium Research,' covering the US and USSR claims to the discovery of elements 104 and 105, accelerators being designed or built to make superheavy elements, methods of forming the superheavy elements, and predicted chemical properties and electronic structures of the superheavy elements, using about 40 slides. As the introduction to my talk, I read my Met Lab memo of January 5, 1944, in which I predicted that plutonium would be a severe hazard if ingested.

"Following the lecture, I was interviewed by Brunner of Radio Stuttgart (South Germany Broadcasting System). Questions were on practical applications of transuranium elements, prospects for superheavy elements and role of magic numbers with mention of contributions of O. Haxel, J.H.D. Jensen, and H. E. Suess at University of Heidelberg 20 years ago, role of heavy ions including mention of Unilac accelerator planned for Darmstadt, possibility of superheavy elements in nature, estimate of when superheavy elements will be synthesized (possibly three or four years).

"After picture-taking on the steps of the Administration Building, we went to lunch at Heinrich Hertz Haus (the Faculty Club of the University of Karlsruhe), where Helen and Robbie joined us. Among those present, in addition to our group, were Clyde McClelland, Professor Dr. Haxel, Dr. Rudolf Greinfeld (Managing Director), Professor Dr. H. Böhm (member of the

Scientific Council), Professor Dr. Franz Baumgartner, Professor Dr. E. W. Becker (Director of the Institute of Nuclear Engineering), Professor Dr. Walter Seelmann-Eggebert (Director of the Institute of Radiochemistry), Professor Karl Wirtz (Director of the Institute for Nuclear Reactors), Dr. Giulio Guazzugli-Marini (Director General of the Euratom Joint Research Center), Dr. Pierre Recht, Professor Roland Lindner (Director of Transuranium Institute, Mr. Hampe (Health Protection Directorate), Einer Saeland, Mr. I.G.K. Williams (Deputy Director General, ENEA), Dr. Emil Wallauschek (Chief of ENEA's Division of Health, Safety, and Radioactive Wastes Management), and Dr. N. Nowlan (Division of Health, Safety and Radioactive Wastes Management). I sat between Saeland and Böhm, Helen between Greifeld and Recht. Saeland made some welcoming remarks with mention of my talk and the similarity of one slide figure to a cathedral.

"Helen had gone shopping in the morning. At about 10 a.m. she and Robbie were picked up by the translator for the Karlsruhe Center and taken to the Karlsruhe Castle where they were met by Mrs. Haxel. A curator, Gabor Kits, showed them the exhibit of Gothic art (1450-1530) of the upper Rhine. This was mainly sculpture and gold work collected from all over the world."

When I returned to Washington I wrote my customary report to the President, dated October 13, 1970, which included the following comments on Germany:

"On September 21, I visited the European Institute for Transuranium Elements at Karlsruhe. This important international research institute was set up by the European Atomic Community (Euratom) adjacent to the site of the German National Nuclear Research Center on the outskirts of Karlsruhe to carry out research on plutonium and its use as a fuel in nuclear reactors. It serves the dual function of meeting the immediate needs of nuclear industry in the European Community and contributing to the development of basic science in the field of transuranium research.

"The Germans are carrying out an important and well conceived fast breeder reactor development program and the Karlsruhe Transuranium Laboratory is playing a significant role in this effort. The United States, Germany, France, the United Kingdom, and Japan, all have major research and development efforts going on in fast breeder reactors and we are exchanging technical information on this area with each of these countries.

"Following my tour of the Transuranium Laboratory, I presented the inaugural lecture of the International Seminar on Radiation Protection Problems Relating to Transuranium Elements. This conference was held at the Karlsruhe Center and was jointly sponsored by Euratom and the European Nuclear Energy Agency. The leading heavy element scientists from the United States and Europe participated in this meeting."

Both of these 1970 visits to Germany, like those in previous years, were extremely worthwhile in connection with US-German nuclear cooperation, as well as pleasant and stimulating from a personal point of view. I spoke of their value on both counts when greeting a group of German Parliamentarians who came to see me in Washington in the spring of 1971. Headed by Mr. Gerhard Flaemig, seven members of the Parliamentary Sub-committee on Science and Technology met with my fellow Commissioners and me on April 6, prior to touring US nuclear facilities. The delegation's mission--to learn of recent developments pertinent to sodium-cooled breeders, lasers, fusion, high temperature gas-cooled reactors, and problems of diversification of nuclear centers--clearly reflected the German legislature's recognition of the vital role of scientific progress in today's world. I was glad for the opportunity to welcome them at the start of their two-week stay in the United States, which was to include a meeting with their US counterpart, the JCAE, and visits to USAEC and private facilities.

As mentioned earlier, when I talked with Minister Leussink in January 1970, I invited him to meet with me in the United States and visit USAEC facilities. He was unable to make the trip in 1970, as he thought might be possible, but he did come the following spring, shortly after Flaemig's visit. On Friday, April 23, 1971, he and his group, which included several officials of his Ministry and members of the German Embassy in Washington, met with me and other members of the Commission, USAEC Staff, and Robert Loftness of the State Department's Bureau of International Scientific and Technological Affairs.

In welcoming Minister Leussink and his party, I expressed satisfaction with the cooperation between Germany and the United States in the scientific field and mentioned briefly my meeting with the Minister early in 1970. I noted that Leussink had been Rector of the University of Karlsruhe during the years I was Chancellor at Berkeley, and I recalled that when I had visited Germany the previous year there had been troubles at the University reminiscent of those at Berkeley.

Turning to our agenda, Professor Leussink first asked my view as to whether the same organization should both develop and regulate nuclear power plants. My response was that the USAEC had been successful in performing the dual function by having separate and independent organizations below the Commission. At some later time, I remarked, this separation probably would become complete.

Leussink then inquired about the possibility of receiving approval for the *Otto Hahn* to transit the Panama Canal. I explained that this matter was under intensive study and approval would probably be forthcoming. I said legislation would be required to establish indemnity for public liability for a permanent solution for nuclear-powered ships to pass through the Canal and to enter US ports.

The Minister's next inquiry concerned the prospects for development of steam-cooled fast breeder reactors. Milton Shaw, Director of our Reactor Development and Technology Division, answered for us by noting that US utilities had looked seriously at steam-cooled reactors and had decided that the concept was not economical because they could not truly be "fast" reactors.

The Germans were especially interested in the diversification efforts under way at Oak Ridge National Laboratory, which they were to visit the following Monday. I pointed out that this effort was a natural development and explained that it was being handled through contracts with other agencies. I gave as examples: desalting (Office of Saline Water--OSW), water chemistry (OSW), environmental matters (National Science Foundation), and the use of the ultracentrifuge for manufacture of pure vaccine and for obtaining basic information on viruses (National Institutes of Health). I also mentioned Commissioner Wilfrid Johnson's concept of an overall national laboratory organization under the Commission in which people could move freely from one site to another, but cautioned that this concept was only in the discussion stage and had not been adopted as a national policy.

Professor Leussink then brought up the subject of US assurances of future supply of enriched uranium fuel for European power reactors. I answered by saying that for the foreseeable future the USAEC enrichment program could meet the needs of the United States and of other countries which have turned to us for supply, and that our production complex has much flexibility, including power increases, preproduction, increase in the tails assay, the Cascade Improvement Program, and the Cascade Upgrading Program. I noted that there was little need to build a new enrichment plant until 1981 or 1982. We discussed the US interest in sharing gaseous diffusion technology, for a price, with our friends, but observed that we were interested only in multinational arrangements. We discussed several possibilities for the construction of diffusion plants in Europe.

The next subject raised by Professor Leussink concerned our interest in cooperating in the development of a thermionic reactor. I stated that cooperation on the contemplated In-core Thermionic Reactor experiment could proceed without any problems, but beyond that, it would be premature to reach any conclusions without further discussions with NASA. Leussink proposed that specialists from the two countries get together to discuss the subject in greater detail. When Myron Kratzer, USAEC Assistant General Manager for International Activities, suggested holding such a meeting at the time of the Fourth Geneva Conference in the fall of 1971, Leussink responded that a much

earlier time was desirable since the results of the discussions would affect German budget matters. (For us the question of cooperation in development of a thermionic reactor was complicated by classification aspects. Until certain technology was declassified, as we expected it to be in the not too distant future, we could not commit ourselves to as broad an agreement as the Germans wished.)

The conversation then turned to Euratom, and I mentioned the safeguards problem that existed between Euratom and the IAEA, which was delaying ratification of the NPT by Germany and the other non-nuclear-weapon-state members of the Community. I expressed the hope that this problem could be resolved. Minister Leussink responded that this hope was shared by the German Government and all but one of the other Euratom members--that is, France. He indicated that the others were prepared to go to great lengths to meet French views since they recognized that with completion of the work of the Safeguards Committee in Vienna (the committee charged with developing the structure and content of safeguards agreements between the Agency and non-nuclear-weapon states pursuant to the NPT), including resolution of the financing problem, time was running out. I remarked that André Giraud, Administrator General of the French CEA, and Bertrand Goldschmidt had sat in the same places as the German delegation several weeks ago, and had taken the position that this problem could be solved. Hans Haunschild of the German delegation, Under Secretary of Leussink's Ministry and a former Euratom official, said that it would be easy to solve the problem if the others were prepared to accept the French terms. He indicated that there appeared to be no problem at all about Germany's ratification of the NPT (which Germany had signed in November 1969) except that questions had been raised by some in Germany as to whether the safeguards procedures really did act to discriminate against the recipient country.* He mentioned recently publicized allegations of the Japanese that USAEC inspectors had interfered with the operation of a Japanese nuclear power plant. I responded that in the opinion of the United States this was solely a psychological reaction and that both of our countries would have to work to demonstrate that the problem was not a real one.

Our meeting was concluded with brief mention of the German fast flux test facility, with Milton Shaw noting that the German effort was a solid one and that he was enthusiastic about it. (Our cooperation with Germany in the fast reactor area, incidentally, has been especially satisfactory, continuing without interruption first on the original bilateral basis, then through the years when it in effect constituted part of the US-Euratom arrangement, and--since expiration of the Euratom Contracts of Association in this field--on into the recent period marked by renewed emphasis on direct bilateral exchanges.)

*The FRG completed ratification of the NPT on March 8, 1974, and deposited the instrument of ratification on May 2, 1975.

While US-German collaboration in the fast breeder field may be considered especially useful, our other exchanges on various aspects of reactor development (such as those involving maritime propulsion and the AVR pebble-bed project at Jülich) have also been productive. In fact, our cooperative activities in general have proved so mutually satisfactory that a new exchange on high temperature reactor research was initiated in March 1971; and at the time I resigned as USAEC Chairman that summer, consideration was being given to exchanges in other areas as well.

CHAPTER 5

ITALY

On December 2, 1967, the world celebrated the 25th anniversary of the first controlled nuclear chain reaction. In ceremonies and other events in the United States and elsewhere, man commemorated his entry into the atomic world and honored Enrico Fermi, the "Italian navigator" who had led the way.

The culmination of the observances was a 3-way live telecast, transmitted by satellite, that permitted the exchange of anniversary greetings and statements between President Lyndon Johnson in the White House, President Giuseppe Saragat in Rome's Capitol, and me, representing the large assemblage of scientists and others who, with me, were completing a two-day memorial program in Chicago near the site of Fermi's momentous experiment. On the stage with me at Mandel Hall on the University of Chicago campus were Mrs. Fermi, Mrs. Arthur Compton, General Leslie Groves, Italian Ambassador Egidio Ortona, Emilio Segré, Herbert Anderson (a member of the Fermi team), Mayor Richard J. Daley, George Beadle, Alice and Paul Wiener (Fermi grandchildren), Gerald F. Tape, Robert R. Wilson, Robert B. Duffield, and Kenneth A. Dunbar. Most of the living members of the Fermi team that had been present in the West Stands on December 2, 1942, including Walter Zinn, who played a leading role in the famous event, were present in the audience.

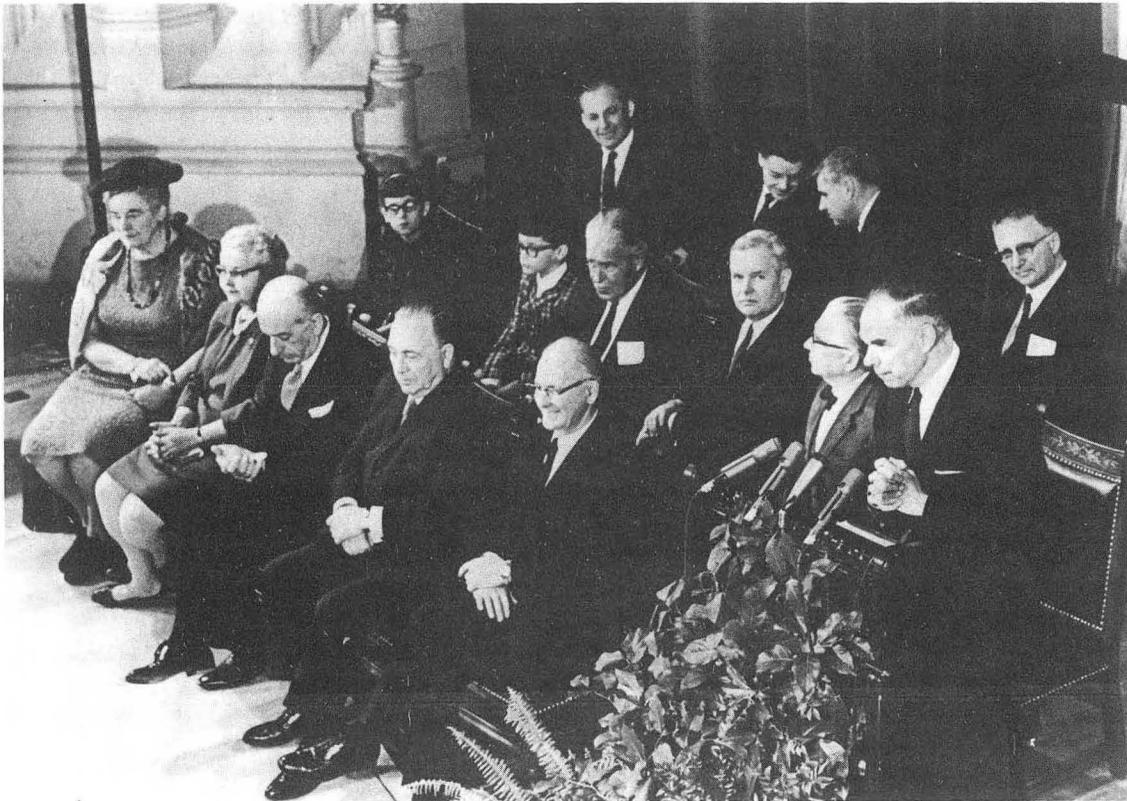
Describing the 1942 achievement as the turning point in mankind's destiny and calling on all nations to insure wise use of nuclear energy, President Lyndon Johnson took the occasion to announce an important US offer regarding application of IAEA safeguards. Of that I shall speak further when discussing the IAEA and the Non-Proliferation Treaty that was under negotiation in 1967.* In the present context I wish rather to emphasize the President's tribute to Enrico Fermi:

This modern Italian navigator was a great man of science. But he was also something more. He was one of millions who, in the long history of the world, have been compelled to leave a beloved native land to escape the forces of tyranny. Like millions before him, Enrico Fermi found here a new home, among free men, in a new world. His life and his career have a very special meaning to all who love freedom....America was born out of the voyages of a great Italian navigator. In a time of greatest danger, another — equally willing to pursue his dream beyond existing charts — took us again into a new epoch.

Today we commemorate our debt to him. And in doing so, we also honor the historic bond between the old world and the new world.

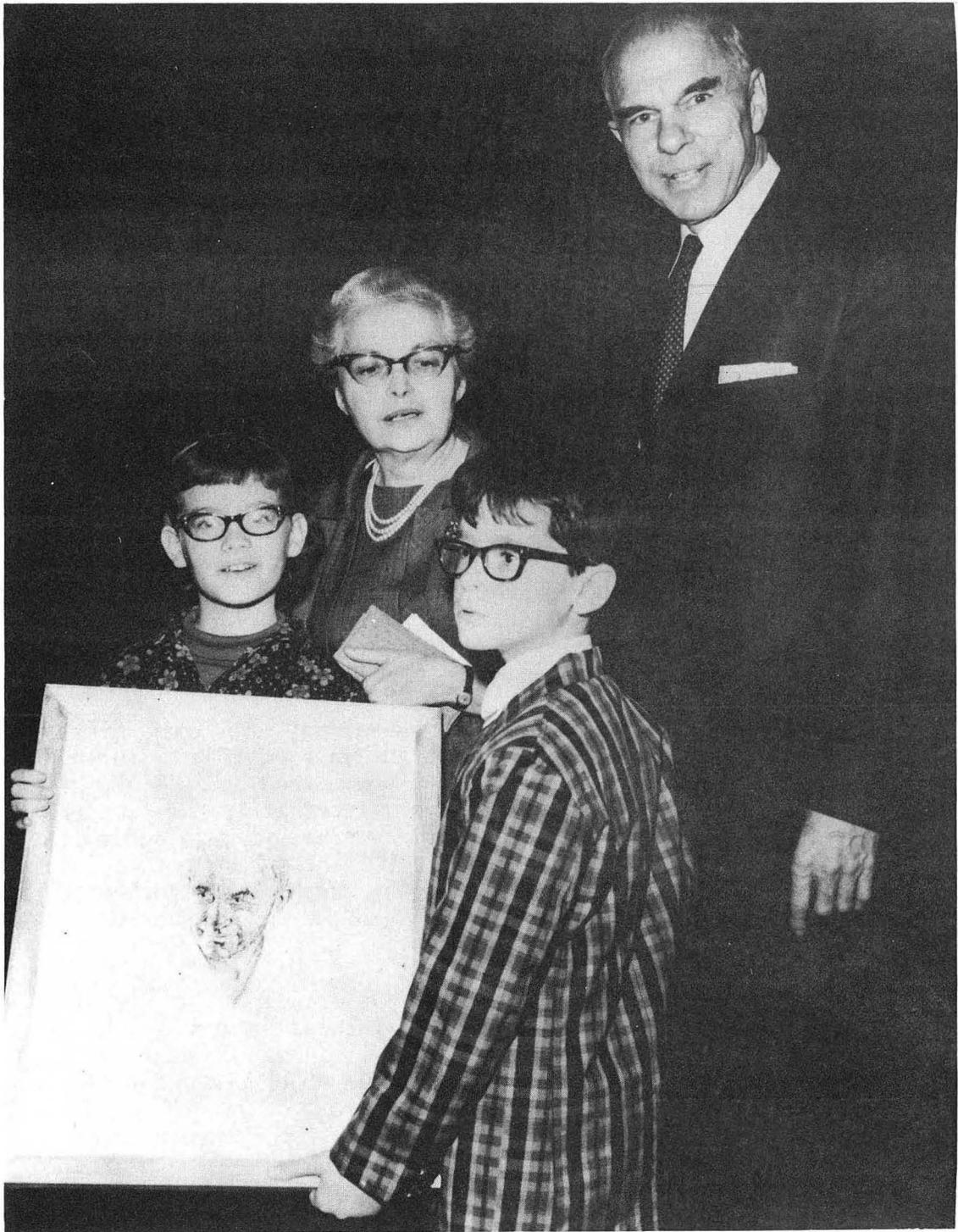
I feel that this "historic bond" between Italy and the United States has been an underlying element throughout our cooperative nuclear activities. Our cooperation with certain other countries has been just as extensive and in some cases broader, but between US and Italian nuclear

*See Chapter 14 Vol. II.



XBB 732-732-1252

Commemoration of 25th Anniversary of First Nuclear Chain Reaction, Mandell Hall, University of Chicago, Dec. 2, 1967. (Left to right) First row: Mrs. Arthur H. Compton, Mrs. Enrico (Laura) Fermi, Italian Ambassador Egidio Ortona, Mayor Richard J. Daley, George Beadle; second row: Alice and Paul Wiener (Fermi grandchildren), General Leslie R. Groves, Gerald F. Tape, Emilio Segré, Seaborg (at lectern); third row: Herbert L. Anderson, Robert R. Wilson, Robert B. Duffield, Kenneth A. Dunbar.



XBB 761-706

Commemoration of 25th Anniversary of First Nuclear Chain Reaction, Mandell Hall, University of Chicago, Dec. 2, 1967. (Left to right) Alice Wiener, Laura Fermi, Paul Wiener, Seaborg.

scientists there is a kind of special relationship rooted in the life and contributions of Enrico Fermi.

Like the other countries of western Europe, Italy was among the first with which we initiated collaboration after the establishment of our Atoms-for-Peace program in 1954. Our cooperation was formalized with the signing in 1955 of a bilateral Agreement for Cooperation, which was superseded by another signed in 1958. In accordance with our policy, already discussed, of letting our agreements with Euratom member nations expire in favor of the US-Euratom agreements, this agreement will be allowed to expire at its present termination date in April 1978.

Cooperative activities pursued under these agreements have been similar to those with other nations, involving many programs including, among others, exchanges of technical information, exchange visits of individuals and groups, assignments of Italian scientists and technicians to facilities in the United States, and the transfer to Italy of special nuclear materials for its peaceful uses program. There is a USAEC Depository Library in Rome; and under the US reactor grant program, a \$350,000 grant was paid in 1959 toward the cost of a reactor (Ispra I) constructed by Italy at its Ispra Research Center. The greater part of facilities at this center, including the reactor, was transferred in 1960 on a 99-year lease to Euratom, to become the largest of the Community's four Joint Research Center (JRC) establishments.

In speaking of our cooperation with Euratom, I mentioned my very brief visit to the Ispra establishment in the fall of 1961.* Further mention of that visit seems appropriate here, since the Center's JRC status was then fairly new and since (under the pertinent Italy-Euratom Agreement) the Ispra-I reactor and related laboratories were to remain under Italian management until 1963. Furthermore, Italy retained the right to continue some of the programs being conducted there by the National Nuclear Energy Committee (CNEN), Italy's counterpart of the USAEC, and approximately 150 Italians were working on these programs at the time of my visit.

Bilateral US-Italian cooperation was the principal concern of my subsequent visits to Italy. Before the first of these occurred, I had several useful meetings in Washington with Italian officials. On February 11, 1964, for example, Commissioner Gerald Tape and I and USAEC staff met with Italian Minister of Industry and Commerce Giuseppe Medici, Italian Foreign Affairs Minister Raimondo Manzini, and others to discuss the future role of nuclear power in Italy. On the basis of available information all appeared to feel that nuclear power was now competitive and the Italians were tentatively planning to build 5,000 MWe of nuclear power capacity within the next 10 years. (This plan proved to be over-optimistic; a number of problems, budgetary and otherwise, slowed progress on this program, and by early 1975 only 600 MWe had been installed, with another 800 MWe scheduled to go into operation later.)

In the fall of 1964 I was able to talk with Professor Carlo Salvetti, Vice-President (and effective head) of the CNEN, about matters of mutual interest when we met at the Third Geneva Conference on the Peaceful Uses of Atomic Energy. Further talks were possible at the annual IAEA general

*See Ch. 2, pp. 13-15, and also my letter to the President reporting on this trip, p. 15.

conferences. I recall in particular extensive discussions at the Eighth IAEA General Conference (1964 also) in Vienna, where Salvetti was then serving as Chairman of the IAEA Board of Governors.

Several productive meetings took place in 1965, both in the States and abroad. Italy was deciding what type of nuclear reactor to use for the future power plants contemplated. In order to have our informal views, Dr. Franco Castelli, the Director for Fossil Fuel and Nuclear Thermal Power Plants for Italy's National Electric Power Agency (ENEL) called on me on May 27, 1965. Dr. Castelli first reviewed his experience with the three nuclear plants in Italy, the PWR at Trino Vercellese on the Po River (SELNI), the BWR at Punta Fiume on the Garigliano River (SENN) - a US-Euratom Joint Program reactor - and the UK-built gas-cooled reactor at Latina. In all three cases, the nuclear plants were proving to be very good and particularly flexible in comparison with conventional plants.

I asked Dr. Castelli whether he had preference for any one of the plants. He responded definitely in favor of the US designed light-water-moderated plants (though he did not express a preference between the BWR or PWR types). He cited two principal deficiencies in the gas-cooled reactors: the large, complex refueling machine, which apparently had operational and maintenance difficulties, and the requirement of a 230-man staff for the gas-cooled station compared to the 130-man staff for a water reactor station. He also objected to the extra-large control room required for the gas-cooled reactor.

Dr. Castelli indicated they would soon be in the market for two 500-600 MWe water-moderated plants and possibly a smaller, advanced gas-cooled type such as the AGR; he stated that Italy was unlikely to purchase additional gas-cooled graphite moderated plants of the Latina design.

He noted a number of factors that pointed toward increasing use of nuclear power in Italy. They were:

1. Air pollution was an increasing problem in Europe and operating restrictions could be anticipated.
2. Some concern was expressed over clogging of ports as increasing quantities of fossil fuels had to be imported to satisfy requirements.
3. Costs of fossil fuels imported to Italy were in the 40¢/million BTU range and nuclear power was very attractive economically.

Our discussion of the above and other matters relating to nuclear power generation was mutually profitable. I was, of course, pleased to have Dr. Castelli's views (which coincided with ours) about the usefulness of nuclear power from a purely economic viewpoint as well as other considerations such as environmental pollution.

In October 1965, on my homeward journey after attending the Ninth IAEA General Conference in Tokyo, I concluded visits to several countries with a stop in Italy, for discussions on a number of topics and an extremely interesting tour of the laboratories at Frascati, the nation's principal research center for high energy physics. On this occasion I had my first look at some of Rome's famous landmarks:

"Saturday, October 2, 1965

"Arnie Fritsch (my Special Assistant) and I flew to Rome. Met by Dr. Giovanni Calderale (Secretary General of the Italian National Nuclear Energy Commission, CNEN), Dr. Achille Albonetti (Director, Division of International Affairs and Economic Studies, CNEN), Walter Ramberg (Scientific Attaché, US Embassy), Frontis B. Wiggins (2nd Secretary, US Embassy). On the way to lunch we crossed the Tiber River, saw the new Sports Palace, new large building of Ministry of Finance, Marconi Obelisk, National Museum building, Palace of Congresses (International Meeting Place, site of USAEC exhibit), Palace of Civilization, in the New City. Saw Baths of Caracalla (old Roman baths), old seven-story Roman building, Arch of Constantine, the Coliseum, in the Old City, then out through San Sebastian Gate and along the Via Appia Antica past Roman Tombs (100 BC-200 AD). Saw old Roman race track, tomb of Cecilia Metella (largest on Via Appia), some original Roman pavement on the Via Appia. Had lunch, hosted by Carlo Salvetti, at Helio Cabala restaurant, with group that met us at airport, and Edoardo Amaldi, Sydney L. W. Mellon (Minister for Economic Affairs, US Embassy), Professor Lucio Mezzetti (Director, Frascati Laboratory). Salvetti gave a toast to me - described US-Italian cooperation, but complained somewhat about difficulties that have arisen due to certain events in the United States. I responded and described my early contacts with Italian work and expressed hope our difficulties would be overcome, referred to Salvetti's coming visit to the United States in November and invited him to visit our installations.

"After lunch drove with Salvetti and Ramberg to Frascati and visited Labs. On the way Salvetti suggested that Italy cooperate with the United States on land-based nuclear marine facility. I was somewhat reserved, saying we should discuss this after our proposed facility is authorized but I said cooperation might be possible. Earlier he had said he hoped we could cooperate on the Italian Uranium Thorium Fuel Cycle Program (PCUT). I replied that 1969 date for takeover of reactor by Elk River Group would create a problem, but we would discuss it when he comes to Washington in November. Mezzetti showed us around Frascati Laboratory with large group who turned out even though it was Saturday afternoon. Fernando Amman, head of Adone (storage ring) Project, showed us this construction, to be ready in fall 1966 - 400 Mev electron linac feeding into 35 meter electron-positron storage ring to give 1.5 Bev energy. This is



XBB 7511-8155

Visit to Frascati Laboratory, Italy, Oct. 2, 1965. (Left to right in foreground) Sebastiano Sciuti, Carlo Salvetti, Lucio Mezzetti, Seaborg, Edoardo Amaldi, Arnaldo Angelini, Giovanni Calderale, Renato Cerchia, Walter Ramberg, Fernando Amman.

being built with much cooperation from Stanford and CEA and others. Carlo Bernardini (head of High Energy Division) showed us 1 Bev electron synchrotron, in operation since 1959. In the Ionized Gases Laboratory Dr. Bruno Brunelli showed us plasma physics (Euratom program) work and their machine, the Caridde; they are featuring high densities with low confinement times. Also met Renato Cerchia, Sebastiano Sciuti, and Arnaldo Angelini, Director of National Electric Power Agency, a nuclear engineer that I had met previously. Had a good impression of this laboratory. Brunelli said USAEC sponsored conference on electron rings last summer was extremely helpful."

I felt highly complimented by the fact that practically all the senior staff members and a large fraction of the some 400 laboratory personnel were on hand at the laboratories even though it was not a regular working day. I was favorably impressed both by the facilities and work in progress. Despite a limited budget, an excellent program was under way in high energy physics and controlled thermonuclear fusion. The unique \$9 million Adone project, incidentally, was finally completed in 1969, and has served as a pioneer colliding beam accelerator to give important results in high energy physics. The Euratom support mentioned for plasma physics work was being provided pursuant to an Italy-Euratom Contract of Association.

The question of US-Italian cooperation on a land-based nuclear marine facility was to be the subject of considerable future discussion. In our conversation on the way to Frascati, Salvetti told me that the CNEN was under mounting pressure to implement a proposal to build a 50,000-ton nuclear-powered tanker. He understood that the USAEC was planning such a project and wondered whether the CNEN might participate financially and by assigning some personnel to it. As things turned out, the USAEC was unable to obtain authorization for our proposed project in this field. Italy eventually went ahead with plans for a nuclear merchant ship project of its own - the *Enrico Fermi* - and sought to obtain the required nuclear fuel material from the US. Since that project was receiving support from the Italian Navy, however, we could not accede to this request under the terms of our Agreements for Cooperation with either Euratom or Italy. The fuel material was finally obtained from France.

The Italian Uranium-Thorium Cycle Program (PCUT) was initiated by the CNEN in 1958 for the purpose of developing a pilot plant in Southern Italy, (ITREC) for the recovery of such fuel and its refabrication into U-235/U-233 fuel elements. They wished to initiate operation of the ITREC plant with fuel elements from the US Elk River Reactor, which was operating in part on uranium-thorium fuel assemblies. Negotiations on this proposal were already under way when I visited Frascati (CNEN Secretary-General Felice Ippolito and I had signed the USAEC-CNEN Memorandum of Understanding in the USAEC Germantown headquarters on November 14, 1962, in the presence of his colleagues Achille Albonetti, head of international activities for CNEN, Gaetano Lanzano, CNEN representative in Washington, and Roberto Cangiano, Lanzano's assistant, and, on our side, USAEC Commissioners Robert E. Wilson, John G. Palfrey, and Leland H. Haworth, and Myron B. Kratzer, USAEC Division of International Affairs); and we were able to complete them during Salvetti's visit to the United States the following month.



XBB 761-7004

Signing of USAEC-CNEN Memorandum of Understanding re Elk River Reactor in USAEC Chairman's office, Germantown, Nov. 14, 1962. Left to right around table: unidentified, Gaetano Lanzano, Achille Albonetti, Felice Ippolito, Seaborg, Commissioners Robert E. Wilson, John G. Palfrey, Leland J. Haworth; Roberto Cangiano, Myron B. Kratzer.

After leaving Frascati, we devoted the remainder of our stay to sight-seeing:

"Returned to Rome to visit historic sites. Saw Circus Maximus on one side of the Palatine Hill, the Forum at its foot, and the Coliseum; Capitoline Hill (where government officials were located in ancient times) - Tiber River bridge (oldest) - St. Peter Basilica - Hadrian's Tomb - Raphael's house. We had cold drinks with Rambergs at their apartment. In evening Fritsch and I visited Piazza Farnesse (pretty palace, now French Embassy) - Campo dei Fiori (flower market) - Piazza Navona (statues of four seasons in square) - Pantheon (138 ft. dome, early Roman church) - Piazza Colonna (Marcus Aurelius column) - Trevi Fountain (horses carved out of rock on back of building) - Piazza del Quirinale (President's house fronts on this) - inside of Coliseum (beautifully lighted) - Spanish steps - Nero's tomb - American Embassy - Via Veneto."

"Sunday, October 3, 1965 - Rome to Paris and Washington

"Ramberg accompanied us to airport for our flight home. On the way visited Ostia (old Roman city at mouth of Tiber River). An extensive area has been excavated - it would be interesting to walk through the old lanes and streets - much remains to be excavated."

In the account of my visit to Frascati, mention was made of Salvetti's intention to visit the United States the following month. He came as planned, timing his visit in order to permit him to address the Atomic Industrial Forum on November 16, 1965. He was accompanied by Achille Albonetti.

A principal subject of the Italians' discussions with us during their visit was the proposed US-Italian cooperation with respect to the PCUT program already referred to. Agreement was reached on this, and on November 17, 1965, Salvetti and I, with USAEC Commissioner John G. Palfrey and Assistant General Manager for International Activities John A. Hall, participated in the public signing of a CNEN contract providing for Italian processing at its Trisaia facility, then still under construction, of fuel elements from the US Elk River Reactor (ERR). At the same time we exchanged two sets of letters, one stating agreement to establish a related technical exchange arrangement dealing with the recycling of thorium-based fuels, and the other outlining cooperation planned in a different area: the application of nuclear energy to water desalination, another matter that had been under negotiation, pursuant to a proposal by Albonetti earlier in the year.

We were not able to satisfy completely the Italian request for cooperation with respect to the PCUT project. Salvetti had hoped that the USAEC would make a financial contribution to the project greater than what we had agreed would be possible as payment for the fuel reprocessing envisaged; we could not do this because of our budget limitations and program interests. Furthermore, during our discussion following the contract signing and letter exchanges, Salvetti asked whether the USAEC could use its good offices to



XBB 761-7005

Signing of USAEC-CNEN Contract for Italian Processing of Elk River Reactor fuel elements in USAEC H Street, Washington, D.C. headquarters, Nov. 17, 1965. (Left to right) seated Carlo Salvetti, Seaborg, standing John G. Palfrey, John A. Hall.

the end that fuel from the Dresden Nuclear Power Station, operated by Commonwealth Edison, might also be reprocessed in the PCUT plant. I pointed out that Commonwealth had already negotiated an arrangement with the US firm Nuclear Fuel Services for the reprocessing of Dresden fuel, and explained that we could not place ourselves in the position of putting pressure on private industry. This was therefore a matter to be resolved by the companies involved. At the suggestion of USAEC Director for International Affairs Myron Kratzer, it was left that the USAEC would have no objection if the CNEN wished to approach Commonwealth and/or NFS.

Despite Italian disappointment on the points mentioned above, Salvetti's visit with us was on the whole a mutually satisfactory and productive one. It concluded with a lunch I hosted for him at the Mayflower Hotel. Among those present, in addition of course to Albonetti, were Italy's Ambassador in Washington, Sergio Fenoaltea, CNEN's Washington representative, Gaetano Lanzano, USAEC members and staff, John Conway and George Murphy representing the JCAE, Donovan Zook of the State Department, and Charles Johnson of the White House Staff.

No significant visits took place in 1966, and it was not until the fall of 1967, again after the IAEA General Conference, that I again traveled to Italy. This time I was able to see more of the sights than in 1965:

"Saturday, September 30, 1967 - Venice to Florence

"The train arrived in Venice about 9:30 a.m. We checked our bags at the railroad station all under one baggage check. This relies on the memory of the attendant to a certain extent to get the same eleven pieces back. Venice (Venezia) is situated on an island criss-crossed with canals and with narrow lanes for roads, permitting no automobiles. Herman (of the State Dept.) and June Pollack, Julius Rubin (my Staff Assistant), Helen and I went down to the nearby canal and hired a gondola to take us to the Piazza San Marco. We passed near the Bridge of Sighs, which connects the Palace (where the Doge passed sentences on criminals) with the prisons on the other side of the narrow canal. We cut across to the Piazza San Marco, disembarked on the back side of the square. This square is overlooked by the Campanile.

"We walked around the Piazza and went to the Palazzo Ducale (Doge's Palace) where we rented headphone sets for the tour. The construction of the palace began in 1424. We walked up stairs, including the Golden Staircase. The Bridge of Sighs was visible out the window. A fire in 1577 destroyed the interior; the murals, therefore, were made after that date. We went through the Sala dell'Anti-collegio, a room of beautiful paintings, still containing its original furniture. Next we went through the Sala del Senato. Here the Doge presided over the assembly. We

visited the Room of the Council of Ten, with the nearby torture chamber. We went through the Sala Della Bussola (Room of the Compass), which contains the Lion's mouth opening for secret messages. We visited the room in which the three heads of the Council of Ten made their deliberations. Then we entered the Hall of the Grand Council, which contains large impressionistic paintings on the four walls and the ceiling (which was decorated with carved gilt wood). This room contains the largest oil painting in the world, extending over the entire 80-foot wall. Next we went to the Sala dello Scrutinio, where elections used to be held. We retraced our steps through the Hall of the Grand Council and crossed the Bridge of Sighs. Seven steps led to 'the cage' (dungeon), which we toured. We completed our tour by walking past the courtyard where the coronation of the Doge took place.

"After lunch at a cafe on the Square, we went into the Basilica of San Marco, where we saw the tomb of San Marco (Saint Mark the Evangelist) and the Golden Screen - a wall chart with gold inlays and some 2800 jewels. We also saw 'The Treasure,' a miscellaneous collection of chalices, jewels, skulls and bones of early saints, Byzantine works of art, altars, etc.

"We then walked back, across the island of Venice, along the narrow streets, to the railroad station. We crossed the well-known Rialto Bridge on the way.

"We boarded the train for Florence (Firenze), leaving about 5:20 p.m., and arriving about 9:00 p.m. During the train ride, I read a stack of AEC papers, sent from my office in Washington."

"Sunday, October 1, 1967 - Florence to Rome

"A car from the American Consulate was put at our disposal by American Vice Consul Allen S. Greenberg, whom we met at our hotel (Anglo-American) before our tour.

"Helen, Julie Rubin, and I started our tour by going to Galleria dell' Accademia. Here the feature attractions were the huge marble sculpture of *David* by Michelangelo and a number of his unfinished sculptures. Next we went to the Uffizi Gallery on the Arno River. (The Arno flooded Florence last year and produced much damage to priceless art treasures.) On the way we passed through the Piazza della Signoria, the largest square in Florence, dominated by the Palazzo della Signoria, containing much statuary. In the Uffizi Gallery we saw many paintings and sculptures by the masters of all ages, including Michelangelo, Leonardo da Vinci, Botticelli, and Titian.

"Next we went to the Museum of the Pitti Palace,

the home of the Medicis. We saw the Museum of Silver, which also contained an amazing collection of goldware. We saw the Great Cabinet in ebony and semi-precious stones, the 54 silver cups gilded by goldsmiths of Augsburg, the Medici jewels, the Cabinet of Alemagna, rare furniture, etc. We saw part of the Boboli Gardens with their formal landscape designs and marble statuary. We visited the Museum of Carriages, which contained a fifth century carriage in good shape, as well as a number from the 15th and 16th centuries, including carriages used by the Medici family.

"We went to the Medici Chapel, but it was closed. We then went to the Buonarroti House, which is the house that Michelangelo Buonarroti had built for his family and which was left to Florence upon the family's extinction in 1858. Here we saw small models for Michelangelo's sculptures (including one for *David*), a collection of his drawings, some large unfinished sculptures, the celebrated Madonna della Scala, his first and second sculptures (done at ages 15 and 16), and his last sculpture.

"We had lunch at the Ristorante La Loggia at Piazzale Michelangelo.

"We visited the Boboli Gardens for a more complete look. We walked clear to the top where a guide described the significance of the marvelous view. He pointed out to us where Galileo had lived and the Belvedere Castle. We then went to the Piazza della Signoria. We saw the famous Ponte Vecchio on several occasions as we crossed the Arno River. We walked around the Piazza dell Signoria looking at a huge copy of *David*, other statuary, and the Signoria Palace.

"We next walked across the Ponte Vecchio. This bridge has very small shops on both sides of the passage-way across the Arno River. This bridge apparently intensified the effects of the flood last year by causing a pile-up of debris.

"We saw water-level marks from the November 4, 1966, flood as high as 12 feet on some of the buildings near the river.

"We next went to the Duomo Square to see the magnificent Cathedral, in Gothic style, adorned with marble veined in green, red, and white. Michelangelo was the architect and painted the murals on the outside front. Next to the Cathedral is the Baptistry, with its famous bronze doors, notably the *Door of Paradise* by Ghiberti. We also saw the 14th century Campanile by Giotto, which is 292 feet high.

"During the morning we had also attempted to visit

the Museum of the History of Science at Piazza dei Giudici, but it was closed. This is apparently a very interesting, although little known, museum containing the early instruments of Galileo.

"We returned to the Anglo-American Hotel, packed our bags, and went to the railroad station. Although we had been told we didn't need train reservations, it was only with great difficulty that we managed to get seats.

"We arrived at the Rome railroad station at about 8:40 p.m. It was a madhouse, due to the mob of people, in getting ourselves and our luggage off the train. We managed to get our luggage aboard the Excelsior Hotel taxi and rode to the hotel, where we checked into a suite.

"We met Walter and Elizabeth Ramberg and went to the US Embassy next door where a car with a driver was made available. We made a short tour of old Rome. We passed the palatial quarters where President Saragat lives at Piazza Quirinale, the seat of the Italian government. We passed the Trajan's Column and Venezia Square containing the building with the balcony from which Mussolini spoke to the assembled masses. We then went to the Piazza del Campidoglio on the Capitoline Hill, the seat of the government of Rome; these buildings were designed by Michelangelo. From here we saw the Roman Forum, including the Senate, the Via Sacra, and the Coliseum. We went to the Coliseum and entered it - a magnificent view even at night. We passed the Arch of Constantine and the Arch of Titus, the Palatine Hill (with the remains of the palaces of many Roman emperors) overlooking the Circus Maximus. Here we saw the place where Romulus and Remus were supposed to have obtained sustenance from the wolf. The Palatine Hill is the oldest section of Rome. We saw a Roman bridge, now used by automobiles, over the Tiber River. We dropped the Rambergs at their apartment, one of three in an old palace still inhabited by members of the Caetani family, which dates back to 800 A.D. in Rome."

"Monday, October 2, 1967 - Rome and Casaccia, to New York and Washington

"Rubin and I met Salvetti, Dr. Achille Albonetti, Ramberg, and Ambassador Frederick Reinhardt in front of the Excelsior Hotel, before setting out for the Casaccia Center, north of Rome. We drove on a road which used to be the old Roman road 'Via Cassia.' The Ambassador described the various objections the Italians have to the Non-Proliferation Treaty - discrimination, violation of their constitution which prohibits signing an unequal treaty, problems with Euratom, indefinite length of the treaty, etc.

"When we arrived at the Casaccia Center for Nuclear Studies, which is one of the main laboratories of the Italian CNEN and is oriented toward technology and engineering, we were greeted by a large number of people who were outside the lecture hall awaiting our arrival. Among these were Dr. Gianfranco Franco (Director of the Casaccia Center for Nuclear Studies), Professor Arnaldo Angelini (Director General of the ENEL), Mario Rollier who worked at the Berkeley Radiation Laboratory in 1951, Dr. Massimo De Biase (Public Relations, Casaccia Center for Nuclear Studies), Mr. Pietro Bullio (Secretary General, Italian Nuclear Energy Forum, FIEN), and Professor Dr. Sebastiano Sciuti (University of Rome, and head of Nuclear Physics at Casaccia).

"Casaccia means 'old house' (or 'bad house,' according to Ramberg). It was named after an old factory (now an electronics building), which occupied the site when the laboratory was started here in 1959.

"We went into the lecture hall, where I was introduced by Salvetti for my lecture, 'Recent Research on the Transuranium Elements,' illustrated by slides, and followed by questions. My lecture was taped for subsequent issue to the staff for their information - we are to send slides to Dr. De Biase.

"After my lecture, Franco and Salvetti gave a description of Casaccia, with the use of maps and charts. They gave us copies of descriptive material to take with us. The total staff consists of 1200 people. The breakdown is as follows: 27% with University degrees, 54% technicians with or without degrees, and 19% in general services. The annual budget is \$13,000,000, of which about 50% is in salaries, and the capital plant investment is about \$22,000,000.

"I discussed with Salvetti the ceremonies in Chicago and Rome scheduled for December 2 on the 25th anniversary of the first controlled nuclear chain reaction. He told me that in the Rome ceremony Amaldi will talk about Enrico Fermi, and Minister Giulio Andreotti (Industry and Commerce) will talk about the 25 years of progress in nuclear energy. They could schedule the Rome ceremony for 6:00 p.m., which would be 11:00 a.m. Chicago time, and thus we could have a direct conversation, perhaps by satellite. Also, President Saragat would participate, if President Johnson would (in his case presumably from Washington). I am to get in touch with Herbert Anderson (Chicago) and John Harris (USAEC) and the White House about this and let Salvetti know when I meet him in Warsaw later this month (on October 17) at the Curie anniversary. Bullio also participated in this discussion. FIEN will participate in the December 2 ceremony in Rome. (FIEN publishes the newsletter, 'Atomo e Industria.')



XBB 761-7003

Lecture Hall, Casaccia Center for Nuclear Studies, Oct. 2, 1967 (Left to right) US Ambassador to Italy Frederick Reinhardt, Carlo Salvetti, Seaborg, Gianfranco Franco, Arnaldo Angelini.

"We then began our tour, using a bus to conserve time. At every stop people were ready, with charts, to present their program. It was done very efficiently.

"We visited first the Radiobiology Section. The head of this work, Dr. Valerio Monesi, described it to us. They are measuring the effects of radiation on generations of mice; they use about 25 different strains, and breed about 80,000 mice a year. They study mutations in wheat, using cobalt-60 gamma rays and neutrons. Their products are tested by raising wheat in numerous countries such as UAR, Libya, Turkey, Iran, and India, in cooperation with FAO and IAEA, and on the Isle of Capri. Monesi talked to me about their proposed exchange agreement with Dr. Sheldon Wolff (Professor of Genetics) and Harvey Patt (Dean) of the Laboratory of Radiobiology of the University of California, San Francisco (Medical School). They have contacted Dr. Herman Lewis, head of the cellular biology section of the National Science Foundation. The money is to come from NSF to be administered by the USAEC at their project at the University of California, San Francisco. The project would involve exchange of personnel, visits, etc. Perhaps we can check on the status of this.

"Next we visited the Nuclear Physics Section. Dr. Antonio Paoletti showed us the work with their Triga (1 MW) research reactor. We had a short look at the Triga reactor and its neutron measuring apparatus.

"Next we visited the Reactor Technology Section. Dr. Giuseppe Bianchi, the head, described their work on water cooling loops. The heat exchange work includes work on the liquid sodium steam producing system in connection with fast breeder development.

"We saw the building under construction to house Tapiro, a fast neutron source reactor of essentially zero power (less than 30 watts).

"In the course of the tour, Salvetti told me about a problem that has arisen in our collaboration with them in which some of our Elk River fuel elements will be processed in PCUT. There are some differences remaining concerning the specifications which we will accept. He will write me concerning this and hopes I will intervene next spring, when their plant will be ready.

"We next visited the Geo-Mining Laboratory. They are exploring for uranium all over Italy, including Sardinia. They have located 1500 tons of ore containing about 12% uranium, recoverable at a cost of \$8-10 per pound, and can see a potential for an additional 10,000 tons.

"Next we visited the Fuel Elements and Materials Technology Department (Metallurgy and Ceramics). Fabio Pantanetti, Vice Chief - Geomining Lab, and G. Colabianchi, Vice Chief - Lab for Material Technology, and other members showed us samples of uranium alloys, uranium fuel elements of numerous shapes, ceramic work on pelletizing and compaction by vibration, and uranium oxide and thorium oxide fuel elements, etc. We saw a Hot Laboratory, rather modest in size, in which fuel from an ENEL power reactor was being examined.

"Following the tour, we were served refreshments. Many of those who briefed us on the tour were present. Salvetti gave me a medallion commemorating the Casaccia Reactor Center. Sebastiano Sciuti asked me to send him some material on the Omnitron, which I promised to do. I was interviewed by Pino Cultrera, Science Editor, ANSA, National Wire System, on my visit to and impressions of Casaccia.

"I then rode to Fumicino (Rome) Airport in Ambassador Reinhardt's car with Rubin and Ramberg. We saw girls along the highway who apparently wanted to be picked up.

"We met Mario Rollier at the airport. He had come to discuss a problem with me. He wants to arrange a cooperative arrangement with some US laboratory (such as National Bureau of Standards or Texas A and M) in neutron activation analysis. He tried to do so with General Atomic (and lent me some correspondence which should be returned to him), but they feel that in view of their status as a private company they cannot do this. Rollier has a Triga Mark II Pulsed Reactor (250 KW) at the University of Pavia. He needs to expand the possibilities with this through such an international cooperative arrangement. If we can locate such an interested party in the US, he will then get in touch with Vincenzo Caglioti, President of the Italian National Research Council, in order to work out the arrangements in connection with the recently effected US-Italian Agreement for Cooperation in Science and Technology.

"Also at the airport was Professor Vera Maxia, a former student of Rollier (who worked with Jack Hollander at Berkeley in 1960-61), and now a professor of nuclear chemistry at the University of Pavia. Rollier said he has another student at Berkeley finishing a two-year stint with Stanley Thompson.

"We encountered an incredible problem at the airport. Although the tickets for our flight were marked for a 2:00 p.m. departure (and we had reconfirmed), the plane had departed at 1:15 p.m., five minutes before we got there.

"The schedule had been changed on September 24 - over a week earlier! We tried to get on an Alitalia flight, but it was full, and the TWA man told us there was no way to fly to the United States tonight. Ramberg phoned the Embassy and they located an El Al flight to New York scheduled to leave Rome at 4:15 p.m., and Rubin and I succeeded in getting seats on this all-coach flight. We spent much of the intervening time in the TWA lounge with Ramberg, Rollier and Vera Maxia, finally departed for New York, then continued on home to Washington.

"Helen was scheduled to fly home tomorrow, so she spent the major part of the day sightseeing in Rome (the Vatican, Sistine Chapel, Vatican Museum, etc.) with Mrs. Ramberg and her daughter. She had dinner with the Rambergs in their apartment and then spent the night at the Excelsior Hotel."

Although that 1967 visit in Italy was my last as USAEC Chairman, there were periodic opportunities for personal discussions with Italian officials concerned with nuclear matters. On December 5, 1967, for instance, I met with Dr. G. Agnelli (Chairman of Fiat in Torino), Vincent Garibaldi (US representative of Fiat), and William E. Knox (Westinghouse, retired) in my office in Washington to discuss details of the Non-Proliferation Treaty and peaceful uses of atomic energy.

In the fall of 1968 I had my usual conversations with Salvetti and others at the IAEA General Conference in Vienna regarding a number of subjects. On one occasion my group and I met there with Salvetti and the Italian Minister of Commerce and Industry, Giulio Andreotti, and the Italian Ambassador to Austria, Roberto Ducci. Their chief concern at that time was their desire for US support for an Italian proposal regarding an enlargement of the IAEA Board of Governors that was expected to permit permanent Italian membership. This subject was a recurrent theme in US discussion with the Italians during the next two years.

Of course, there continued to be occasions for conversations in Washington with Italian officials. On November 10, 1968, for example, a reception given by Mr. and Mrs. Gaetano Lanzano (the CNEN's Washington representative) provided an opportunity for brief talks with Italian Ambassador Egidio Ortona and Carlo Salvetti, as well as European Community Commissioner Fritz Hellwig. Fuller discussion of questions of mutual concern was possible some weeks later, on December 18, when Ambassador Ortona and Umberto La Rocca (Counselor Italian Embassy) called on me in my office. After first thanking me for the copy I had sent him of the film taken at the 25th anniversary celebration of the first controlled nuclear chain reaction (which he had attended in Chicago), he turned to the matter of the IAEA Board of Governors enlargement. He emphasized that this was extremely important to Italy, and he related it (as had Andreotti in Vienna) to the Italian signature of the NPT; he stated that it was important as an indication that Italy was in on major decisions in the nuclear field.

The second item introduced by the Ambassador was the UK-Dutch-German plan to collaborate in the development and exploitation of the gas centrifuge process for producing enriched uranium. He stated that Italy wanted to take part in the development of this process. He expressed understanding that this was a classified area but requested that a US veto on Italian participation due to the classification not be the deciding factor in regard to their joining others in centrifuge development. The Ambassador stressed Italy's desire to participate actively in this project, not merely to take advantage of the results as a later member of some broader arrangement. He noted that Italy, like the Netherlands and Germany, was a member of Euratom, and he mentioned Italy's interest in and support for the UK bid to enter the Common Market.

I cautioned the Ambassador against placing too much dependence on the promise of the gas centrifuge. I indicated that I was optimistic but that a large amount of work and expenditure of funds for many years would be required to make this process competitive with our present gaseous diffusion system for enriching uranium. The Ambassador stated that it was his understanding the Dutch were ahead of others in this development. I responded by indicating that they might be further along than some others, but that their progress was still very small in the total yardstick of achieving a reliable operating system.*

During the succeeding years our bilateral cooperation continued along established lines except with respect to Italy's PCUT project. The 1965 arrangement to have uranium-thorium fuel elements from our Elk River Reactor (ERR) reprocessed and refabricated in the CNEN's pilot plant could not be carried out, for various reasons. A basic problem was the delay in completion of the Italian reprocessing facility; this made it impossible for them to reprocess and refabricate ERR fuel elements in accordance with the agreed schedule. Subsequently the decision was made to shut down the ERR, and this made fabrication of a new core unnecessary. Therefore renegotiation of the USAEC-CNEN contract, to provide only for reprocessing the ERR fuel, was undertaken. In the spring of 1970 the Italians negotiated an agreement with the Norwegian Institute for Atomic Energy (IFA) to fabricate some of the recovered ERR fuel into fuel assemblies that could be used in the ENEA Halden Reactor Project in Norway. Continued difficulties at the PCUT facility ultimately resulted in cancellation of these plans, however.

At the IAEA General Conferences of 1969, 1970, and 1971, and at the Fourth International Conference on Peaceful Uses of Atomic Energy, held in Geneva in early September 1971, there were numerous occasions for talks with Italian representatives such as Carlo Salvetti, Roberto Ducci, and Massimo Casilli d'Aragona, Italy's Acting Permanent Representative to the IAEA. In Geneva, in addition to Salvetti and others from the Italian nuclear community attending the Conference, there were several representatives of the Italian press with whom I met for various types of interviews. The questions they asked reflected the Italians' keen interest in all aspects of peaceful nuclear development,

* Italy eventually elected to join the Eurodif consortium, which is developing the gaseous diffusion technique for uranium enrichment.

and the content and quality of their Geneva exhibit showed their determination to press forward especially in the field of nuclear power.

In Vienna, a major item on the agenda at the 1970 IAEA General Conference was Italy's proposal for enlargement of the Board of Governors, and there were many discussions on this (and on various other enlargement plans), both with Italian delegates and with others. The United States had decided to support the Italian proposal. We joined a number of other nations in co-sponsoring it; and when the vote was taken, this proposal was decisively approved by the Conference.

Again in 1971, Italy (like the other European Community nations) had a special interest in one of the principal topics at the Agency's General Conference - the agreements to be made between non-nuclear weapon states party to the Non-Proliferation Treaty and the IAEA, to provide for Agency administration of safeguards. As I have already indicated, this matter represented a particular problem with respect to Italy and other non-nuclear weapon state members of Euratom. Although they had signed the NPT, these nations were not prepared to initiate ratification procedures until an accord had been worked out providing for IAEA verification (rather than replacement) of the Euratom Safeguards system. When the 1971 General Conference opened, the Council of the European Communities had not yet authorized the Commission of the Communities to undertake negotiations directed toward such an agreement. There was general relief and satisfaction when, as noted in my journal of September 22, 1971, Mario Pedini of Italy "made the important announcement that the Council of the European Community had... approved the mandate for negotiating the Safeguards Verification Agreement with the IAEA." Though a year and a half would pass before the agreement was finally approved, the essential first step had been taken toward NPT ratification by Italy and its Euratom partners.

CHAPTER 6

BENELUX

Belgium and the Netherlands, despite their small size, play significant roles on the international nuclear scene. Together with tiny Luxembourg, they have been staunch supporters of Euratom and the other Communities. In fact, these three nations may be said to have taken the lead in the movement toward European integration when they adopted on January 1, 1948, a customs union that was expanded to the Benelux Economic Union ten years later.

As I have already reported,* one of Euratom's Joint Research Center (JRC) establishments is located in Belgium (the Central Nuclear Measurements Bureau at Mol) and another in the Netherlands (the High Flux Reactor and related facilities at Petten). In addition, nuclear-related functions of the European Communities are based in Luxembourg.

Both Belgium and the Netherlands have their own extensive research facilities, and both have long conducted important nuclear programs, which grew dramatically during the 1960's; Belgium's nuclear energy budget, for example, more than doubled between 1960 and 1969. Both nations have recognized the potential importance of nuclear power. Undiscouraged by difficulties that for two years plagued the Franco-Belgian SENA plant, constructed under the US-Euratom Joint Reactor Program, Belgian utilities joined with French in 1969 in another binational power project (SEMO), located at Tihange in Belgium; and another, entirely Belgian venture was launched at the same time at Doel (400 MWe), north of Antwerp. The Netherlands, having started their utilization of nuclear power with a small (54 MWe) station at Dodewaard that attained criticality in July 1968, also moved ahead in this area with construction of a 470 MWe plant (Borssele-1) in the province of Zeeland.

Belgium and the Netherlands are also energetically engaged in research and development of advanced reactor concepts. Fast reactor work, partially supported by Euratom, has been conducted by these nations in collaboration with each other and with Germany; Luxembourg also participates in a limited way in this project. Both Belgium and the Netherlands (particularly the latter) have carried out studies related to nuclear ship propulsion. Fuel reprocessing and other stages in the nuclear fuel cycle have also received attention; and I mentioned earlier the Dutch participation with Germany and the UK in the tripartite ultracentrifuge enrichment project launched in 1969.* In 1974 Belgium ordered (from its own manufacturers) four nuclear power units (two 950 MWe and two 1000 MWe), scheduled to go into operation at the end of the decade.

* See Chapter 2.

In line with their generally international outlook, both Belgium and the Netherlands have actively supported not only Euratom but other multilateral organizations such as the European Organization for Nuclear Research (CERN), the European Nuclear Energy Agency (ENEA), and the International Atomic Energy Agency (IAEA). They also cooperate with other nations independently and together; aside from instances already cited, mention may be made of a tripartite Dutch-Belgian-USSR cooperation agreement that went into effect in 1955.

Our country's association with Belgium in the nuclear area goes back to World War II. Uranium ore from the Belgian Congo, which had been taken to the United States by Edgar Sengier of Union Miniere, was used in the Manhattan Project; and, later, in 1944, additional supplies of this vital source material were assured by agreement with the Belgian Government-in-Exile in London. After our Atoms-for-Peace program was launched pursuant to the Atomic Energy Act of 1954, formal cooperation between the United States and Belgium and the Netherlands was initiated with agreements signed in 1955 (Belgium) and 1956 (the Netherlands). (The 1955 Agreement with Belgium was amended in a document signed by Louis Scheyven of Belgium and William R. Tyler and myself on August 7, 1963.) These Agreements were allowed to expire in 1965 and 1967, respectively, in line with our "fold-in" policy of letting such agreements lapse and thenceforth supplying special nuclear materials under our agreement with Euratom. As with France and Germany, we emphasized when the individual agreements terminated that bilateral cooperative activities would continue uninterrupted. These activities have included information exchanges, visits and training assignments, provision of USAEC Depository Libraries, the lease and sale of special nuclear materials for research and power purposes, and a \$350,000 grant each toward construction of research reactors at Mol, Belgium, and Petten in the Netherlands.* In addition, we have engaged in technical exchanges with the Dutch in two research areas. One of these exchange arrangements, in effect since 1962, concerns work being done in the field of homogeneous slurry reactors by the Dutch firm (partially government-supported) Electronic Materials Testing Company (KEMA), and related USAEC activities. This has involved close contacts between KEMA and our ORNL, with visit and information exchanges and assignments of ORNL scientists to KEMA to assist in the latter's construction of its Suspension Test Reactor (KSTR).

Our other exchange arrangement was initiated in the fall of 1970 between the USAEC and the Netherlands Organization for industrial Research (TNO) in the area of fast breeder research. This arrangement provides for the exchange of information on TNO's Sodium Component Test Facility (SCTF) at Hengelo in the Netherlands and our Sodium Component Test Installation (SCTI) located at the Liquid Metal Engineering Center (LMEC) at Santa Susanna, California.

*On March 29, 1963, I personally presented the research grant check for \$350,000 to Ambassador J. H. van Roijan of the Netherlands.

Close contact with Belgian and Dutch nuclear organizations and scientists is assured through the USAEC Scientific Representatives in Brussels, whose liaison and reporting responsibilities include not only Euratom but also the national programs of its members countries. (An exception should be noted in the case of the French national program and US-French cooperation, which constituted the primary interest of the USAEC office in Paris for over 15 years. In 1972 the decision was made to close that office and transfer its functions to USAEC Brussels.)

With Belgium the location of Euratom headquarters, it is not surprising that meetings and discussions during my many visits to that country involved primarily our dealings with the Community. However, there were also occasions for meetings devoted instead to Belgium's national nuclear program and US-Belgian bilateral cooperation, and there were opportunities to inspect Belgian facilities. In fact, on my initial trip to Belgium as Chairman of the USAEC, my first contacts were with Belgian officials and my first visit was to Belgium's principal nuclear research installation, the Nuclear Energy Study Center (CEN) at Mol, about 50 miles northeast of Brussels:

"Friday, September 21, 1962 - Vienna to Brussels

"I flew to Brussels with Dan Wilkes (USAEC Consultant), Algie Wells (Director, USAEC Div. of International Affairs), and Chris Henderson and Cecil King (staff assistants). We were met by John Erlewine (our AEC representative) and Mr. Paternotte of Belgian Foreign Office and others. We were driven to Mol Laboratory where we visited the BR-1, BR-2, and BR-3 reactors, the Transuranium Laboratory (where americium and curium work is going on), and the plutonium ceramic laboratory. I saw Greg Choppin, and Al and Kay Florin (of Met. Lab. days). I had dinner with Louis De Heem (Director General of Centre d'Etudes de l'Energie Nucleaire--CEN--Belgium), Julien Goens (Scientific Director of Mol Center), Jean Van Der Spek, and others."

The BR-2 reactor mentioned above was the one partly financed by a US grant. It had achieved criticality a year before my visit. Pursuant to a Contract of Association, it was operated jointly by Euratom and CEN through 1967. Since then, it has been operated jointly by the CEN and the German firm Gesellschaft für Kernforschung (GFK), primarily for irradiation experiments under the fast reactor program.

As I reported when speaking of our relations with Euratom,* I visited Belgium again in the fall of 1964 following the Third General

* See Ch. 2, pp. 20-21.

Conference on the Peaceful Uses of Atomic Energy. At that time plans were being completed for the introduction in the United States of "toll enrichment" arrangements, whereby the USAEC, instead of selling or leasing enriched uranium, would normally (starting in 1969) sell the service of enriching uranium owned by prospective users. United States Government elements and foreign officials responsible for nuclear power planning shared a belief that it would be helpful for me to explain developments to a representative audience abroad. An appropriate opportunity was seen when my 1964 itinerary was being decided. Through the cordial assistance of Dr. William A. de Haas, President of both the Netherlands Atomic Forum and Foratom--an international organization of non-governmental nuclear associations of European countries--and under the particular sponsorship of Belgicatom, the Belgian member association, arrangements were made for me to speak during my stop in Brussels. After a day of meetings with Euratom officials and some sightseeing, including a visit to Waterloo by Mrs. Seaborg, Arnie Fritsch, Dan Wilkes, and myself, I addressed the Foratom gathering:

"Friday, September 11, 1964 - Brussels

"Gave a talk on the past, present, and future US nuclear fuel supply policy, to invited guests of Foratom at the Shell Auditorium. The talk was well attended. I was introduced by de Haas of Phillips, President of Foratom. Later had lunch at Ambassador (to the European Communities) John Tuthill's with Paul de Groote, Robert Margulies, Emanuel Sassen, Jean-Marc Boegner, Albert Borschette, des Muelen, Ugo Mosca, de Haas, Alphonse Huss, General Lucien Leboutte, Giorgio Riccio, John Schaetzel, Myron Kratzer (Director, Division of International Affairs, USAEC), and Charles F. Schank (USAEC Scientific Representative, Brussels)."

In my Foratom talk I first stressed US cooperation with Euratom and paid tribute to the latter's "leadership in finding new and constructive means for organizing peaceful nuclear power." After referring to the widespread, growing confidence in the potential contribution of nuclear power generation, I spoke briefly of certain reactions to the advances achieved in power reactor manufacturing. One of these reactions I deplored:

A second--and most regrettable--reaction is a growth in the tendency toward economic nationalism in reactor manufacturing competition. We know that certain types of reactors have become identified with certain nations. Technological-economic advances in one nation are sometimes viewed as an economic threat in a country emphasizing another type of reactor.

The entry of economic nationalism into the nuclear power field is most unfortunate. Nuclear power rose from one of the most remarkable chapters of the history



CBB 769-8612

Visit to Waterloo, September 10, 1964. (Left to right) Arnie Fritsch, Seaborg, Mrs. Seaborg.

of international cooperation in scientific research and development. The names of the collaborators - Hahn, Joliot-Curie, Bohr, Fermi, Rutherford, Lawrence - belong to many countries. The subsequent evolution of nuclear power development has been marked by further international collaboration. While certain countries have since chosen to concentrate on specific power reactor types, there has been international cross-fertilization in the development of almost every reactor concept. And the same collaboration will continue in the future, as witness the recently concluded arrangement between Euratom and the United States for an extensive exchange of information on fast breeder reactors.

Turning to the principal subject of my address, I gave a full exposition of our fuel supply policy, emphasizing particularly the availability of fuel material, our enrichment capability, the toll enrichment arrangements authorized by recently passed legislation, the basic procedures (Agreements for Cooperation, followed up with supply contracts) through which customers abroad could obtain US-enriched uranium, the terms and conditions offered in US supply contracts, the fact that our charges were based on actual production costs and were the same for foreign and domestic customers. In conclusion, I reiterated the fundamental US policy of cooperation with the European Community.

In 1965, a matter of primary interest with respect to US-Belgian cooperation in peaceful nuclear applications was the expiration on July 31 of our bilateral agreement. I have already spoken of our policy in this connection, designed to support Euratom as the agency through which special nuclear materials from the United States would be supplied and, therefore, as the agency responsibility for safeguards administration. Although they welcomed our "fold-in" proposal as calculated to advance European unity, the Belgians had two concerns. First, they were anxious that close and direct cooperation between our two countries continue unimpaired. Secondly (fully aware of France's reluctance to accept termination of its bilateral), the Belgians wanted to be sure of non-discriminatory treatment in the event we extended an agreement with any other Euratom nation. A letter of July 30, 1965, from Ridgway B. Knight, US Ambassador to Belgium, to Foreign Affairs Minister Paul-Henri Spaak, provided the desired reassurance on both counts; and the matter concluded amicably with expiration of the agreement as planned. The agreement with Belgium was the first of our bilaterals with Euratom members to expire, and the handling of this matter served as a precedent for expiration of the others.

A second visit to the Belgian laboratory at Mol and a look at the CEN plutonium fuel processing facility was possible on March 11, * 1966; as indicated in my journal excerpt for that day quoted earlier, my concern was almost exclusively with Euratom questions.

Also in discussing Euratom, I mentioned in passing a visit to facilities in the Netherlands in September 1967. My journal account of that visit gives a good idea of the wide range of topics and overlapping interests that arose during such trips:

"Thursday, September 21, 1967 - Paris, Amsterdam, Petten, and Brussels

"Julie Rubin (my Staff Assistant) and I flew to Amsterdam. We were met by Ambassador William Tyler, Commissioner Gerry Tape, Myron Kratzer, Dixon Hoyle (AEC Senior Scientific Representative in Brussels), Philip F. Vandivier (Science Liaison Officer, US Embassy the Hague, and our Control Officer), and others.

"I rode with Ambassador Tyler and Commissioner Tape to Petten, which is the site of both the Dutch Reactor Center (RCN) and the Euratom Joint Research Center. On the way we drove under the North Sea Canal, after passing through the outskirts of Amsterdam, north through flat dairyland countryside, near the North Sea.

"At Petten we were met by Dr. Jules Guéron (Director General for Research to the Community Commission), Dr. Günther Sternheim (Acting Director of Euratom at Petten), Dr. Ernst L. Kramer** (Chairman of the Board, Reactor Centrum Nederland, RCN), Professor Johannes Pelser** (Technical Managing Director, RCN), Professor Dr. Jacob A. Goedkoop (Managing Director for Research, RCN), Dr. Adriaan H. W. Aten (Scientific Director, RCN, Director of the Chemistry Division at the Institute for Nuclear Research, IKO, Amsterdam, also connected with the Transuranium Laboratory at Karlsruhe), Dr. Jacob Kooi (Chemistry Department, Institute for Nuclear Research, Amsterdam), and Dr. Jacob C. Post (also a scientist at the Institute for Nuclear Research.)

"Others we met at Petten included Dr. Paul Herrinck (Head, Administration Division of Euratom at Petten), Dr. Samuel J. Lloyd (Assistant Director of Euratom at Petten), Dr. Robert W. R. Dee (Director for Administration

* See Chapter 2, pp. 24-29.

**I had met Kramer and Pelser on their visit to my Washington office, with Mr. Herman C. van Vierssen (Science Attaché, Netherlands Embassy), just a few months before, on May 3, 1967.



Visit to Petten, September 21, 1967. (Left to right) William R. Tyler, Gerald F. Tape, Jacob A. Goedkoop, Josephus J. M. Snepvangers, Dixon B. Hoyle, Jacob Kooi, Jacob C. Post, Günther R. Sternheim, Jules Guéron, Samuel J. Lloyd, Seaborg, Ernest L. Kramer, unidentified, Johannes Pelsler, Robert W. R. Dee, Philip V. Vandivier, Myron B. Kratzer, and Paul Herrinck.

and Finances of RCN), Dr. J.J.M. Snepvangers (Head of the Reactor Department of RCN), Dr. J. Wervers (in charge of the Hot Laboratory at RCN), Dr. J. Coehoorn (in charge of KRITO and LFR of RCN), Dr. W. W. Nijs (Project Coordinator of RCN Fast Reactor Program), and Dr. B. Verkerk (Head of the Chemistry and Metallurgy Department of RCN).

"We all went to the conference room of the High Flux Reactor (HFR) building. Dr. Sternheim made a presentation on the organization and work of Euratom at Petten, and Professor Dr. Goedkoop made a presentation on the organization and work of RCN at Petten. The budget of RCN is about \$6,000,000 from the government. The Philips Company has a building and a cyclotron on the site which is devoted to the production of radioisotope compounds. The staff of RCN consists of 900 people, of whom 700 are at Petten, 150 at The Hague, 20 at Kjeller, Norway, 30 at Amsterdam (working on the gas centrifuge process for separation of uranium isotopes), and 10 at Arnhem (working on the aqueous suspension reactor). Euratom has about 230 people at Petten, of which 160 are working scientists. There is cooperation with state universities, utilities and industry by RCN at Petten. Goedkoop described the work on NERO, a potential pressurized water ship propulsion reactor at 66 MW thermal, by RCN in cooperation with Euratom at Brussels (not Euratom at Petten). The critical facility for this ship reactor is KRITO at Petten. Also at Petten is the Low Flux Reactor, an Argonaut type reactor. Work on NERO is being phased out. The main line of work is shifting to fast reactor work. The High Flux Reactor (HFR) is owned by Euratom, but operated by RCN for Euratom.

"After the presentation in the conference room we visited the HFR, a copy of the Oak Ridge reactor with MIR type fuel elements. We were shown around by Dr. Snepvangers.

"Then we visited the High Activity Laboratory under the guidance of Dr. Wervers. Here we saw some very good remote control handling equipment. We toured the Euratom site under the guidance of Dr. Sternheim. We went through the Technical Building, which is the original building, and we saw the newly completed Materials Research Building which, when occupied, will add another 150 people to the Euratom site. Next we visited the critical experiment, KRITO, and the Low Flux Reactor in the Enrico Fermi (Physics) Building under the guidance of Dr. Coehoorn.

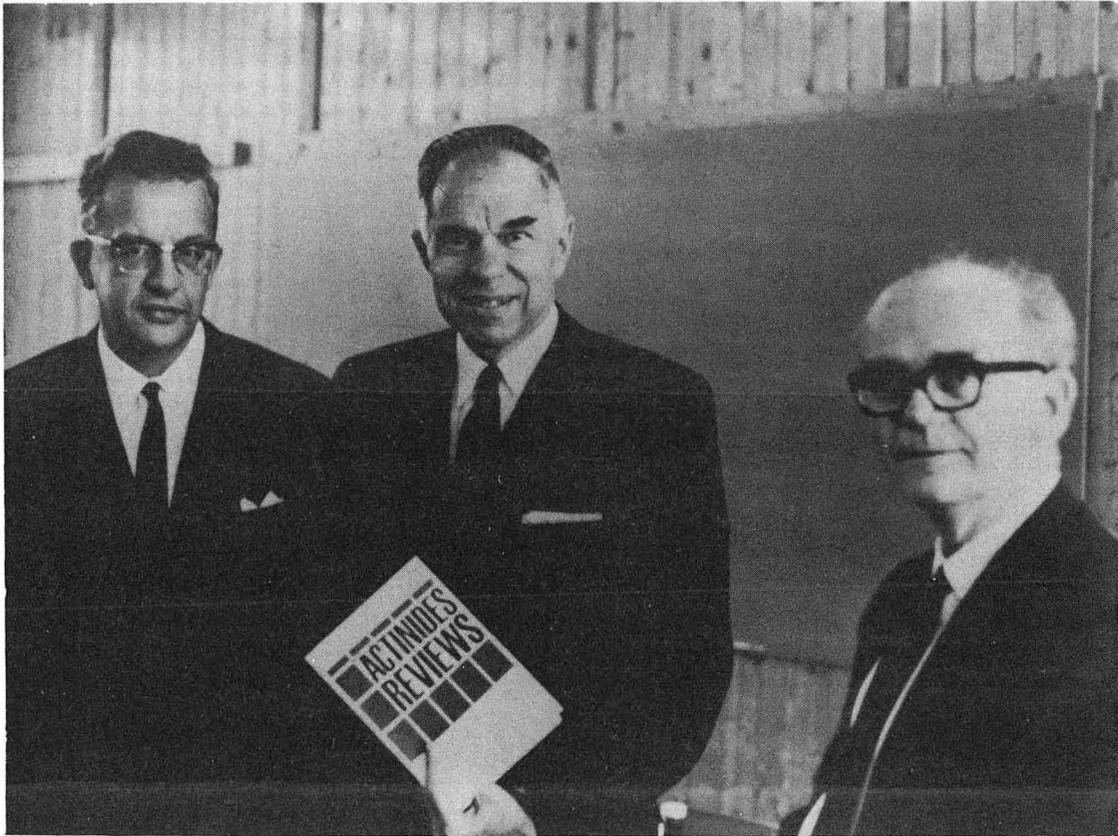
"We then went to the conference room in the Fermi Building where Dr. W.W. Nijs presented a description of the RCN fast reactor programs. This included fuel studies, canning of fuel elements, corrosion, heat transfer, design

studies (steam and sodium cooling), physics of fission products, and fuel requirements. He described the need for 200 kg of highly enriched uranium, for a program in KRITO to study primarily the physics of generated fission products, required in fabricated form between the beginning of 1969 and September 1969; it will be needed for a period of three years. They would welcome US ideas and US scientists to cooperate in these experiments. Since it is the same as the US Argonne ZPR fuel, they asked whether we would lease it on a cooperative program basis, and whether it could be similar to the NORA program.* Already the United States has leased 1700 kg to Euratom (out of an authorized total of 2000 kg), due to be converted to sale by June 30, 1968. If we do this (i.e., lease it), it would be a common program with the United States, and although the published results might be available to the United States even if we didn't do this, it wouldn't be as good as if we participated. Germany and Belgium are cooperating with the Netherlands in this, and the role of Euratom is not yet clear.

"After we receive the essential information on their proposal we will let them know. We know the quantity needed and dates when it would be required, but we need more data on the size and shapes. First, we must determine whether any material is available from Argonne. We can give a first reading on our answer before we receive any additional information. The material would be returned to the United States. I mentioned our plans to increase the lease charge.

"We went to lunch with the same group that had been with us since the beginning of our visit. Here we were met by Dr. Aten, and Dr. Kooi (who gave me a copy of the first issue, Volume 1, No. 1 of the quarterly *Actinides Reviews*, which contains, as its first article, my article entitled 'History of the Synthetic Actinide Elements'). Kramer made a few welcoming remarks at the lunch, and I expressed our appreciation.

*NORA (Norwegian Zero Power Reactor Assembly) was the focus of an international research project in reactor physics. The US leased fuel for the facility, whose construction had been aided by a US research reactor grant, and provided other assistance for the project in the form of fellowships and financial support of specific research.



CBB 769-8616

Petten RCN and Euratom JRC, Netherlands, Sept. 21, 1967. (Left to right) Jacob Kooi, Seaborg, Adriaan H. W. Aten.

"Following lunch we returned to the Fermi Building conference room where, after being introduced by Goedkoop, I gave a talk on 'Recent Research on the Transuranium Elements,' illustrated by slides, to members of the Petten staff. This was followed by questions, such as one by Aten concerning the means and rate of production of curium-244.

"Following the talk, my party rode to Schiphol Airport, where we met Ambassador Born, the Dutch Ambassador to NATO."

The NERO project mentioned above involved development of a pressurized water reactor for marine propulsion, an area in which the Dutch have been especially interested. After this design project was completed in 1968, their work in that field continued in collaboration with the Germans, with the aim of developing an improved second core for the *Otto Hahn*. The critical facility KRITO, which I saw at Petten, was originally constructed for nuclear physics research related to the NERO project. At the time of my visit, however, the Dutch were already planning its conversion to a coupled fast-thermal zero-power reactor for use in connection with the German-Benelux fast-breeder program. It was for this facility that, as indicated above, the Dutch wanted us to supply some highly enriched uranium. We were able to approve this request, and in 1968 we provided 190 kg of 90% enriched U-235 (partly on lease, partly on straight sale).

After that very interesting visit to Petten in 1967, we flew on to Brussels for the meetings with Euratom Community officials that I described earlier.* Then, late Friday morning, September 22, 1967, we headed for Ghent, where my participation in "American Day" at the Ghent Fair gave me an opportunity to stress the potential of nuclear energy to a group with wide-ranging interests:

"We met Chris Petrow (Counselor for Economic Affairs), Jerome Lavalley (Commercial Attaché), Richard Smith (Assistant Commercial Attaché), George Knight (the Ambassador's brother), and Leonard Warren (Political Section, who made detailed arrangements for my appearance at the Ghent Fair) in front of the USEC.

"We also met Ambassador Ridgway B. Knight (US Ambassador to Belgium) in front of the US Mission (USEC), and Tape and I rode to Ghent with him. Kratzer, Rubin, Howard Brown (USAEC Assistant General Manager), James Goodby (USEC Political Officer), Hoyle, Theodore Iltis, Petrow, Lavalley, Smith and George Knight followed in other cars.

*See Ch. 2, pp. 30-35.

"We drove through the old section of Ghent, with its narrow streets and medieval houses, and saw the Town Hall (built in two styles - early and later Renaissance) and the Guild Houses. We drove by the open air market and visited an old dock bordered by numerous old buildings, some dating back to 1200. We passed the old castle of Ghent.

"We arrived at the Ghent Fair and went first to the Restaurant Casino for the luncheon. There we met our old friend Carl Thomas, who is now US Consul General at Antwerp. We met President F. Meyvaert of the Ghent Fair. This Fair has been an annual event for hundreds of years. We went inside the Restaurant Casino and met Auguste de Winter (Minister for Foreign Commerce), Theo Lefevre (Minister of State and former Prime Minister), Roger de Kinder (Provincial Governor of East Flanders), and others.

"I also met Arthur Compton (Arthur and Betty Compton's son, former Consul General at Antwerp, now living in Brussels). Arthur is head of the State of Illinois trade promotion group in Brussels.

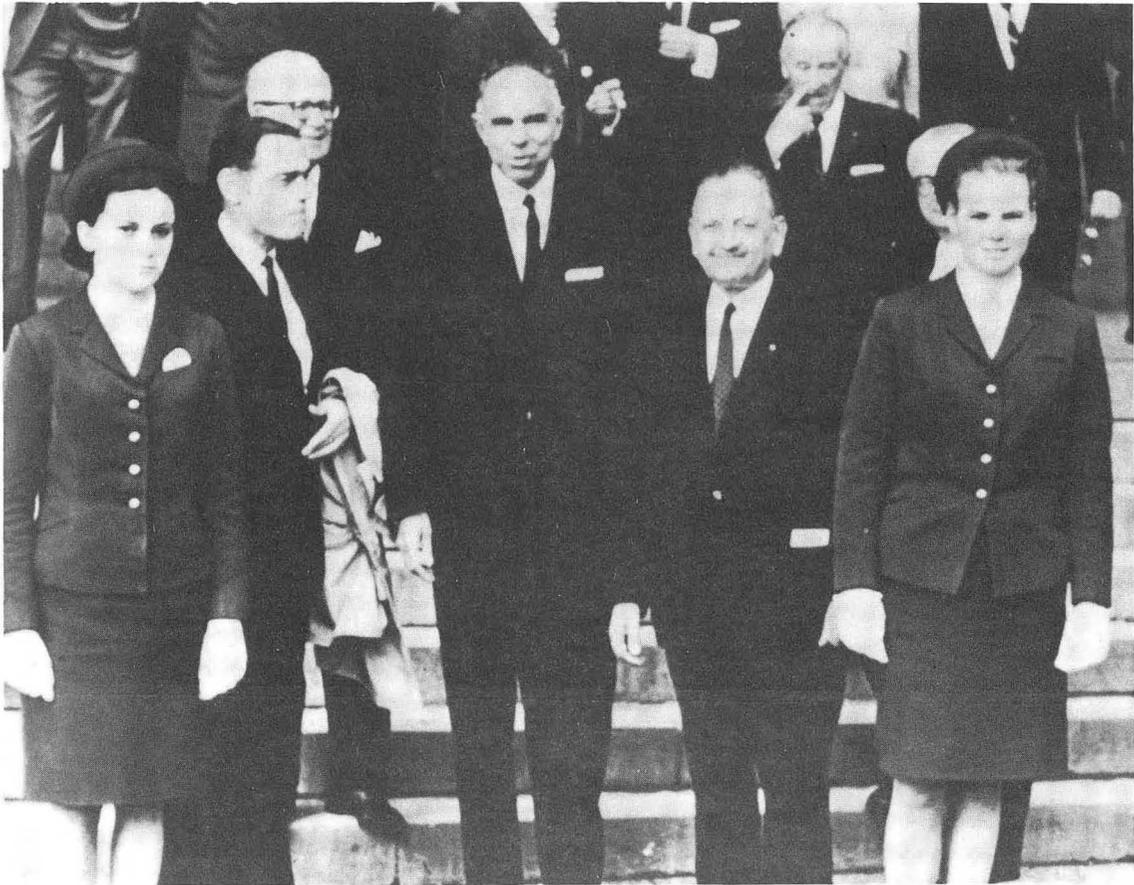
"At the 'American Day' Ghent Fair luncheon I sat between de Winter and J. J. Bouckaert (Rector, Ghent National University). Meyvaert served as master of ceremonies at this function, which was tied in with the Ghent Rotary Club. Also present at the head table were Ambassador Knight, de Kinder, Lefevre and others.

"Meyvaert introduced me, and I gave my talk, 'Nuclear Energy's Credible Future.' This was followed by an expression of appreciation (in Flemish, English, and French) by de Winter.

"After lunch we toured part of the Fair, the Italian exhibit. This was preceded, as we entered the building, by playing of the US national anthem and a short excerpt from the Belgian national anthem. Meyvaert led the tour--the group included all of the American group that had accompanied us to Ghent, as well as de Winter and Lefevre. Arthur Compton also accompanied us and introduced me to H. J. Oosten of Gene Graves' staff of the state of Illinois."

When I returned to Washington, I made my customary personal report to the President in a letter dated October 5, 1967. The following comments on this visit are taken from that letter:

"In Belgium, on my way to Vienna, I paid my first official call on the new Commission of the European Communities, which now serves as the combined executive authority



CBB 769-8618

*Start of Tour of Ghent Fair, Sept. 22, 1967. (Left to right)
between girl guides in foreground, Arthur H. Compton, US
Ambassador to Belgium Ridgeway B. Knight, Seaborg, F. Mayvaert.*

for Euratom, the Common Market, and the European Coal and Steel Community. At the invitation of Ambassador Knight, I also appeared as the guest speaker at the Annual America Day ceremonies of the Ghent Trade Fair.

"The Netherlands has a large nuclear research establishment at Petten on the North Sea coast near The Hague. A large portion of this center has been transferred to Euratom, and constitutes one of the four units of Euratom's Common Research Establishment. The level of technical sophistication at both the Dutch and Euratom portions of this laboratory is high. However, the Netherlands has so far made only a small start on the application of nuclear power. The recent large natural gas discoveries in the Netherlands, as well as their decentralized electric generating industry are the main factors delaying the early application of nuclear power on a large scale."

Except for the 1967 trip to Petten, I have not had other opportunities to visit the fine facilities in the Netherlands. There have, however, been occasions for talks in the United States with representatives of that country. For example, on November 10, 1966, I was visited by Mr. A.F.K. Hartogh, Director General for European Cooperation in the Netherlands Ministry of Foreign Affairs. Mr. Hartogh was particularly interested in the situation regarding increased plutonium for Euratom; I was glad to be able to tell him I was confident Congress would pass the enabling legislation. We also discussed the Dutch position regarding IAEA-Euratom relations in the safeguards area, which was of primary interest to me. In the interest of furthering these relations, the Netherlands had at one point proposed parallel IAEA-Euratom inspection of the Eurochemic re-processing plant. They had later withdrawn their proposal. Mr. Hartogh explained to us that they had done so because of the negative attitude of their Euratom partners. He thought, however, that it was essential to develop a formal relationship between Euratom and the IAEA.

An occasion of particular interest came in May 1969. Netherlands Prime Minister Petrus J. S. de Jong and Foreign Minister Joseph Luns had come to Washington for discussions with President Nixon and certain high officials regarding a number of topics, among which was their desire for US cooperation in the field of maritime nuclear propulsion. Although, as I have stated, they were collaborating with the Germans in the area of merchant ship propulsion, they were considering the desirability of undertaking a nuclear submarine project. This, however, lay outside the scope of our Atoms-for-Peace program, which was explained to the Dutch leaders. The discussions between them and the President concluded simply with a decision to study the possibility of closer

cooperation between our two countries in the general field of nuclear propulsion. There was no follow-up on this, however. Various factors, including the extremely high costs involved in R and D of this sort, may have led the Dutch to be content, at least for the time being, with their cooperative work with the Germans.

In any case, the presence of de Jong and Luns in Washington provided me with an opportunity for worthwhile discussions with them at a dinner given in their honor by Netherlands Ambassador Carl Schürmann on May 28, 1969, at the Embassy residence. It was an interesting evening. In addition to the group from The Hague that had accompanied the Ministers and members of their Embassy here, guests included many US officials, headed by Vice-President Agnew and Under Secretary of State Elliott Richardson, members of Congress, officers of the International Bank for Reconstruction and Development, and others. Conversations in which I participated, while naturally including US-Dutch peaceful nuclear cooperation, also ranged to many other topics. Over coffee and after-dinner drinks, Senator Fulbright and I had a long talk in which we were joined by Prime Minister de Jong and Secretary Richardson. We discussed a variety of subjects such as the NPT, the Vietnam war, the ABM, and the environmental effects of nuclear power plants. On the latter I explained the relative advantages of nuclear and fossil-fueled plants, and emphasized the fact that the small amount of radioactivity released by nuclear plants is not harmful to health. The discussion of the Vietnam war became quite spirited, I recall.

Later, in July of 1969, I had an interesting talk with our Ambassador to the Netherlands, J. William Middendorf, who came to visit me in my Washington office. He wanted to discuss the possibility of US cooperation in the Dutch development of the experimental gas ultracentrifuge process for the enrichment of uranium, a project that the Dutch were launching in cooperation with Germany and the UK. (The gas ultracentrifuge process has the capability of operating on a smaller scale than the gaseous diffusion process and thus might be more easily applied to the production of enriched uranium for use in nuclear weapons.) I indicated that Congressional opposition, as well as Commissioner Ramey's opposition, to US cooperation was so great that such cooperation was not feasible at the present time, but that we might raise the question again, if and when the NPT comes into effect. (The opposition stemmed from fear that such cooperation could help provide a commercial advantage and could help the Dutch and Germans construct nuclear weapons. I felt that such views were outmoded, that such countries could proceed without our help in any case, in which case we would be in a position of minimal influence. Also, if they wanted to produce nuclear weapons they could do so through the plutonium approach, over which we have no control, but there was no evidence that they contemplated such action; they seemed clearly to be ready to sign, ratify, and adhere to the Non-Proliferation Treaty. I felt that it was in our national interest to cooperate with them, rather than indulge in economic warfare, in the uranium enrichment business, which was destined to grow to large proportions. But most important, such cooperation would make it more difficult for such countries to divert enriched uranium to nuclear weapons.)

Ambassador Middendorf returned to see me again on February 18, 1970. Commissioner Johnson and Myron Kratzer were also present to hear his reports on recent conversations with Dutch officials regarding progress on the tripartite ultracentrifuge project mentioned above. He said that while the tripartite effort was not now competitive with US prices for uranium enrichment by the gaseous diffusion process, he was concerned about our position in about five years. (He said that he had come to emphasize his interest in protecting the \$1 billion per year projected revenue from US enrichment of uranium.) I assured the Ambassador that we were concerned about this export market, which is one (but not the most important) of the reasons the USAEC was exploring the possibility of exchanging gaseous diffusion technology with foreign countries. It would not be possible to enlarge this technology exchange to include the gas centrifuge process because of congressional opposition, which was so strong that it could even jeopardize our present plans regarding the exchange of information on gaseous diffusion techniques. Commissioner Johnson stated that a healthy Europe would eventually require its own enrichment facility. Kratzer explained that we were attempting to use exchange of US information in the gaseous diffusion technology to defer a premature commitment to build a major non-economic all-European independent gaseous diffusion enrichment plant. Again our main aim was to be in a position of influence to prevent the proliferation of nuclear weapons through the insured operation of safeguard procedures.

In the spring of 1970 I was visited by Dr. Hendrik G. van Bueren, Chairman of the Netherlands Scientific Council for Nuclear Affairs. Dr. van Bueren met with me and several USAEC staff members to discuss various topics including certain problems he faced in his capacity as a policy-maker:

"Dr. van Bueren asked me first whether it appeared reasonable on a national basis to include nuclear energy in an overall energy policy. I said that it could be considered in that light and might eventually be so considered here. Turning to the subject of program planning, Dr. van Bueren indicated that the domestic nuclear energy program conducted at their centers was divided into three major parts: (1) assistance to the light water reactor program, (2) a fast breeder program and (3) basic research. As a matter of policy, he wondered whether research in other areas should be conducted to complement their basic program. I said I saw no reason why this should not be done; I mentioned that some of our national laboratories had branched over into other areas of science. Van Bueren commented that with Euratom effectiveness in joint research not being all it should be and the Netherlands being a small country, he wondered how his country should apply its resources for the best hope of returns. Participation with larger countries, he felt, had sometimes worked out more to the advantage of the large country than to their own. In this connection, he expressed misgivings as to

whether the centrifuge program (of which, he remarked, the Dutch were the instigators) was being 'taken over' more and more by the larger countries. He wondered about the possibility of getting into other studies such as fusion. I advised that this would be a very expensive undertaking and there should be other areas more suitable for exploitation by the Dutch. After some discussion in this area, Dr. Abraham Friedman, Deputy Director of the USAEC Division of International Affairs, noted that there definitely was a place for contribution by the smaller countries; he cited the contribution to nuclear physics made by Denmark.

"Dr. van Bueren raised the question of potential environmental effects of fast breeder reactors, questioning whether they have a potential beyond that of light water reactors for adversely affecting the environment since they use plutonium and sodium. I replied that our experimental reactor systems utilizing plutonium and sodium had already demonstrated that they can operate in reliable fashion with less release of radioactivity to the environment than the water systems. I added, however, that it was entirely possible that the thermal breeder would be the answer to the problem, at least on an interim basis. Here we had some discussion of the KEMA project involving the suspension type thermal reactor.

"Referring to the International Nuclear Information System (INIS) of the International Atomic Energy Agency, Dr. van Bueren indicated that the Netherlands has been for some time very interested in the technical literature field. They have many scientific journals and find that the information utilization is an expensive operation. He expressed the view that the large amount of information INIS distributes to the underdeveloped countries might pose a dilemma for the latter, as they would be literally flooded with information and would undoubtedly be unable to digest and assimilate the information. He indicated that the Netherlands had been reluctant to participate in the INIS program. Dr. Friedman said that the INIS system provided or at least could provide profile data on specific interests of recipients of the system.

"Dr. van Bueren noted that the Dutch had engaged in the development of two programs to the point where they could have been assumed by private industries, but there was no industrial interest. His question was, basically: How does the United States provide for programs developed by USAEC to be assumed by private industry? Are the basic programs decided on in collaboration between industry and AEC or does the AEC develop these and turn them over to private industry? I indicated that we had one division

in the AEC whose duty is to coordinate all areas of interest between private industry and the AEC: Our Division of Industrial Participation. I noted that some of our programs have been developed solely by the AEC and others have been developed jointly by the AEC and private industry. Remarking that we have a good working agreement with our private industry, I explained that the AEC withdraws from work in an area that has developed sufficiently to be assumed by private industry. Generally speaking, most AEC development is basic rather than applied. When it reaches the applied state there may be collaboration between AEC and private industry but subsequent to that it is assumed by private industry."

Regarding his reference to the centrifuge program, mentioned earlier in this chapter, and which I also mentioned when writing of Euratom and Italian matters,* after the UK, Germany, and the Netherlands announced in November 1968 their intention to explore the possibility of a joint centrifuge enrichment project, they conducted negotiations and prepared detailed plans through the next year. The treaty, finally signed by the three parties on March 4, 1970, provided for construction of two pilot enrichment plants--a combination Dutch-German facility in Almelo, the Netherlands, and the other at Capenhurst in the UK --with a tripartite supervisory and administrative organization headquartered in Germany. When Dr. van Bueren met with me in Washington, construction work at the Almelo site was already under way. Considerable progress was made during the next 12 months, and by late spring 1971 the Dutch centrifuge-manufacturing plant was in operation and construction of the separation facility was well started. Before the end of 1972 both the Dutch and UK separation plants were in operation and were starting to produce small quantities of enriched U-235.

During my many trips to Europe as USAEC Chairman, I frequently regretted that schedule pressures prevented a visit to Luxembourg. An occasion for that came at last in 1971, after the final session of the Fourth Geneva Conference on the Peaceful Uses of Atomic Energy:

"Thursday, September 16, 1971 - Geneva, Frankfurt, Luxembourg

"Helen, Justin Bloom, Stan Schneider, Abe Friedman and I flew to Frankfurt, where we changed planes for Luxembourg. We had a tremendous view of the Swiss Alps on the way--also a spectacular sunset.

"We were met by Mr. and Mrs. Stephen Lande (he's Economic Officer at US Embassy in Luxembourg), Dr. Rudolf Bree

*See Ch. 2, p. 44, and Ch. 5, p. 145.

(Head of Center of Information and Documentation, CID, of the European Community), Van Hegelson (CID official) and Glenn Bradley (USAEC Senior Representative, attached to US Mission to the Communities, Brussels).

"Helen and I rode with Mrs. Lande to the Embassy residence, which Ambassador Gould uses as a guest house."

"Friday, September 17, 1971 - Luxembourg - Paris

"Helen and I had breakfast at the Embassy residence with a group hosted by Ambassador and Mrs. Kingdon Gould, Jr. Pictures of many of the group were taken by a local newspaper photographer after breakfast. Those present were: Minister Marcel Mart (Dept. of Transport and Energy); Commissioner Jean Hoffman (National Dept. of Energy); Justin Bloom, Stanley D. Schneider, Abraham S. Friedman, Glenn Bradley; Mr. and Mrs. Clinton L. Olson (he is a Foreign Service Inspector, visiting Luxembourg to evaluate the Embassy); Counselor of Embassy Fred Galanto; and Stephen Lande. We learned that a study is underway in Luxembourg for the construction of an 800,000 kilowatt nuclear power plant on the Moselle River. Construction of such a reactor, probably a US type, would probably be financed by Germany and France in return for an option on the purchase of the produced energy.

"I gave autographed copies of *Man and Atom* and AEC 25th anniversary medals to Minister Mart, Hoffmann and Ambassador Gould, and Helen gave 'Century of the Atom' record to Mrs. Gould.

"Helen and Mrs. Olson then visited sites of interest in Luxembourg under the guidance of Mrs. Roger Krieps. They got out at the memorial for Schuman, who is credited with getting the European community started. After a drive through the center of the city, they stopped at the 13th century cathedral. They came to the Chamber of Deputies, which is located next door at the Royal Palace, and were given a special tour of the chambers where the deputies meet (they are not open to the public). They were then driven to the American cemetery in Hamm, just outside the city. General Patton is buried in this cemetery. Then they rode through the Royal Forest and some farmland, where they stopped to see Mr. Krieps' aunt of more than ninety years.

"Meanwhile, we were having our meeting with European Community officials. Bree came by the Embassy residence and took us to one of the downtown Luxembourg headquarters buildings of the European Community, the Aldringen.

"We met in the conference room of the Aldringen, sitting on opposite sides of a large table--Bree, Van Hegelson and Guggenbuhl on one side and our group on the other.

"Bree opened the meeting by apologizing for the absence of EC Vice President Wilhelm Haferkamp (due to illness) and Director General Fernand Spaak (due to a conflict of schedule) and by asking me to identify our interests so as to guide the conversation. I said we were interested in Luxembourg's role in the European Community, its plans in the atomic energy field, and the general status of safeguards. Bree then started with a general description of Euratom's history and the troubles it ran into because of the diverse national interests of its members. He described the problems involved in the handling of information of industrial interest created from Community research. They make special efforts to limit the distribution of such information outside of the Community for a year or two, but a good fraction of such work is published. They have averaged one publication per \$20,000 spent by Euratom. He described the Euratom mechanized information system, and its relationship to the INIS system of the IAEA, which has taken over much of the task. The Euratom information program is centered at Luxembourg.

"Bree explained that Luxembourg's main role in the European Community is in the coal and steel area. The role in the atomic energy aspect is very limited. Luxembourg is now studying the possibility of building a nuclear power station. The Euratom safeguards function is centered in Luxembourg but our hosts chose to emphasize the nuclear information program rather than the safeguards program. Spaak, who is in charge of the safeguards program, makes his headquarters in Brussels. (Beyond this, Bree said nothing about safeguards, though I had mentioned it as one of the subjects of particular interest to us.) At the end of the meeting we met Leon Rawlings, a division head in the Center of Information and Documentation (CID) of the European Community. I gave an autographed copy of *Man and Atom* to Dr. Bree.

"We then had a short time for some sightseeing. Luxembourg has a population of nearly 400,000 and the city a population of 70,000. The country produces 5,500,000 tons of steel per year, 1% of the world's output.

"Bree drove us to the old Luxembourg Fortress. We saw the part of the Fortress used by General Vauban at the time of Louis XIV (late 17th century), then the remnants of the Fortress nearby dating to about the year 1000 located at the crossroads between the Rhine valley and France. We then drove down into the valley below the Fortress where we saw houses hewn from stone dating back to the Middle Ages and parts of fortresses of the 14th and 15th centuries. We saw the remnants of the castle of the County of Mansfeld built at the beginning of the 17th century. Above this we saw the rather well-preserved remains of a 17th century fortress. Near here is the Kirchberg, the narrow 21-story Luxembourg headquarters of the European Community.

"After our tour Friedman, Bradley and I rode with Dr. Bree to the Luxembourg airport where we joined the others including Helen, who had completed her tour. Helen phoned Mrs. Mildred Steinmetz, wife of the former Luxembourg Ambassador to the US and a fellow member with Helen in the International Neighbor's Club in Washington, D.C. [We had met the Steinmetzes at receptions given at the Luxembourg Embassy in Washington.]

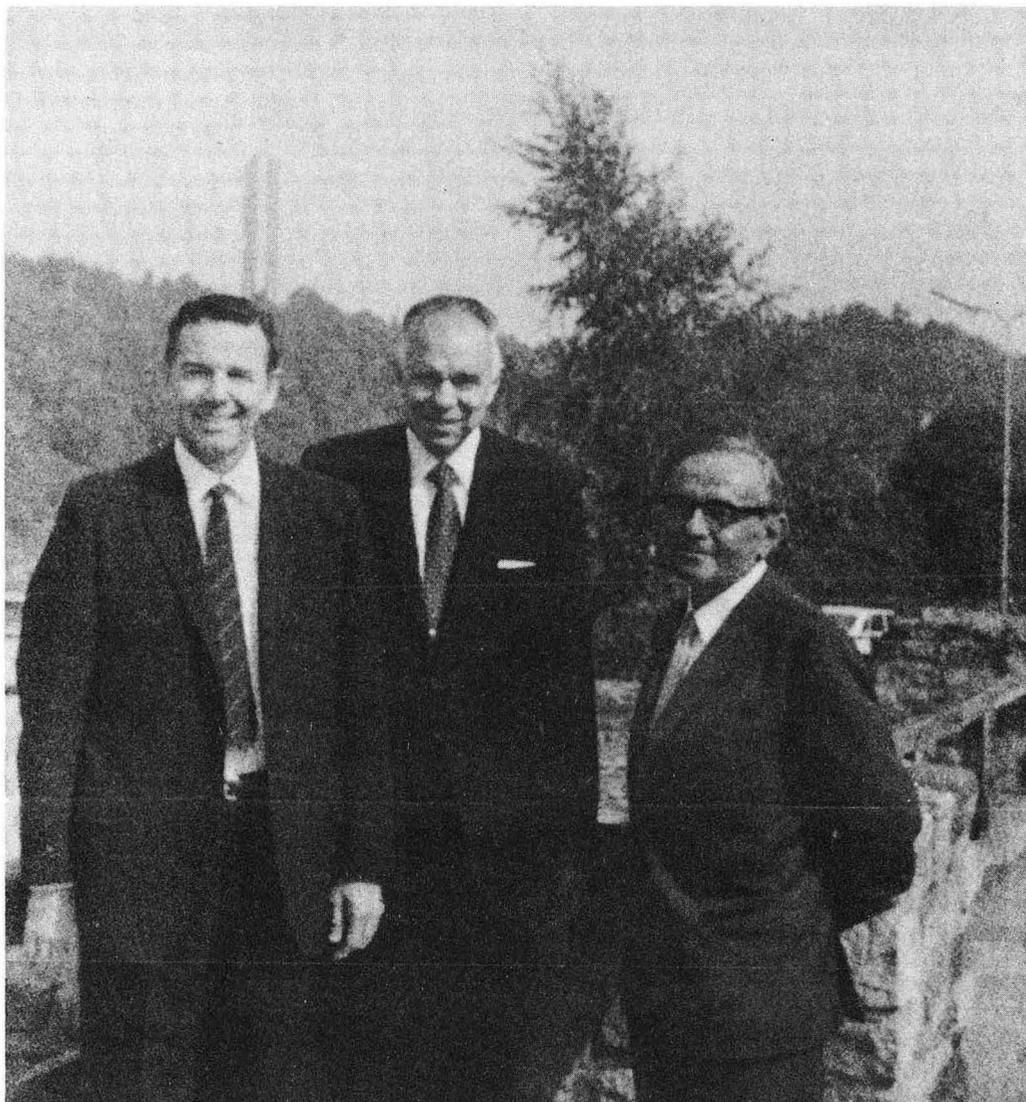
"Helen and I were handed a gift from Minister Mart-- a print map of Luxembourg of 1643 and a print of Mansfeld Palace.

"Lande and Bradley saw us off."

On October 8, 1971, I wrote a letter to the President, reporting on this trip, with the following comments on this visit to Luxembourg:

"Immediately after the closing session of the Geneva Conference on September 16, I flew to Luxembourg, which is the site of several of the offices of the European Coal and Steel Community, as well as the Headquarters of the European Community's Nuclear Safeguards, Nuclear Information, and Health and Safety Directorates. Luxembourg is also the site of the Court of Justice and the Headquarters of the European Investment Bank and of the General Secretariat of the European Parliament.

"I met and had useful discussions with Ambassador Kingdon Gould and, at a working breakfast which he hosted on September 17, we met Luxembourg Minister of Transport and Energy Marcel Mart and Jean Hoffman, in Mr. Mart's Ministry. I learned of the feasibility study which is underway in Luxembourg for the construction of an 800,000 kilowatt nuclear power plant on the Moselle River. They



SBB 769-8620

Visit to Luxembourg, Sept. 17, 1971. (Left to right) Glenn Bradley, Seaborg, Rudolf Bree.

are considering a US type reactor which might be built by Germany under license from an American company. Construction of such a reactor would probably be financed by Germany and France in return for an option on the purchase of the produced energy. Following my discussions with Minister Mart and Ambassador Gould, I met with Dr. Rudolf Bree, Director General of the European Community's Nuclear Information Program. We had a long discussion of the Euratom program in general and their information system in particular."

CHAPTER 7

UNITED KINGDOM

In the fall of 1940, a British committee code-named MAUD, which had been charged with investigating the feasibility of producing an atomic bomb, established liaison with the American "Advisory Committee on Uranium" engaged in a similar mission. Thus began the close nuclear cooperation (formalized in August 1943) between the United States, the United Kingdom, and Canada that continued until after the successful completion of the Manhattan Project. It was the first intergovernmental project in which our country participated in the nuclear field.

The Atomic Energy Act of 1946, which established the US Atomic Energy Commission, imposed strict limitations on our nuclear cooperation with other nations, including our wartime allies. As a result, the active tripartite collaboration of the early forties was followed by a period during which only a very restricted program of exchange of technical information was possible with the United Kingdom and Canada. The restrictions were somewhat relaxed by a trilateral *Modus Vivendi* of January 1948 and by a 1951 amendment to the 1946 Act, but activities were still extremely limited.

Promptly after passage of the Atomic Energy Act of 1954, however, steps were taken to initiate new programs of cooperation with both Canada and the United Kingdom. During the 1960's our cooperation with the United Kingdom touched almost all aspects of peaceful nuclear research and development and also included collaboration in military applications.

An Agreement for Cooperation in Civil Uses has been in effect between the United States and the United Kingdom since July 1955. This Agreement, as amended in 1963, 1964, 1966, and 1970, authorizes a broad exchange of data and the transfer of up to 2400 kilograms of U-235 for civil research and development programs. It also permits the transfer to the United Kingdom, from third countries, of Special Nuclear Materials (SNM) of US origin to be reprocessed in the United Kingdom, and enables the latter to convert and/or refabricate enriched uranium of US origin for use in the United Kingdom or third countries. Under a recent amendment (signed on September 10, 1970), the United Kingdom is also authorized to receive SNM from the United States for conversion and refabrication and return to the United States.

In addition to the above, a separate Civil Power Applications Agreement, negotiated in 1966, covers the supply of 8000 kg of U-235 for use in the United Kingdom's civil nuclear power program. It is of interest to note that up until 1974 the United Kingdom generated more nuclear power than any other country (although the United States has moved into the lead in installed nuclear generating capacity as early as 1970).

Our civil uses agreements with the United Kingdom have been complemented by several formal technical exchange arrangements. Mention of the principal areas involved will give some idea of the range of our cooperation:

1. The Fast Reactor Exchange, first developed in 1956 and expanded in early 1965, covers the exchange of research and development data on all types of fast reactors and includes the construction and operation of prototype reactors (excepting detailed reactor design and fuel manufacturing technology).

2. The Libby-Cockcroft Agreement, (so-called after USAEC Commissioner Willard Frank Libby and Sir John Cockcroft of the UK Atomic Energy Authority or UKAEA, British counterpart of the USAEC), started in 1958 and augmented in 1966, provides for exchange in specific areas of research and development, including basic research; controlled thermonuclear reactions; uranium oxide fuels technology; gas coolant compatibility, including graphite chemistry and physics, and metals and ceramics; plutonium recycle technology; and the effects of irradiation on cladding and structural materials.

3. A Uranium Feed Materials Agreement, in effect since 1960, covers exchanges in this specialized area.

4. The Dragon-USAEC Collaboration Agreement, which became effective in March 1960, provides for an exchange of information on the High-Temperature Gas-Cooled Reactor at Peach Bottom, Pennsylvania, and the European Nuclear Energy Agency (ENEA) Dragon Reactor Project* located at the UK's Winfrith research establishment. In this exchange with the USAEC, the United Kingdom represents all Dragon Project signatories (12 ENEA members, including the six Euratom countries).

Aside from the exchanges specified in these formal arrangements, there have been numerous exchanges conducted simply under the basic Agreement for Cooperation. For a number of years, for example, we exchanged information on gas centrifuge technology. There are also still active informal arrangements with respect to reactor safety and radioactive waste treatment and disposal.

An issue that strained our relationship for a while was the question of possible unauthorized use of US gaseous centrifuge technology for the production of enriched U-235. The US and the UK had collaborated in this field during the period 1960-1965; when the UK joined with the Netherlands and West Germany in a tripartite agreement for the development and application of the gaseous centrifuge method in 1969, the US wanted assurance that the UK wouldn't utilize any significant information acquired from the US during that collaboration.

While throughout this account I am concerned primarily with our international programs in the civil uses of nuclear energy, it is worth mentioning that the US-UK cooperation in the nuclear military field, which ended after the war, was revived in an "Agreement Regarding Atomic Information for Mutual Defense Purposes," signed at the same time as our civil uses agreement, on June 15, 1955. This was succeeded by a similar, somewhat broader agreement, which entered into force in August 1958 and is still in effect. In addition to authorizing the exchange of information and the transfer of materials and non-nuclear equipment in the nuclear weapons field, this agreement authorized the United Kingdom to purchase a submarine nuclear propulsion plant and related information in support of its own nuclear submarine construction program.

*The Dragon Project was apparently abandoned for lack of funding late in 1975.

This brief summary of our cooperation with the United Kingdom since 1955 shows not only that an active program was under way at the time I became USAEC Chairman, but also that many developments took place in the program during the succeeding years. These developments, as well as our common concern with respect to other matters such as the IAEA, have occasioned many meetings and discussions, in the United States and abroad.

London was my first overseas destination in my travels as head of the USAEC. I stopped there on my way to the Fifth General Conference of the IAEA in Vienna, in the fall of 1961. I should perhaps recall here that this was a time of high East-West tension. Negotiations with the USSR on the subject of a nuclear test ban treaty had collapsed. The mid-August closing of the border between East and West Berlin had been followed by construction of the Wall. The Soviet Union had resumed nuclear testing in the atmosphere on September first; in consequence we had felt compelled to resume underground testing and were seriously considering resumption of atmospheric testing ourselves. There were, obviously, many grave matters to be discussed with our friends of the United Kingdom.

On September 20, 1961, accompanied by my assistants Howard Brown, Cecil King and Dan Wilkes, I flew from New York to London, where we were met by Carl Walske (USAEC Scientific Representative there). I was able to spend almost the entire next day in useful talks with members of the Atomic Energy Authority:

"Thursday, September 21, 1961 - London

"With Howard Brown, Cecil King, and others, I met with Chairman Sir Roger Makins, Deputy Chairman Sir William Penney, and members Sir Claude Pelly and Sir Alan Hitchman of the UKAEA, to discuss the US weapons testing program, US-UK collaboration on reactor development, including nuclear submarines, US-UK positions at the forthcoming IAEA meeting in Vienna, etc. Sir Roger raised the question of UK use of the Nevada Test Site, if they should decide to resume testing, and also discussed the possibility of resuming atmospheric testing.

"I had lunch at the General Services Club with Sir Roger Makins, and later I met with Harold Watkinson (UK Minister of Defense), along with Makins and Walske. Watkinson warned me that Her Majesty's Government would not now support the United States on resumption of atmospheric testing (as they had on underground testing).

"At 3:00 p.m., I met with the UKAEA at their Board Meeting. Chairman Makins, Deputy Chairman Penney, members Hitchman, Pelly, and Sir Leonard Owen, part-time members Sir John Cockcroft and Sir James Chadwick, Secretary David Peirson and others were present. We discussed the economics of nuclear power, differences between the USAEC and the UKAEA, etc.

"After the Board Meeting, I worked on a letter to President Kennedy describing the UKAEA proposal to use the Nevada Test Site and Sir Harold Watkinson's observations on atmospheric testing.

Later I toured London, especially the Piccadilly Circus area, with Dan Wilkes. I had dinner at Boodle's Club with Makins, Penney, Pelly, Hitchman, Cockcroft, Sir Solly Zuckerman, Lewis Jones (US Minister to the UK), Sir David Ormsby Gore and others. We discussed the extent to which Western Europe would need to rely on the United States through NATO in the future."

I met with Sir Roger again, this time in my Washington office, on November 18, 1961. My journal for that day describes the meeting:

"Commissioner Haworth and I met with Sir Roger Makins who was accompanied by Dr. Donald Avery (UKAEA Scientific Representative) and Group Captain John S. Rowlands (Military Attaché) of the British Embassy. General Betts, Algie Wells (Director, USAEC Division of International Affairs) and Howard Brown were also present. We discussed (1) the progress of the US-UK negotiations over the use of Christmas Island for atmospheric testing; (2) the question of US purchase of plutonium from the UK; (3) the question of the UK furnishing France with plutonium for their fast reactor experiment; and (4) the question of the UK purchasing U-235 from the US for military and civil power uses.

"After the meeting I called Bundy and told him that as a result of my conversation with Sir Roger I have a feeling that the matter of our using Christmas Island will be more complex than we had realized. The British are going to want to learn quite a bit about our weapons in this exchange in order to make their evaluation of the necessity for the tests. This will require some sort of authority for the exchange of information. We will have to give a lot of thought to how far we can go within the framework that exists at the present time. Secondly, they will want a written agreement, rather than just a loose arrangement. Regarding the President's reply, which would accept the British offer of a reconnaissance of Christmas Island, I suggested that we might also move on the next step, i.e., to agree that our experts should get together with the British experts to convince them of the need for these tests, but without actually setting a date for the meeting. Both these steps will be necessary before we will know whether this whole approach is feasible. Bundy agreed that we should proceed immediately on the reconnaissance phase; but on the second step, he feels we have to come up with a clearer position of our own testing plans.

"Bundy suggested I make the arrangements with Sir Roger, on the basis that we would like to undertake the reconnaissance, and that the President will be in touch with the Prime Minister later. I replied that Sir Roger as much as said that he is not in a position to do this on his own because the matter is on the Prime Minister-President level. Bundy said he will take this matter up with the President in a telephone conversation later today, and that he will strive for a reply on Monday to

to the Prime Minister. He reiterated that his reaction to the 'expert' phase is that we have a lot of homework to do (in the new committee on atmospheric testing) before we engage in conversation with the British experts. And, until we do come up with a clearer position, he does not believe the President will wish to harden the national position."

Just a month later Sir William Penney and I were to see each other, in a very different setting: Bermuda, at a meeting of President John Kennedy and Prime Minister Harold Macmillan. By then the decision had been made that resumption of atmospheric testing by the United States was essential to our national security. The Bermuda meeting had been arranged to permit an exchange of views on this matter and various other aspects of the current situation, including our proposed use, for our new test program, of the coral atoll mentioned above, Christmas Island, claimed by both the United Kingdom and the United States. Without going into the details of the discussions, my journal notes will give a good indication of the substance and the general flavor of the meeting:

"Thursday, December 21, 1961 - Palm Beach to Bermuda

"I accompanied President Kennedy and his group to Bermuda, flying on the Presidential jet. We had lunch at the Bermudiana with Sir Norman Brook,* Sir Evelyn Shuckburgh, Secretary Dean Rusk, Ormsby Gore, Earl Home,* General Chester V. Clifton, Sir William Penney and William Tyler (Deputy Assistant Secretary of State). We discussed the Berlin and Congo problems, the Indian invasion of Goa, the Dutch-Indonesia problem, and the status of the UK possessions throughout the world.

"I attended the meeting of President Kennedy and Prime Minister Macmillan* at Government House and participated with Rusk, Home, Penney, and Harold Brown (Chief Scientist, US Department of Defense) in a discussion of the atmospheric testing question and our possible use of Christmas Island.

"I had dinner at Government House with the Governor General of Bermuda Sir Julian and Mrs. Gascoigne, President Kennedy, Gascoigne's son and his wife, McGeorge Bundy, Shuckburgh, Brook, Rusk, Charles E. Bohlen (Assistant to the Secretary of State), Ormsby Gore, Home, Clifton, Penney, Tyler and others. I sat one place removed from President Kennedy, which gave us an opportunity to talk. He invited me to go along - and I accepted - on his trip to California to give the Charter Day address at Berkeley near the end of March; he also accepted my invitation to visit the Radiation Laboratory at that time. I also had the opportunity, over coffee, to talk to President Kennedy and

* I had met Brook, Home, and Macmillan in April of 1961 at a dinner given at the British Embassy in honor of the Prime Minister by Ambassador and Lady Caccia.

Prime Minister Macmillan about nuclear testing.

"The trip to Bermuda took me away from the first annual Christmas reception that Helen and I were to give at our home for the members of the Chairman's and Commissioners' staff. In my absence, Helen went ahead with the reception, and this evening I telephoned home from Bermuda to express my greetings."

Friday, December 22, 1961 – Bermuda – Washington, D.C.

"I attended a continuation of the meeting between President Kennedy and Prime Minister Macmillan at Government House. The joint communique that they issued decried the continuing arms race and expressed the hope that progress could be made on disarmament and that the USSR would sign the Test Ban Treaty tabled by the United States and the United Kingdom at Geneva. The Prime Minister didn't want to give us an answer on the use of Christmas Island before he has consulted with his Cabinet after he returns to England. Sir William Penney and I agreed on a Statement of Principles, governing the use of Christmas Island, which will be further studied by the lawyers. The prospects look moderately good that the use of Christmas Island will be granted. The President and the Prime Minister also agreed that another attempt will be made through the US Ambassador in Moscow to renew diplomatic contacts with the Soviet Union. They favored the present talks between Adoula and Tshombe regarding the Congo crisis and hoped that there would be no renewal of armed action. They expressed the hope that discussions regarding England's joining the Common Market would be successful."

The above-mentioned communiqué, which touched on a number of subjects discussed at the meeting, contained the following paragraph:

"The President and Prime Minister considered the problems of the nuclear arms race. They took note of the new situation created by the massive series of atmospheric tests conducted in recent months by the Soviet Government after long secret preparations. They agreed that it is now necessary, as a matter of prudent planning for the future, that pending the final decision preparations should be made for atmospheric testing to maintain the effectiveness of the deterrent."

Following the Nassau meeting, agreement was in fact reached (in February 1962) on our use of Christmas Island for a new program of atmospheric testing. Accordingly, the "Dominic" series was initiated there on April 25, 1962. (Dominic constituted our last atmospheric testing. New efforts to achieve some agreement with the USSR on a nuclear test ban were finally rewarded with the signature on August 5, 1963, of the Limited Nuclear Test Ban Treaty, under which atmospheric testing was prohibited.)

In the spring of 1962 Penney and I talked again, this time in Washington. Among other topics discussed during our meeting on March 19, 1962, at the USAEC Headquarters office on H Street, were plans for the third Geneva Conference on the Peaceful Uses of Atomic Energy. At Sir William's request, I explained our feeling that the Conference should be sponsored by the IAEA through an *ad hoc* committee and should probably take place in 1964. He, for his part, expressed the hope that we would support the UK position that an international "Reactor Physics Committee" and all such committees should be under the IAEA rather than the ENEA.

Less than a month later, Sir Roger Makins was in town. He came to see me on April 10, accompanied again by Don Avery and Captain John S. Rowlands of the British Embassy. Algie Wells was present during our discussion, which covered a number of matters including the following:

"Makins asked whether the United States could fabricate the U-233 pellets and reprocess the U-233 in the US-UK cooperative program involving the zero energy critical experiment with slow neutrons. He pointed out that the most expensive part of this cooperative program is running the experiment. Wells said that this is being studied by the staff, and that a paper, with a recommendation, will come up to the Commission.

"With respect to the third Conference on the Peaceful Uses of Atomic Energy, Makins said the United Kingdom was lukewarm to large conferences, but felt that if the Conference were not held until 1964, they would go along. He agreed that the IAEA should have a large hand although this will need money, probably from the UN. He said that Penney wants to eliminate such topics as fusion, mining and exploration, biology and medicine, and isotopes. I said that this matter would need to be explored; in particular, I wasn't so sure about the elimination of isotopes. We agreed that expensive exhibits were not desirable.

"With respect to Euratom, Makins indicated that the UK proposal had received a chilly reception by the European Commissioners; that no reply can be expected until May, and therefore negotiations can't start until summer. We agreed that the US and UK position on this was one of agreement. Apparently the exact status of the UK military and civilian bilaterals is unclear until further UK-Euratom negotiations have been carried out.

"We agreed that the cooperation on the gas-cooled reactors and on the gas centrifuge work was proceeding satisfactorily, and there were no problems.

"It was noted that Donald Avery will be replaced by Joseph Stephenson as the UKAEA Scientific Representative at the British Embassy.

"Sir Roger hoped that I could visit England again before my IAEA trip this fall, and perhaps see Aldermaston (the UKAEA

Weapons Group Headquarters, and location of Atomic Weapons Research Establishment, AWRE) and the AGR facility at Windscale."

Sir Roger met with me in Washington still another time, on July 24, 1962, before we saw each other again in England prior to the Sixth IAEA General Conference. During my stop in the United Kingdom time did not permit the suggested trip to Aldermaston and Windscale, but a visit to the UKAEA establishment at Harwell was possible:

"Thursday, September 13, 1962 - London to Harwell

"Algie Wells, Cecil King, Chris Henderson, and I drove to Harwell with Sir Roger Makins. On the way we discussed: (1) the use of special nuclear materials exchanged under our Mutual Defense Agreement; (2) US willingness to furnish 10 kg of uranium-233 to the United Kingdom and share the cost of fabrication, etc.; (3) US desire to participate in information from UK-Belgium Spectral Shift reactor project; and (4) furnishing of plutonium to Euratom for fast reactor program.

"Harwell is more formally known as the Atomic Energy Research Establishment (AERE), Harwell; it is the principal research and development center of the UKAEA.

"At Harwell we were greeted by F. A. Vick (Director) and Sir William Penney (Deputy Chairman of the UKAEA). We toured the Metallurgy Division, with Peter Murray as host, and part of the Chemistry Division, with F. J. Stubbs as host. I talked to H. A. C. MacKay and Kenneth W. Bagnall regarding heavy element chemistry (higher neptunium and plutonium oxides and protactinium chemistry) and Gilbert N. Walton on fission research. We had lunch with a large group, including Wells, King, Henderson, Penney, Vick, Robert Spence (Deputy Director of Harwell), Egon Bretscher, and Thomas G. Pickavance (Director, Rutherford High Energy Laboratory). We toured the Neutron Project with Bretscher, Ernest R. Rae (Physics Division), and Michael J. Poole (Applied Physics) as hosts, and the Rutherford High Energy Laboratory, with Pickavance and Stratton as hosts. I rode back to the Westbury Hotel with Penney. We discussed the French program (he believes that by 1970 they will have an annual capacity of 4-5 tons of uranium-235, 300-500 grams of tritium (via EL-4 reactor), as well as a lithium-6 capability. We discussed fast reactors, the US-UK plutonium-uranium-235 exchange arrangement, and the recent UKAEA organization changes. I attended a dinner given for me by Sir Roger Makins at the Brooks Club, with Penney, Sir Claude Pelly, Alan Howard Cottrell (part-time science member of the UKAEA), Dr. N. Levin (Director of Aldermaston), Hon. Viscount Hailsham (Minister for Science and Technology), Ronald H. Campbell, Sir Harold Caccia (now Permanent Under Secretary of State for Foreign Office), Mr. Jarret, and US Ambassador David K. Bruce."

Upon my return to Washington I reported to the President in a letter dated October 9, 1962, part of which described my talks with Sir Roger:

"The UK is faced with two politically sensitive problems in regard to its nuclear program. The first of these is their *unannounced* intention to integrate a nuclear power reactor utilizing slightly enriched uranium, similar to those developed under our own program, into their electrical network. This represents a significant departure from their approach to date, which has been one of concentrating on natural uranium as a reactor fuel. The second problem area that the UK faces is the announced intention to integrate with the European community; they are now scheduled to commence negotiations this October to join Euratom, the community's civilian nuclear arm."

My next meeting with British nuclear officials occurred on Wednesday, February 13, 1963, in my Washington office:

"I met with Dr. H. Kronberger (Deputy Managing Director, Reactor Group, UK), R. C. Orford (Head, Commercial and Overseas Relations, UK) and Joseph Stephenson to discuss their desire to renew the agreement to exchange information on fast reactors. We also explored the possibility of US-ENEA cooperation in view of UK Common Market and Euratom difficulties and the possibility of a US-UK-Euratom Agreement for Cooperation."

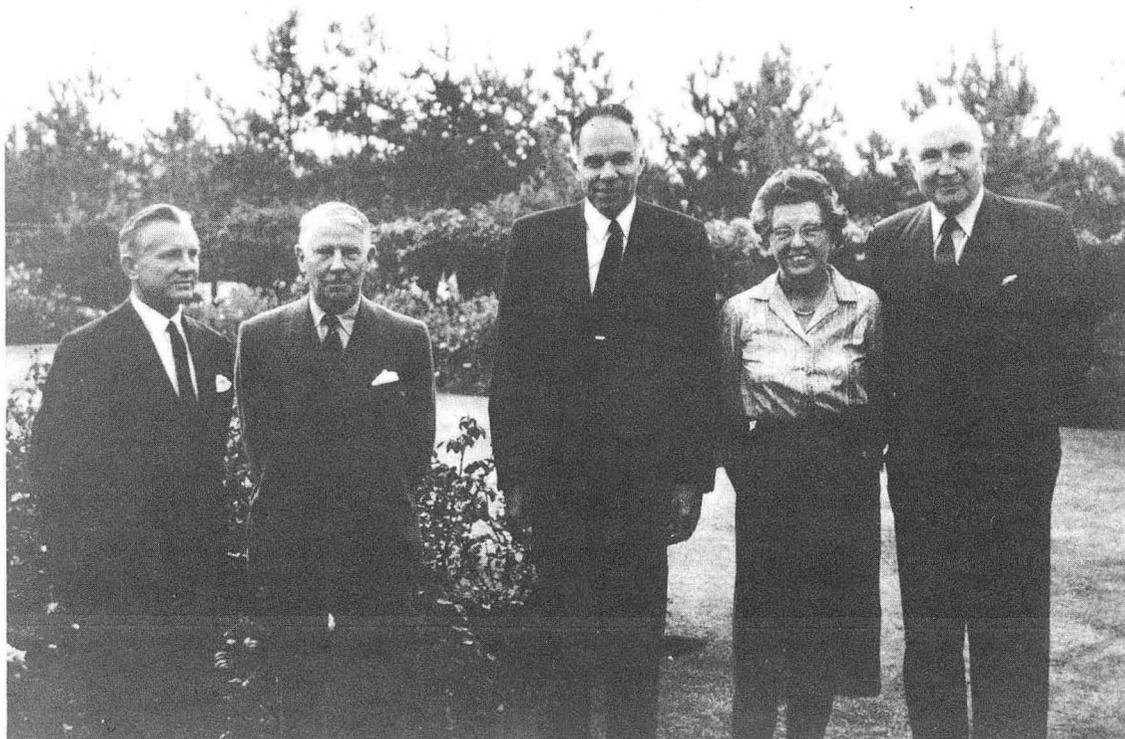
A few months later, on June 5, I participated in the signing of the instrument amending the Agreement for Cooperation in Civil Uses, which was described earlier in this chapter. Richard H. Davis and I signed for the US and Ormsby Gore signed for the UK.

My annual IAEA trip afforded an opportunity for the deferred Aldermaston visit in the fall of 1963:

"Tuesday and Wednesday, September 17-18, 1963 - Washington, London, Aldermaston

"After spending the day at the H Street office, I flew to London with Arnie Fritsch (my Technical Assistant), Wells, and King. We were met by Samuel G. Nordlinger, the USAEC Scientific Representative in London. We were driven to Aldermaston where we met Sir Roger Makins and had breakfast at the home of Sir Claude and Lady Pelly. Our party then toured the plutonium laboratory with Sir Roger Makins and saw a display of weapons models. Sir William Penney, Pelly, Levin (Director), and E. F. Newley (Deputy Director) accompanied us.

"The entire UK weapons effort appears quite sound and generally along the lines of our laboratories, although their total laboratory and staff is considerably less than that involved in the US program.



XBB 761-7033

*In Rose Garden of home of Sir Claude Pelly, Aldermaston, Sept. 18, 1963.
(Left to right) Algie Wells, Sir Claude Pelly, Seaborg, Lady Pelly, Sir
Roger Makins.*

"After lunch Fritsch and I talked to Makins, Penney, Pelly, Levin and Newley on the plutonium weapons proliferation problem. I rode back to London with Makins and Penney and on the way told them about my May talk with Bertrand Goldschmidt; also we agreed not to pursue for the present the question of British weapons people working in weapons laboratories (as discussed by Commissioner Robert E. Wilson with the British at Stocktake meeting). Sir Roger gave us a dinner at the Athenaeum Club attended by Lewis Jones, Lord Hailsham, Sir William Penney, Sir William Cook (Member for Reactors, UKAEA), James C. C. Stewart (Member for Production, UKAEA), Professor Alan Cottrell, Sir Harold Caccia, Professor Harry J. Emeleus, Fritsch, Wells, and Nordlinger."

While there was no further opportunity for me to visit England until the fall of 1966, trips by UKAEA officials to the United States afforded numerous occasions for meetings here. On February 20, 1964, for example, Sir Roger Makins came to see me at USAEC Headquarters. We discussed a variety of subjects, including the following as reported in my journal:

"Sir Roger said that his people had decided that they want to arrange as soon as possible an expansion of our current exchange in the fast reactor field, and that they agree pretty much to proceed on the terms that we have proposed.

"Following this, they will probably want to discuss an agreement for the exchange of information in the field of water reactors.

"Makins said that the decision on the future operation of Capenhurst for the production of U-235 will not be made for a few months yet. His own guess is that the United Kingdom will plan two sources for their U-235; some from a modernized Capenhurst, and some from the United States.

"We also talked about nuclear maritime propulsion; he felt that the United Kingdom is finding this too costly to be interesting at the present time."

On June 29, 1964, William R. Tyler and I participated, with Lord Harlech (Ormsby Gore), in the signing of the Agreement for Cooperation between the United States and the United Kingdom that arranged for the sale of up to 400 kg of enriched uranium, an amendment to the previous Agreement.

The following year, on February 11, 1965, Sir William Penney, who had succeeded Sir Roger Makins as Chairman of the UKAEA, met with me in Washington. On this occasion Penney and I exchanged letters initiating a new 10-year information exchange program on fast reactor technology between the USAEC and UKAEA. The arrangement called for exchange of research and development data on all types of fast reactors for civil, land-based power stations up to and including construction and operation of prototype reactors. Present

at the signing ceremony were David E. H. Peirson, Secretary of the UKAEA, and Joseph Stephenson, of the UK Embassy in Washington, and, on our side, John A. Hall, Assistant General Manager for International Activities, Myron B. Kratzer, Director, Division of International Affairs, and Samuel G. Nordlinger, USAEC Scientific Representative at the US Embassy in London.

A private discussion between Penney and me touched on a wide range of topics including details of arrangements for underground weapons testing; Indian interest in participating in the UK's test detection activities; and the problem of giving IAEA safeguards inspectors access to a UK chemical extraction plant where reactor fuels for nations such as Japan will be processed but where weapons grade material is also processed. Penney expressed concern about our decision to maintain a secrecy classification on gas centrifuge technology, particularly in view of the amount of information in this area that the United States had already declassified:

"[He said] they plan to build four or five such centrifuges for use in hospitals, in the study of viruses, etc. He wanted to know whether this plan would lead to embarrassment of the United States if we went ahead with the meeting between the United Kingdom and the United States on this subject, scheduled for this spring. He said that the United Kingdom could build these centrifuges on the basis of already declassified information. We agreed that the United States would let Frank Panton at their Embassy here know the answer to this question of whether the US-UK meeting should be held this spring in view of this development."

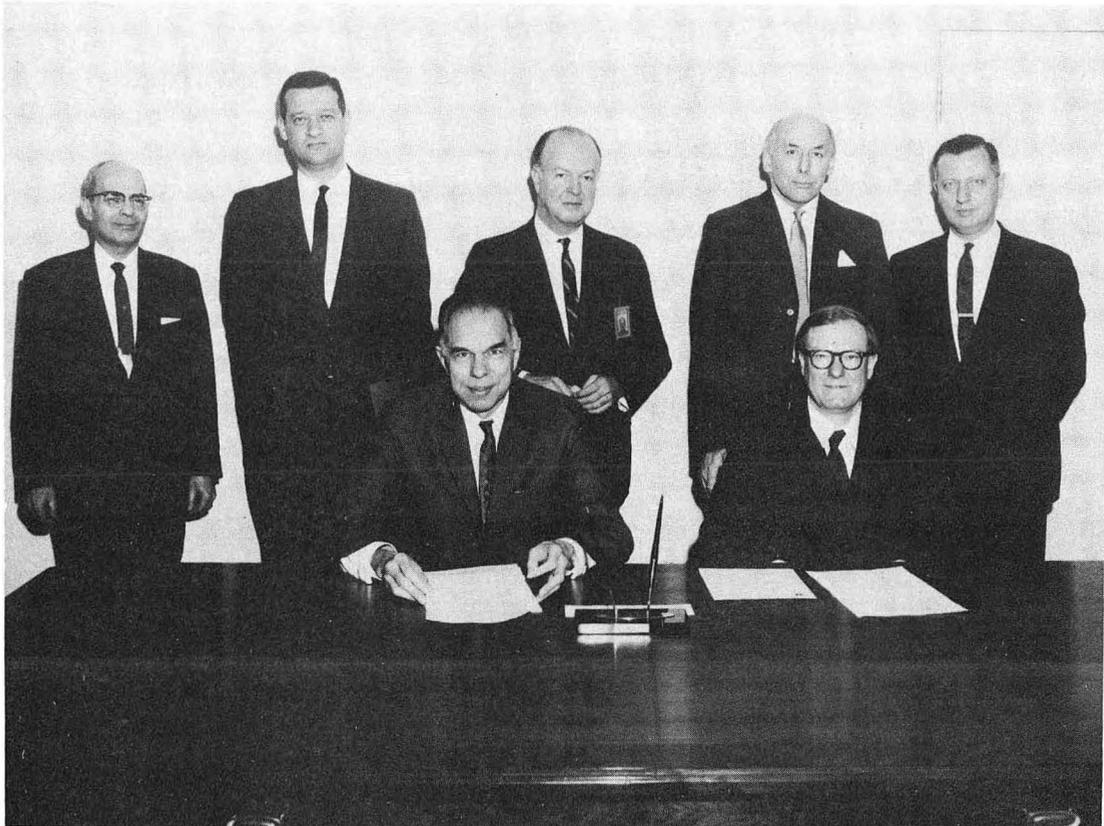
The meeting mentioned by Penney had been scheduled as a "close-out" meeting on our gas centrifuge technology exchange, which by 1965 had advanced as far as was possible under the terms of our Agreement for Cooperation. This meeting did take place as arranged, in April 1965; any difficulties pertaining to the British plan to use centrifuges for medical purposes were satisfactorily resolved.

Another problem with our relations with the British concerned the fast reactor exchange. We interpreted our exchange policy as allowing us to place an observer at the Dounreay site where the British were building their prototype fast breeder reactor. However, as the following excerpt from my journal indicates, this proved to be unacceptable:

"Monday, November 1, 1965 - D.C. Office

"At 2:30 p.m. Dr. Ronald Sowden (British Embassy) delivered to me a letter from Sir William G. Penney, in which Penney explained problems associated with placing a USAEC observer at Dounreay Plant."

Penney felt that such an observer would be in a position to obtain information that was specifically excluded from the Agreement.



XBB 761-7034

Signing of letters initiating information exchange program on fast reactor technology, USAEC Chairman's H Street office, Washington, D.C., February 11, 1965. (Left to right) Standing, Samuel Nordlinger, Myron Kratzer, John Hall, D.E.H. Peirson, and Joseph Stephenson. Seated, Seaborg, Sir William Penney.

On June 2, 1966, J. Robert Schaetzel (Deputy Assistant Secretary of State, Bureau of European Affairs) and I, as well as Patrick Dean (British Ambassador to the US) participated in the signing of the amendment to our Agreement for Cooperation on the Civil Uses of Atomic Energy with the UK, increasing by 2,000 kg the amount of enriched U-235 transferable to the UK for use in civil research and development programs, and increasing the term of the agreement by ten years. We also signed a new Agreement for Cooperation in Civil Power Applications of Atomic Energy, providing for the US to supply up to 8,000 kg of U-235 for use in the UK's civil nuclear power program for a period of ten years.

I testified on the amendment involving research reactors, as well as the proposed new Agreement regarding power reactors, shortly thereafter:

"Tuesday, June 28, 1966 - D.C. Office

"At 11 a.m. I testified before the Joint Committee on Atomic Energy (Senator Albert Gore, Chairman of the Subcommittee on Agreements for Cooperation) on the proposed Amendment to the Agreement for Cooperation with the United Kingdom and on the proposed new Agreement for Cooperation in the Civil Power Applications of Atomic Energy with the United Kingdom.

"The proposed Amendment will extend for a period of ten years the existing Agreement for Cooperation... which is now due to expire on July 20, 1966, and increases the amount of U-235 transferable to the UK by 2,000 kg. The amended Agreement will continue the Statutory guarantees in the existing agreement that no material, equipment, or devices transferred pursuant to the Agreement will be utilized for military purposes.

"The proposed new Agreement... will provide for the supply of up to 8,000 kg of U-235 for use in the United Kingdom civil nuclear power program during the next ten years. Representative Craig Hosmer pressed me pretty hard as to why we are so accommodating to the United Kingdom as to furnish them with 8,000 kilograms of enriched U-235. I explained our nondiscriminatory trade policy. He also pressed me on the adequacy of our enrichment capacity. I said this was no problem, but I will furnish him data on our uranium resources."

Another interesting conversation in Washington took place on October 15, 1966, with Sir Solly Zuckerman, then recently assigned as Chief Scientific Adviser to Her Majesty's Government. Sir Solly told me about his new position; he said that a new advisory committee at the ministerial level had also been created and that his responsibilities included advising this committee on scientific matters. He went on to speak of a recent trip to the Soviet Union:

"He told me that during this trip he talked chiefly with Millionshchikov and Emelyanov and three other Soviet leaders on the problem of seismic detection of underground nuclear explosions. He said that, surprisingly, they are now ready to discuss this,

and apparently will send a team to England to pursue these discussions. He said that these five men gave him the impression that the Soviet Union didn't particularly need any more underground tests for nuclear weapons development, and also they didn't seem to be much interested in the use of nuclear explosions for peaceful purposes.

"When he learned that I would be in England in about a week, he suggested that I meet with Anthony Wedgwood Benn, Minister of Technology, to whom Sir William Penney reports. He also wants to discuss with me the future of desalting with dual purpose reactors in England."

When telling about our bilateral cooperation in Germany, I spoke of the trip I took to England in October 1966, in order to present the Enrico Fermi Award to Lise Meitner.* Though brief, that trip provided an opportunity also for worthwhile talks with UK Government officials (including Benn, as proposed by Zuckerman) and scientists and a visit to the UKAEA Culham Laboratory. Here is my journal account of my activities after the award presentation on October 23:

"Sunday, October 23, 1966 -- London

"I rode back to the Europa Hotel in London, where I had a press conference with Anthony R. Michaelis (*Daily Telegraph*), C. L. Boltz (*Financial Times*), P. A. Tucker (*Guardian*), E. N. Shaw (*Nuclear Engineering*), John Davy (*Observer*), and Donald Gould (*New Scientist*), with the help of William Dunn (Chief Editor of USIS). After my description of the Fermi Award events this afternoon at Cambridge, I was asked questions on nuclear power growth, the US breeder program, new programs of the USAEC, transuranium elements, Plowshare, enrichment plans and toll enrichment, my satisfactions as USAEC Chairman, etc.

"Monday, October 24, 1966 -- London and Culham Laboratory, Berkshire

"I rode in a UKAEA car with Peirson, Fritsch and Malmstrom to Culham Plasma Physics and Fusion Research Laboratory. We were shown the various machines by Dr. John Adams, the Director, Dr. Basil Pease (Chief of Experimental Division A) and others, and also the rocket work on ultraviolet spectroscopy of the sun by Dr. Robert Wilson (Chief of Spectroscopy Division). I had lunch with John Adams, Mr. Dennis Wilson (Secretary), Dr. John B. Taylor (Chief of the Theory Division), Dr. Basil Pease, Dr. Peter C. Thonemann (Deputy Director), Dr. Robert Wilson, Mr. Robert Carruthers (Chief of the Technical Division), Fritsch, Malmstrom, and others.

* See Ch. 4, pp. 98-100

"We rode back to London where I met with US Ambassador Bruce, along with Willis Armstrong (Chief of Embassy's Economic Section), Fritsch and Malmstrom. We discussed the Fermi Award presentation to Meitner, the Pole-Czech offer of IAEA safeguards, the UK attitude on safety of US reactors, including the problems created by their public criticism of this safety, etc.

"We then attended tea in the building housing the Engineering Department at the Imperial College. Those present included Lord Sherfield (Sir Roger Makins), John Vernon Dunworth (President, British Nuclear Energy Society, and Director, National Physics Laboratory), Dr. A. S. McLean (Chairman of the Papers and Meetings Committee), Armstrong, Fritsch, Malmstrom, and others. Then we went to the Lecture Hall in another building where, after an introduction by Dunworth, I gave my lecture – the fifth annual lecture of the British Nuclear Energy Society – on 'Nuclear Power – Two Years After Geneva.' There were about 300 people present. My talk, illustrated with 17 slides, was followed by a question period. Questions were on relative safety and economics of US and UK reactors. My comparison of the economics was disputed. The question period was followed by a dinner, at which I sat next to Dunworth and Peter Shore, who is Undersecretary of the Ministry of Technology and is said to have the ear of the Prime Minister and who is an intelligent and very personable fellow. There were some 25-30 people at this dinner, including Lord Sherfield, McLean, Fritsch, Malmstrom, Dr. Gordon Brown (in charge of AGR reactor development), and others."

"Tuesday, October 25, 1966 – London, Washington

"Fritsch, Malmstrom and I called on Sir Solly Zuckerman in his office. Frank Press and three others were present. We discussed nuclear desalting and possible entry of the United Kingdom into the foreign market for such reactors. The conclusion seemed to be that it is doubtful that this will be profitable. We discussed his trip to the USSR to discuss seismic detection of underground nuclear explosions – the Soviets agreed to meet in two months with the United States and United Kingdom to discuss this subject, but there is some doubt that the meeting will take place that soon. Then Zuckerman and the three of us went to meet with Anthony Wedgwood Benn in his office. Michael I. Michaels of the UKAEA also was present. Benn exhibited much interest in the US nuclear power program, the methods by which approval decisions are reached on USAEC projects, the effect of future cheap nuclear power on the whole economy of the United States, the role of breeders, the prospects for nuclear fusion power, the examination of the future support of basic science in England, etc. I gave Zuckerman a copy of my British Nuclear Energy Society speech and promised to send a copy to Benn at his request. The discussion with Benn was quite lively; he seems to be a most capable and intelligent person. I also met Richard Crossman (Lord President of the Council), and we had a short discussion about the USAEC."

I mentioned earlier that the United Kingdom, up until 1974, generated a larger amount of electric power with nuclear energy than any other country. It took an early lead in this field, first utilizing a gas-cooled, graphite-moderated type of reactor fueled with natural uranium, and later turning to an "advanced gas-cooled" (AGR) model which uses slightly enriched uranium dioxide fuel. While moving ahead with their construction program based on these proven types, the British have at the same time devoted intensive research and development efforts to three reactor concepts considered most promising for future power systems: the High Temperature Gas-Cooled Reactor (HTR), the Steam Generating Heavy Water Moderated Reactor (SGWR), and the Sodium-Cooled Fast Breeder (FBR); in 1974, after debating whether to turn to water-cooled reactors, they decided to place future emphasis on the SGWR.

Despite the overall good record of its nuclear power reactors now in operation, the British have been generally unsuccessful in attempts to market their models abroad. Disappointment has been augmented by a falling off of domestic orders in the mid-sixties. The situation itself, as well as speculation as to the reasons for it and possible corrective measures, drew increasing attention in the press; and the subject inevitably arose from time to time during our discussions with UKAEA and other UK officials. As one illustration of the type of concern expressed informally, I shall cite remarks made in conversation with me by Mr. Tam Dalyell, Labor Member of Parliament and a Member of the House of Commons Committee on Science and Technology. Mr. Dalyell met with me at USAEC Headquarters on May 23, 1967. Abraham Friedman, Deputy Director of the USAEC Division of International Affairs, and my Technical Assistant Arnold Fritsch were also present.

Mr. Dalyell began the discussion by noting the present "reactor dilemma" facing the United Kingdom; he emphasized his concern over the fact that while the United Kingdom had a good record in nuclear science research, its sales record of nuclear reactors was extremely poor, especially abroad. At present, he pointed out, each of the three nuclear power consortia could expect to get one new reactor order every six years.

In response to Mr. Dalyell's observation that one way out of the dilemma would be increased US-UK cooperation on fast breeder development, I pointed out that the roadblock to further cooperation in this field was the reluctance of the United Kingdom to share information it regarded as "proprietary." I indicated that the USAEC remained eager to further our fast breeder exchange.

Mr. Dalyell's preoccupation, as I have suggested, was widely shared by governmental, industrial and other decision-making elements in the United Kingdom. Partly as a result, plans for a major restructuring of the British nuclear industry, involving also certain modifications of the UKAEA, were announced about a year after the above conversation.

The next day (May 24, 1967), I met Anthony Wedgwood Benn again, who came to my office with William Knighton and Gordon Bowen of the UK, as well as Ieuan Maddock (of Sir Solly Zuckerman's office, whom I knew from his 1936-38 stay at Berkeley), Ronald Sowden and Reginald G. Voysey of the

British Embassy. Arnie Fritsch and Abe Friedman were also present. We discussed our breeder program and USAEC relations with other departments and agencies.

While most US-UK discussions regarding our cooperative nuclear activities have naturally taken place in the United States or in England, there have been occasions elsewhere. One useful meeting, for example, occurred on May 31, 1967, in Montreal, where informal tripartite (US-UK-Canada) talks were being held on matters of common concern in the nuclear area. Sir William Penney, now UKAEA Chairman, requested a separate US-UK meeting at this time. He wished primarily to discuss the prospects for UK reprocessing of US irradiated reactor fuels; several other subjects also arose during our conversation. Sir William was accompanied by Dr. John M. Hill, UKAEA Member for Products, and Dr. Sowden. With me were Commissioner Tape and Arnie Fritsch.

The United Kingdom wished to obtain an amendment to the US-UK bilateral agreement to permit the United Kingdom to process US reactor fuels and then return the separated U-235 to the United States. The British had expressed their desire for this permission some time before this meeting; and they were of course familiar with our position that this could not be allowed as long as it might have a harmful effect on the US reprocessing industry. The latter was by now on reasonably firm footing, however, and Commissioner Tape and I were able to assure Sir William that there was now general agreement, on the part of the United States, to allow this eventually. Nevertheless, we could not yet set an exact date, as the British desired. We emphasized that selection of the exact date involved numerous factors and, moreover, would probably have to be considered in the broader context of reprocessing abroad in general and not just in the United Kingdom. The discussion concluded with an agreement that we would try to give the United Kingdom two years' advance notice of a change from our present policy which prohibited foreign reprocessing of US reactor fuels. (As I have already stated, an amendment enabling the United Kingdom to reprocess US reactor fuels was in fact signed in 1970.)

My trip to the Twelfth General Conference of the IAEA, in September 1968, gave me the rare luxury of a purely extracurricular stop in England *en route*. After a busy day at USAEC Headquarters, I left for London in the evening on Tuesday, September 17, with Arnie Fritsch (Helen had left on an earlier flight).

"Wednesday, September 18, 1968 – London

"Fritsch and I were met by Bill Rice (USAEC Representative in our London Embassy Office). We met Helen and we all rode to the Europa Hotel. Helen and I checked in, and later we took the subway to the Tower of London, which was built by William the Conqueror. We toured the Tower of London complex including the Tower itself. We saw the armour rooms in the White Tower, which included a number of armours worn by Henry VIII (a tall, as well as big, man), the sword rooms, and the jewel rooms (which included the Crown Jewels of numerous monarchs, and numerous candlesticks, bowls, tableware, etc., made of gold). We saw the Bloody Tower,

where many important prisoners were kept, including Sir Walter Raleigh, the Wakefield Tower (built by Henry III), the Bell Tower, Traitors Gate, the Lion Tower, the Middle Tower, the Byward Towers, and the Beauchamp Tower. We saw the engravings made by the prisoners in the stone walls in the Bloody Tower, the Beauchamp Tower, etc.

"We then took a boat on the Thames to Westminster. On the way we saw the Fish Market (11th century), and the Monument of Christopher Wren. We went under the London Bridge, the Cannon Street Bridge, and the Summit Bridge (the smallest one). We saw the spire of St. Mary's Church (containing the famous bells), the Cardinal's House (where Sir Christopher Wren stayed), the spire of St. Bride's Church (designed by Sir Christopher Wren), went under two railway bridges and another bridge (all together), saw the head offices of Lever Brothers (semi-circular), the dome of Old Bailey Criminal Court, Temple Arch (marking the boundary of the City of London and the City of Westminster), Captain Scott's ship (which went to Antarctica), went under the Waterloo Road Bridge (opened in 1945), saw the new (1967) Queen Elizabeth Concert Hall, the statue of Lord Nelson in Trafalgar Square, went under Charing Cross Railway Bridge (has the highest suicide rate of all the bridges), saw the Whitehall Court residence (George Bernard Shaw lived here), the Defense Ministry (contains nuclear shelter, the first in London), behind which is No. 10 Downing Street (the official residence of the Prime Minister), the old building which used to be the headquarters of Scotland Yard (now the Defense Ministry), went under Westminster Bridge, and saw the Houses of Parliament with Big Ben. We docked at Westminster Pier and visited Westminster Abbey, which we toured rather thoroughly.

"We then took a cab to Simpsons-on-the-Strand, where we had dinner. Fritsch then went on to a show (*Charley Girl*) and Helen and I went for a long walk. We walked to and around Piccadilly Circus, down Regent Street and across on Beak Street to Carnaby Street (a picturesque street in the Soho District), which we walked up and back, then on to Oxford Street and back toward our hotel."

The following morning I flew to Brussels for meetings which I have described in my account of our cooperation with Euratom. Helen stayed on in London for more sightseeing – Buckingham Palace, Queens Gallery, Bird Cage Walk, Westminster Abbey, No. 10 Downing Street, Trafalgar Square, Covent Garden, Drury Lane, Old Curiosity Shop, Dickens' House, and the British Museum – before flying to Cologne in the evening to meet me there.

I did not visit the UK during 1969, but my journal entries describing the visits of a number of UK officials that year and on into 1970 tell their own story:



XBB 761-7035

Seaborgs at Tower of London, Sept. 18, 1968.

"Saturday, May 3, 1969 - D.C. Office

"The Commissioners met with Sir Solly Zuckerman this morning. Also present were Clive M. Rose (Counselor, British Embassy), Myron Kratzer, Howard Brown, John Pender (General Counsel's Office), Julius Rubin, and Jack Rosen.

"The purpose of the meeting was to discuss the difficulty that has arisen with respect to the possible transfer of US gas centrifuge information by the UK to the new consortium (UK, The Netherlands, and Germany). Zuckerman began the meeting by describing the present status of the consortium. He said there will be a meeting at the ministerial level in June in Bonn; and then a ministerial meeting in July, at which it is hoped that the agreement will be signed. The plan is to have two companies: one concerned with research and development and production of the machines, and the other concerned with operating the machines.

"He said that the UK and the Dutch are very concerned with the proliferation implications of the arrangements, especially as concerns Germany, and a great deal of attention is being given to the problem of getting Germany to sign the NPT in order to mitigate this problem.

"He said that the latest cost projections by the Dutch suggest \$47 per kilogram of separative work at the 25 tons per year level, going down to \$32 per kilogram unit at the 100 tons per year level.

"Zuckerman told us frankly that the Dutch and Germans have not yet been told of the difficulties between the US and the UK on this transfer of information question, and have not been told that the UK is committed to tell the US in the future about any information passed to the consortium that might possibly have come from US-UK collaboration during the 1960-1965 period.

"I said that the main concern, and the one we should direct our attention to, is the question of whether the UK intends to pass any US-derived information to the consortium. Ramey indicated that he thought the US should have access to the Mark I production model in order to assure that no US-generated information has been transferred to the consortium. Zuckerman said this possibility had been considered at the highest level and it has been concluded that such access would be inequitable from the standpoint of the UK. Such access would require reciprocal information from the US, meaning a further exchange of information, which of course is not practical. Thus, he said it would imperil the whole enterprise.

"After further discussion and emphasis of the extremely high concern of the JCAE, especially Holifield, on this matter,

Zuckerman agreed to discuss the matter further at the Cabinet level (where it has been considered) in the UK, raising the question whether they might not grant access to the Mark I production model to the extent required in order that we might assure ourselves that it does not include any US-generated information.

"I had lunch at the Metropolitan Club with Sir Solly, Tape, and Frank Costagliola. We continued our discussion of the US-UK relationships in the nuclear energy field. We discussed the question of the renewal of the Agreement for Cooperation with the UK on the Uses of Atomic Energy for Mutual Defense Purposes about which Sir William Cook and Commissioner Tape have been corresponding. We indicated that because this agreement expires at the end of this calendar year it is necessary for the White House to make a positive determination that they wish to recommend renewal, and this would also require action by the JCAE. Tape and I also indicated that the JCAE is apt to relate its attitude toward the problem of the renewal of the above Agreement for Cooperation to the successful resolution of their worries concerning the possible role of US-generated gas centrifuge information in the development of such machines by the consortium. We indicated that one of the problems that must be resolved is the level of information in the field of nuclear weapons that should continue to be exchanged. It may be considered that this exchange is no longer on an equitable basis in view of the diminishing effort of the UK in this field."

"May 14, 1969 – D.C. Office

"Based on our conversations with Sir Solly Zuckerman on May 3, a cable was sent to the American Embassy in London, spelling out the arrangements concerning the US-UK gas centrifuge discussions, which, we hope, might be a final solution to this problem."

(The arrangements referred to concerned the right of the US to make inspections of the key UK centrifuge equipment in order to assure ourselves that US technology was not being used in the tripartite arrangement.)

"June 6, 1969 – D.C. Office

"I met with Sir Solly Zuckerman. Also present were Clive M. Rose, George Springsteen and Wolfgang Lehmann (Department of State), Commissioner Johnson, John Ryan (for Commissioner Ramey), Bob Hollingsworth, Myron Kratzer, Howard Brown, and Julie Rubin. We continued our discussion of May 3 because the problem of US access to the information on (and model of) the gas centrifuge that the UK is going to present to its tripartite partners, the Netherlands and West Germany, is still unresolved. The problem is whether the UK will include information that they received from the

United States during the period of US-UK cooperation, 1960-1965. The matter has some urgency due to the meeting of ministerial representatives of the three countries that will be held in Bonn on June 9. This meeting will be attended by Dr. Stoltenberg (Minister of Scientific Research) and Dr. Harkort (State Secretary, Ministry of Foreign Affairs) of Germany, Mr. L. de Bloch (Minister of Economic Affairs) and Mr. J. M. H. Luns (Minister of Foreign Affairs) of the Netherlands, and Mr. A. Wedgwood Benn (Minister of Technology) and Mr. F. Mulley (Minister of State, Foreign and Commonwealth Office) of the United Kingdom.

"As a result of the discussion we concluded that: (1) the meeting on June 9 should go ahead because there would be no technical information exchanged at that meeting; (2) the UK will furnish us evidence, such as the real proof by Sir Alfred Pugsley, an independent engineer without access to data from the centrifuge program, that such items as the End-Cap could be invented from first principles without access to US or UK work; (3) the question of granting the US access to the UK centrifuge model must be urgently resolved because at the next meeting of tripartite representatives, probably in July, it might be necessary to exchange technical information; (4) if the UK persists in denying the US access to their model, they might obtain a secret US patent on it in order to protect their information while giving the US access to it. Sir Solly said that he would bring this plan to the immediate attention of the UK authorities and would let us know their reaction as soon as possible."

"July 3, 1969 - D.C. Office

"I received a letter today from British Ambassador Freeman, transmitting an *aide-mémoire* from his government about their granting visual access to the current UK production model of gas centrifuge in order to assist the US in forming a judgment whether the model reveals US Restricted Data furnished under the 1955 agreement between the US and UK."

(The *aide-mémoire* indicated that the UK was willing to have US representatives inspect essential UK centrifuge equipment in order to ascertain that significant US technology was not involved.)

"July 22, 1969 - D.C. Office

"I presided over Information Meeting 930. We heard a report by Commissioner Thompson and Paul Vanstrum and Edwin Badelay of Union Carbide on their trip to England last week for the purpose of inspecting UK centrifuge work, including an actual model, in an attempt to resolve the issue of whether the UK is passing US Restricted Data on to the three-nation consortium (West Germany, Netherlands, UK). They learned that the UK is building, at Capenhurst, a

rather low-grade centrifuge plant with a first step capability of 50 tons of separative work a year, to be ready by 1972, from which the product will be quite expensive. It appears that the UK may be incorporating some US technical information, but the extent of this is so small we would not be able to resolve the issue."

"Friday, August 1, 1969 - D.C. Office

"Commissioner Thompson and I, accompanied by General Giller, Bob Hollingsworth, Fred Tesche and Jack Rosen, met in the executive session room of the JCAE with Congressman Holifield and Hosmer, Ed Bauser, Col. Schwiller, Bill England, and George Murphy. Toward the end of the session Senator Aiken joined the group.

"...Commissioner Thompson, Bob Hollingsworth and others [discussed] the problem concerning UK involvement with the Netherlands and West Germany in the development of the gas centrifuge for the enrichment of uranium. Thompson described the results of his discussions on this with the British during his recent trip to England at which time he and his group were given access to the UK gas centrifuge operating model. He succeeded in convincing the members of the Joint Committee present (Holifield, Hosmer, and Aiken) that we should not stand in the way of the UK proceeding with the Netherlands and West Germany on this development; the dependence of the UK development on information obtained from the US during our period of cooperation (1960-1965) is too minimal to justify continuing complaints from us."

(This then wound up a troublesome matter, which I believed right along was being over-emphasized by the people on our side.)

"April 15, 1970 - Washington

"Helen and I attended a reception at the British Embassy given by Mr. and Mrs. Michael Lock (Scientific Counselor) for the UK Minister of Technology, Anthony Wedgwood Benn. Among those present were: Charles Schultz, Mr. and Mrs. Dael Wolfle, Dr. and Mrs. Lee A. DuBridge, Mr. and Mrs. John S. V. Andrews (Atomic Energy Attache, British Embassy), the Turners (daughter of the Andrews), Dave Beckler, Doug Cater, Mr. and Mrs. Howard E. Shuman (Sen. Proxmire's assistant), Myron Tribus, Mr. and Mrs. Gordon McDonald and Ted Neuriter. At the end of the reception Lock introduced Benn, who gave a slide-illustrated talk describing in historical terms the situation in Great Britain and how it had changed since the Labor Party came into power in 1964. He placed this in a worldwide perspective, describing the tremendous change brought about by science and technology since the war and indicating that this is the cause of the present unrest and uncertainty in so many countries in

world. He said we are using outmoded political, social, and economic methods to deal with a new situation that is different in kind from the situation for which these methods were devised."

"Friday, April 17, 1970 - D.C. Office

"The other Commissioners and I met with Anthony Wedgwood Benn. Others present were: Sir Ronald Melville (Secretary for Aviation, Ministry of Technology), Robert Marshall (Deputy Secretary for Finance, Ministry of Technology), Anthony Newsome (Principal Officer, International Technological Cooperation Branch, Ministry of Technology), Derek Moon (Chief Information Officer, Ministry of Technology), I. T. Manley (Private Secretary to Minister Benn), John Andrews, Donovan Q. Zook (Department of State), Ed Bloch, Frank Baranowski, General Crowson, Myron Kratzer, Frank Parks, Bill Yeomans, and Julie Rubin.

"I opened the meeting with welcoming remarks. I referred to my meeting with Benn in London in the fall of 1966 and to his meeting with us at the USAEC in the spring of 1967; I indicated that there had been a lot of developments since that time in our respective national programs and in the international area that made today's meeting timely. I referred favorably to the speech he gave at the British Embassy on April 15, and, at my request, he said he would give us copies of his main slides and texts from similar speeches.

"I then referred to the agenda and suggested that Minister Benn begin with a discussion of the UK views on the tripartite centrifuge arrangements and its further development. He described this undertaking, making it clear that he felt the centrifuge method is economically competitive with the gaseous diffusion method and cannot be held secret too much longer in view of the worldwide interest in its development.

"I then went on to the second item and described the review under way in the US government on the possibilities of US cooperation with Western Europe and the United Kingdom in the field of gaseous diffusion. I said that no decision had been made as yet and that the US initiation is intended as a possible supplement to the efforts already under way in Western Europe in the enrichment field and was not directed against the European tripartite gas centrifuge project. I said that in the event the US elects to initiate some type of cooperative agreement with the Europeans, it would be our intention to consult with the British at an early stage.

"Minister Benn then described in some detail the proposed reorganization, actually dismemberment, of the UK Atomic Energy Authority.

"I then went on to the discussion of the safeguards under the Non-Proliferation Treaty, indicating that there was a slight difference of opinion between the UK and the US on this. I said that the US doesn't want to revise the IAEA safeguards document, but believes that it is flexible enough to accommodate the changes that might be required to bring additional nations into the Non-Proliferation Treaty. I emphasized that Euratom's multilateral system may not apply to States having only national safeguard systems, and we should be careful not to erode the effectiveness of the IAEA safeguards. It is a balance between making the safeguards attractive enough to draw additional important nations to NPT, but not so weak that the NPT would be ineffective. I indicated that we would like to consult with Western countries and the UK on the implementation of the NPT and that we might soon be in touch with them for this purpose. Mr. Benn said that he had profited from the discussion and also, since the responsibility for this lay in the Foreign Ministry, he would perhaps now be in a better position to discuss this matter from the UK side."

"Tuesday, August 25, 1970 - Germantown

"I met with David Peirson, Secretary of the UKAEA, who was accompanied by John Andrews. Myron Kratzer, Jim Ammons, and Julie Rubin were also present. It was mainly a courtesy call, which included some discussion concerning my forthcoming visit to England, September 26 - 30. I inquired as to the status of the reorganization, or dismemberment, of the UKAEA, for which I understood that plans had been shelved. Mr. Peirson indicated that these plans had indeed been dropped and, in fact, John Davis, chief critic of Wedgwood Benn's plans in this regard, is now Minister of Technology in the new liberal government, which indicates that there isn't much chance that this plan will be put into effect. The result is that the UKAEA will continue in full force."

The fall of 1970 provided the opportunity for my longest and perhaps most interesting trip in the United Kingdom. Visits to major reactor development centers, meetings with a wide range of UKAEA and industry officials, useful talks with members of our Embassy in London, a chance to see something of the north - all these and other factors combined to make this a memorable journey. The days immediately prior to this trip were spent in Vienna, where the 14th General Conference of the IAEA opened on September 22. I left Vienna on the 26th:

"Saturday, September 26, 1970 - Vienna, London

"At the Airport we met Sir John Hill, who has succeeded Sir William Penney as Chairman of the UKAEA and who flew to London on the same plane as we (Justin and Robbie Bloom, Abe

Friedman, Helen and I). We were met by William Rice, and were driven to the Britannia Hotel (Grosvenor Square). We had trouble getting into our room, which was still occupied, even though it was 4 p.m. (According to the posted regulations, guests are required to vacate rooms by noon; but apparently, as Abe put it, 'Britannia waived the rules.')

"We then rode with Friedman to the Columbia Club where the USAEC (represented by Rice) and Ambassador and Mrs. Walter Annenberg hosted a reception for us. Others present, in addition to our party and Mr. and Mrs. Rice, were Mr. and Mrs. Trevor Griffiths (Chief Inspector, Nuclear Installations Inspectorate) and Mr. W. S. Gronow (Deputy Chief Inspector, Nuclear Installations Inspectorate) from Ministry of Technology; Sir John and Lady Hill (Chairman of UKAEA), Sir Charles and Lady Cunningham (Deputy Chairman), Air Chief Marshal Sir Denis and Lady Barnett (Member for Weapons), Mr. David E.H. Peirson, Dr. and Mrs. Andrew Sinclair McLean (Director, Health and Safety Branch), Mr. and Mrs. J. A. Nicol (Commercial Policy) from UK Atomic Energy Authority; Dr. and Mrs. Francis Harry Panton (Assistant Chief Scientific Adviser - Nuclear) from Ministry of Defense; and US Minister Stanley Cleveland and Mr. and Mrs. Stephen H. Rogers from the American Embassy. Ambassador Annenberg invited me to play golf with him on his Palm Springs golf course sometime, such as during his visit home next April.

"After the reception Helen and I rode with Sir Charles and Lady Cunningham to the Vaudeville Theater where a group of us saw the play *Lady Frederick*, starring Margaret Lockwood and Tony Britton. Others in attendance were Sir Denis and Lady Barnett, Peirson, Mr. and Mrs. Nicol, Mr. and Mrs. Bloom, Mr. and Mrs. Rice, and Friedman. It was a very charming play."

"Sunday, September 27, 1970 - London, Glasgow

"Helen and I began a long walking tour, down Baker Street (passing No. 221, the residence of Sherlock Holmes) on to Regents' Park. We walked through Queen Mary's Gardens, a very impressive view of flowers. We then walked on to the South Gate of the London Zoo and entered the Zoo. We saw a pair of Chinese leopard cubs, Anna the new baby elephant, a baby black rhinoceros, the panda, the excellent collection of primates, etc. We watched them bathe the elephants, a comical scene of give and take with the water.

"We then had a sandwich lunch at a refreshment stand just outside of the Zoo, after which we continued our walk. We walked along Tottenham Court Road and New Oxford Street and across to the Old Curiosity Shoppe (of Charles Dickens fame). We then walked back along a route including New Oxford Street to the Britannia Hotel.

"We joined the Blooms, Rice, and Friedman, and left immediately from the Hotel to go to Heathrow Airport for our flight to Glasgow and Scottish nuclear sites. At the Airport we met Sir John and Lady Hill, and their children Andrew and Victoria, and Peter D. Dawson, private secretary to Hill. We arrived at Glasgow (Abbotsinch Airport) at about 5:30 p.m. On the way we had a very good view of the Windscale nuclear power station site on the western shore of northern England and the Chapelcross nuclear power site a few miles inland in southern Scotland. The weather was beautiful, affording an excellent view of England and Scotland on the way. At Glasgow Airport our party boarded a chartered DeHaviland Herron (4 engine, 12-seater) furnished by The Nuclear Power Group, Inc. We arrived at the Downreay Airport exactly on schedule just as the sun was setting, a spectacular sight. We had an exceptional view of the Downreay reactor site against the backdrop of the setting sun. We were met by George Malcolm. Helen and I rode with Sir John and the others followed to the Royal Hotel in Thurso (a town of about 10,000 people) about ten miles away. We saw a number of rather large, flagstone houses on the way.

"Our party had an excellent dinner in the Hotel dining room, followed by serving of coffee and tea in one of the parlors, where we spent the remainder of the evening in conversation."

"Monday, September 28, 1970 - Downreay, Eskdale

"Friedman and I rode with Sir John to the Downreay site, followed by Bloom, Rice and Dawson in another car (Helen and Robbie remained behind to go on a tour of the Caithness countryside). On the way, I raised with Sir John the question of the United States assigning a Fast Reactor Fuel Engineer to Downreay for one or two years to work on LMFBR fuel cladding and fuel irradiation.

"We were met by Clifford W. Blumfield (Assistant Director, Downreay Experimental Reactor Establishment - DERE) and George Henry Kinchin (Chief Scientist, DERE). We went to a conference room where Blumfield and Hill briefed us. I gave a souvenir pen to Blumfield as I signed the guest register.

"We learned first that the wife of the Downreay director, Peter Mummery, was ill, and Mummery couldn't return to Downreay as scheduled. Downreay is the UK's principal fast reactor establishment, although fast reactor physics work is performed at Winfrith. Two projects at Downreay which are of special interest are the Super-NaOH experiment (to study liquid sodium-water reactions that might result from leaks in steam generators) and the Prototype Fast Reactor (PFR) being built on the site. The existing Downreay Fast Reactor (DFR) operates on enriched uranium, but the PFR will operate on plutonium oxide fuel, which will be fabricated at Windscale

and reprocessed in the small reprocessing plant at Dounreay (mostly for convenience). The Dounreay site is involved with the operational aspects of fast reactors and with fuel development. For example, investigations are made on methods for detecting small leaks in steam generators, fuel pins, etc.

"The fire [which had occurred at the DFR not long before] was due to a NaK leak in a 1" pipe weld, through a hole about 1/32" in diameter. The hole is believed due to an occlusion of tungsten which ultimately leached out, the tungsten having come from a welding electrode. Attempts were made to put out the sodium fire by flowing in salt with a carbon dioxide gun, but the leak was too high above the floor to permit a crust to form. A vermiculite blanket was, therefore, built up and then the application of salt put out the fire. Only about 2 gallons of NaK leaked from the pipe.

"Delays in construction of the PFR were announced publicly by the UKAEA about a year ago, but the British press (*Daily Telegraph*) decided only recently to make a big story out of the delays.

"We then drove to the DFR building, where we met Fred Barclay, the DFR manager, and John Kirk, the Deputy Manager, who explained the construction and operation of the reactor. The reactor began operation in 1959 and has been used more recently to irradiate mixed Pu-U oxide to 7.5% burnup (75,000 MWD/t) of heavy atoms. At first, three-pin bundles were used, but now an initial exposure is obtained with 77-pin bundles which are then dismantled and the irradiation carried further in three-pin bundles; if desired, the exposure can be carried out until the pins fail. The flux in the large test bundle is 2.5×10^{15} . I asked about UK interest in the Gas Cooled Fast Breeder Reactor and Blunfield answered that it was a good alternative to the Liquid Metal Fast Breeder Reactor, but would push gas technology to the limit. I also asked if there were any problem with public acceptance of fast reactors and was told that there was none in the United Kingdom. The AEA believes that fast reactors are the safest kind, and hopes to begin construction of a 1300 MWe commercial LMFBR in 1974. LMFBR fuel reprocessing will probably be done in Europe, but some capacity exists at Dounreay and Windscale. In the future, high level waste will be stored for 10 years to permit the short-lived activity to decay and it will then be solidified. A good exchange of information on waste management is maintained with Hanford.

"The DFR has been used to irradiate over 800 oxide pins and 100 carbide pins to more than 5% burnup. A temperature limit of 650°C is placed on the walls of oxide pins, although in some cases the temperature has been allowed to rise to 710°C deliberately. In mixed oxide fuel, the plutonium

content is 25%. Power density achieved is 205 watts/gram. Their studies indicate that in these fuels close to 100% of the fission product gases are released from the fuel matrix.

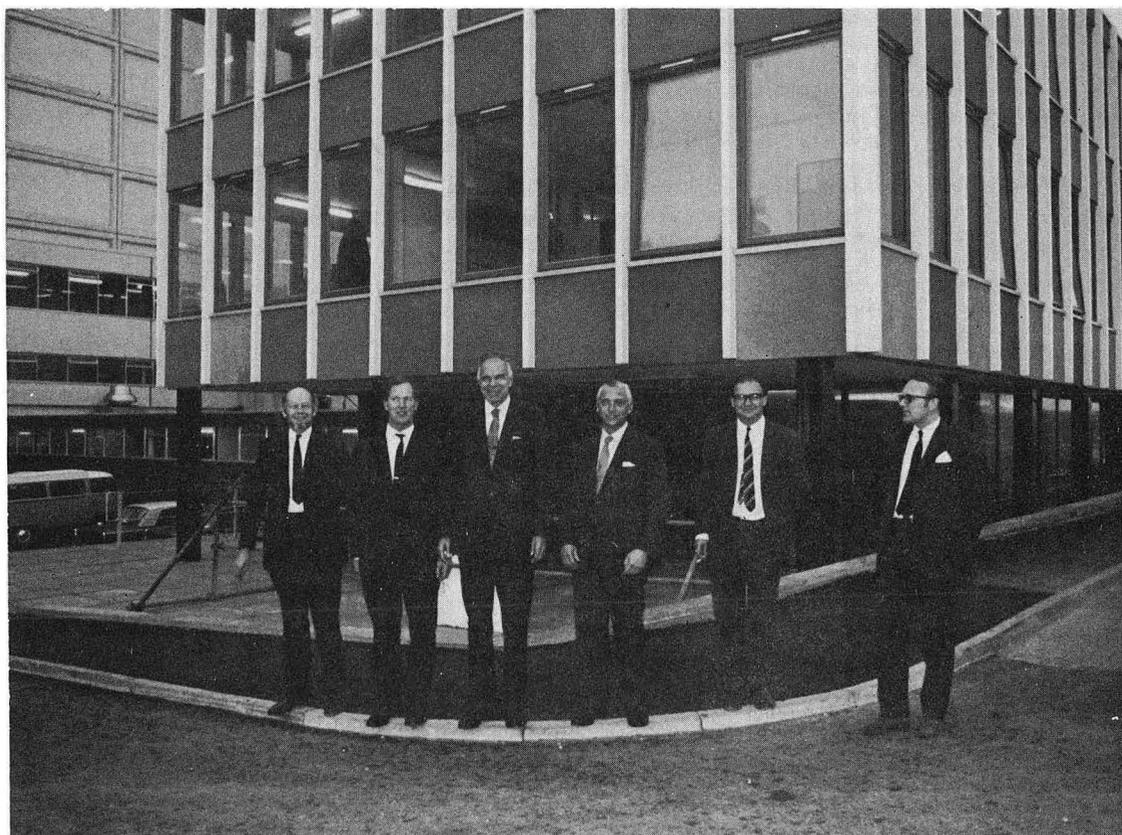
"We then visited the DFR itself and stood on top of the reactor. The reactor was closed down between cycles. The reactor operates at 60 MWt (15 MWe) on a 55-day cycle equivalent to 1.5% burnup. One-third of the core is then replaced.

"Our next stop was the facility where sodium fires are created intentionally. Alan Bray and John Humphries described the equipment. Up to 300 pounds of water can be injected into molten sodium, which circulates through a loop simulating a steam generator. The reaction proceeds smoothly, but huge quantities of sodium oxide dust are given off which are trapped in a cyclone separator. A similar system will be used in the PFR as a safety precaution in the event water leaks into the sodium. The experimental facility has full-sized equipment, but the sodium inventory is limited to 2.5 tons.

"We returned to the central administration building where I gave a lecture on the transuranium elements to the Doumrey staff. My talk was essentially the same as the one I gave at Karlsruhe. I was introduced by Blumfield, and Sir John Hill offered some concluding remarks.

"We then went to the Director's conference room where we were served lunch. In addition to Rice, Friedman, Bloom and me, those in attendance were: G. D. Wilson, K. W. Matthews, Alfred D. Evans, Jack S. Broadley, Blumfield, Sir John Hill, Kinchin, and Dawson.

"Following lunch we were taken to the PFR construction site, where we were met by Donald Smith and John G. Walford, the station manager. Evans briefed us on some of the reactor details. It will produce 250 MWe at 41.5% thermal efficiency. It will have an inventory of 1000 tons of sodium. Three pairs of intermediate heat exchangers will transfer heat from the pot-type reactor to a secondary sodium system. Three pumps will circulate the primary sodium through the core; the sodium inlet temperature will be 400°C and the outlet 600°C. One-sixth of the core will be discharged six times per year. One-sixth of the core is equal to 12 fuel subassemblies. The core discharge will be scheduled over weekends. The sodium pool of the reactor has storage space for 20 fuel assemblies. Cooling time in the pool will be 30 days. The reactor is designed so that spent fuel can be removed while the reactor is running. Construction of the reactor is to be completed by January 1, 1972, and full power is to be achieved by January 1, 1973.



XBB 761-7036

At Dounreay Experimental Reactor Establishment, Sept. 28, 1970. (Left to right) G. H. Kinchin, C. W. Blumfield, Seaborg, Sir John Hill, A. D. Evans, P. D. Dawson.

"At this time John Davies, head of construction for the PFR, from The Nuclear Power Group, joined us and took us on a tour of the reactor. I learned that its basic construction cost is 34 million pounds (\$82 million).

"The entire reactor and turbine equipment are located in one large building and there is no secondary containment. We could see the reactor tank being assembled far above its final elevation. Upon completion it will be lowered by jacks into place. Adjacent to the reactor vessel is a large room where the head of the reactor and all of the pumps and heat exchangers attached to it will be assembled for testing. Problems in fabricating the head have delayed construction by about a year, and it is not yet on the site. Part of the lost time will be recovered. Outside the main building we saw the channels that have been built to bring cooling water from the sea and to return the hot water to the sea. A smaller building already houses the sodium inventory in tanks. In the main building, large rotating screens have been constructed to remove sand, fish, etc., from the sea water.

"Upon returning to the administration building of the reactor, we resumed our discussions with the staff. When the reactor piping system is completed, it will be tested with water at 60-70°C to simulate sodium. Many properties of water at this temperature are very close to those of sodium except heat capacity. The use of water for testing will entail taking elaborate precautions for drying the system before introduction of sodium. An exceptionally long commissioning program, lasting about one year, will be followed to insure the reliability and safety of the reactor.

"The design of the reactor and ancillary equipment has been optimized for extension to a 1000 MWe size. The fuel elements and core, for example, can be scaled up.

"The largest turboalternator that is being manufactured for the CEBG is rated at 660 MWe; therefore, future plants will be built at this power level or twice this figure.

"The PFR is expected to cost about 5% more than a water or gas cooled reactor of the same size, but it will have much lower fuel costs. We were not given a power cost in mills/kwh when we asked, apparently on the basis that this is not critical in the British power economy.

"Other features of the PFR include asymmetric placement of the blanket elements around the core and the most elementary kind of core meltdown protection - a thick stainless steel 'catcher'.

"Sir John was asked to describe the business arrangements for building the PFR. He said that the UKAEA started out to

construct the reactor but it had too many groups who tried to determine the design. Therefore the UKAEA merged its design groups with The Nuclear Power Group (TNPG), a combination of several manufacturers and constructors. The UKAEA now has two members on the board of TNPG. The reactor is being built on a cost-type contract with UKAEA, and many former UKAEA staff members, such as Davies, now work for TNPG.

"We found that plans for building a commercial LMFBR are still uncertain, with no site having been picked yet and with no firm schedule. It was said that a public hearing will probably be held prior to beginning construction.

"Tea, sandwiches, and cookies were served at this time, because of the long airplane flight to Silloth Airport (Windscale) still ahead of us. At the end of the tea, we exchanged gifts. Sir John gave me a Downreay necktie, glass paper weight, slides and brochures. I gave him a special USAEC keyring (with uranium), paper weight and autographed copy of *Peaceful Uses of Nuclear Energy*. Others who received gifts were Dawson (keyring), Blumfield (paper weight), Kinchin (paper weight), Evans (keyring), and Davies (keyring).

"Helen and Robbie and their guides for the day's activities, Mrs. Kinchin and Mrs. Pearson, met us as we were finishing our tea and refreshments in the Exhibition Room of the Prototype Fast Reactor central building. They had ended their tour with a visit to the Caithness Glass Works at Wick where Helen bought a number of glass items, after their lunch at the Portland Arius Hotel in Lybster.

"We then all rode to the airstrip, said goodbye, and our traveling group boarded the plane (the same one that brought us to Downreay yesterday). We flew south and a little westerly, to the Silloth Airport (about 40 miles north of Windscale), where we arrived at about 6:35 p.m. The weather was cloudy with poor visibility all the way in sharp contrast to yesterday's flight.

"We rode to the Bower House Inn and Hotel in the foothills some ten miles inland from Windscale in the village of Eskdale.

"On the way inland we drove on a road near the route of an old Roman road that went from Ravenglass on the ocean to the ruins of a Roman fort and beyond.

"Our group had dinner in the Inn with our hosts, Mr. and Mrs. Gordon Rushworth Howells (General Manager, Windscale, Chapelcross, and Calder Works, UKAEA), and Mr. and Mrs. Thomas Garfield Hughes (Supervisor, Chemical Plants, Windscale), Mr. and Mrs. George Eric Buckley (Superintendent Reactors, Windscale), Mr. and Mrs. Tom Tuohy (Director Production Group, UKAEA, Risley), Dr. Norman Laurence Franklin (Member for Production, UKAEA).

The Bower House Inn dates originally from about 1600. (I met Howells in October 1949, during my visit to Risley and Springfields Plants of UKAEA, and to Chester.)"

"Tuesday, September 29, 1970 – Windscale, Hunterston

"Sir John, Bloom, Friedman, Rice, Dawson, Franklin and I rode to the site of the Windscale Works. We were met by Howells and started the visit by a briefing session in his office. Windscale is on the site of the former Windscale farm or estate, on the west coast of Cumberland.

"The Windscale site was selected because the sea could be used for discharge of low level wastes, land was available (the site was a wartime TNT factory), and there was a good supply of fresh water for cooling. However, gas cooled reactors were ultimately built. Windscale was originally intended to be only a plutonium production site and two production reactors were built and operated until 1957. During this period the four Calder Hall reactors were built and began operating in 1956. Four more power reactors are operating at Chapelcross. All eight reactors are dual purpose primarily for power, incidentally for plutonium. The on-load factor for the reactors averages 92 - 94%. Fewer than 100 people per reactor are required for operational purposes. All eight reactors are of the Mark I Magnox type (natural uranium, carbon dioxide closed cycle cooling, graphite moderated), and are rated at about 50 MWe each. They have a thermal efficiency of only 20%.

"Also at the Windscale site is the Prototype Advanced Gas-Cooled Reactor (PAGR), a 35 MWe test bed for advanced gas cooled reactors. It has operated on an 80% load factor.

"All commercial fuel reprocessing is done at Windscale. It has sufficient capacity to meet the country's needs until at least 1980, and maybe at 2000. A total of 4000 people are employed at the site, which consists of only 600 acres.

"The UKAEA safeguards offer to the IAEA would include the Windscale reprocessing plant except for the times when it would be handling defense material.

"Shipments of spent fuel are received from overseas at the port of Whiteshaven and then taken by truck to Windscale. The plant can handle about 2000 tons of spent fuel of the Magnox type per year. Foreign Magnox fuel comes from Japan and Italy. Oxide fuels are received from Germany, Sweden, Italy and Spain.

"(During our briefing Sir John left the room to answer an urgent telephone call and returned to announce the Dr. Hans Kronberger, UKAEA Member for Reactor Development, had died in London this morning.)

"Hughes then took us on a tour of the reprocessing plant. The first stop was an outdoor storage pond for spent fuel. One layer stored fuel amounts to 2000 tons, and it is possible to store two layers. (The Magnox fuel jackets slowly react with water, liberating hydrogen bubbles which float to the surface.) Fuel elements from the pool are loaded into a basket and transferred under water into the decanning building. The alloy jackets are split from the uranium metal by a mechanical apparatus in a hot cell, and the jackets (swarf) are collected in buckets and stored in another building for five years before being disposed of as low level waste. The uranium rods are loaded into shielded casks for transport to the main reprocessing building. Here they are unloaded into a continuous dissolver - an unusual piece of equipment in that it is non-maintainable. If it fails, it will be abandoned. The same holds true for the first extraction step. A new, unused dissolver is available, and we were able to crawl around it. The dissolver has a capacity of 5 - 8 tons of fuel.

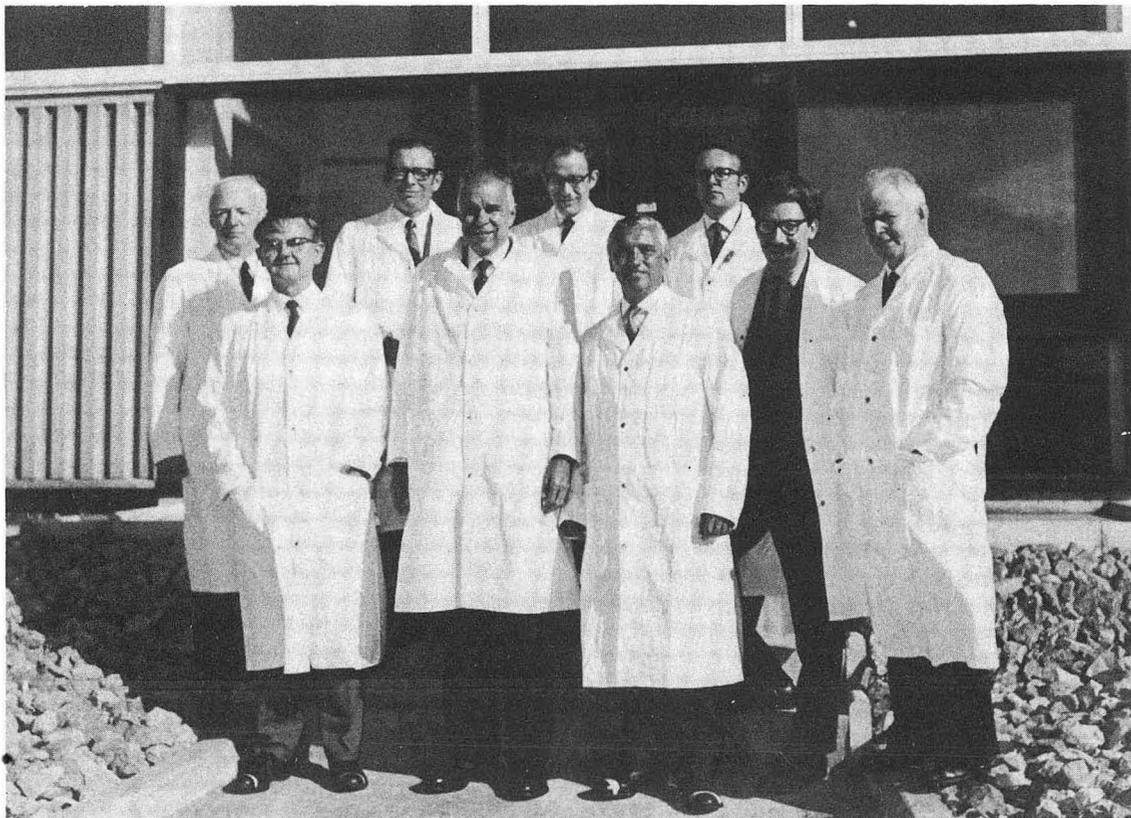
"NO₂ evolved in the dissolution step is converted back to HNO₃ in a tower above the dissolver. The fuel is cooled for at least 100 days prior to dissolution to minimize iodine releases. The dissolver solution has a uranium concentration of 300 grams per liter. The first dissolver has operated since 1964 without failure.

"In the control room, 400 sensitive process points are monitored and recorded. Criticality control is by concentration limits, with plutonium concentrations measured by alpha counting, specific gravity, or neutron counting.

"We then saw the mixer-setter area and a glove box area where plutonium is handled. No plutonium was visible.

"We then walked to the plutonium fuel fabrication plant where we were met by Mr. Davidson, the manager. It is here that the mixed Pu-U oxide fuel for the PFR will be fabricated. Each fuel subassembly will consist of 325 pins loaded with annular pellets about 3/16" in diameter. The pellets are sintered at 1550°C after debonding at 800°C. The bonding agent used in the pelletizing process is called Granco. (Breeder pellets are made at Springfields and brought to Windscale for loading into the pins.)

"We inspected the entire box line of the fabrication plant and found it to be extremely well engineered and immaculate. The plant was said to cost \$5 million and to have sufficient capacity to fuel a full-size fast breeder. Its capacity can be doubled if necessary without adding to the building.



XBB 761-7037

At Windscale Works, Sept. 29, 1970. (Left to right) T. G. Hughes, N. L. Franklin, J. L. Bloom, Seaborg, Bill Rice, Sir John Hill, P. D. Dawson, A. Friedman, and G. R. Howells.

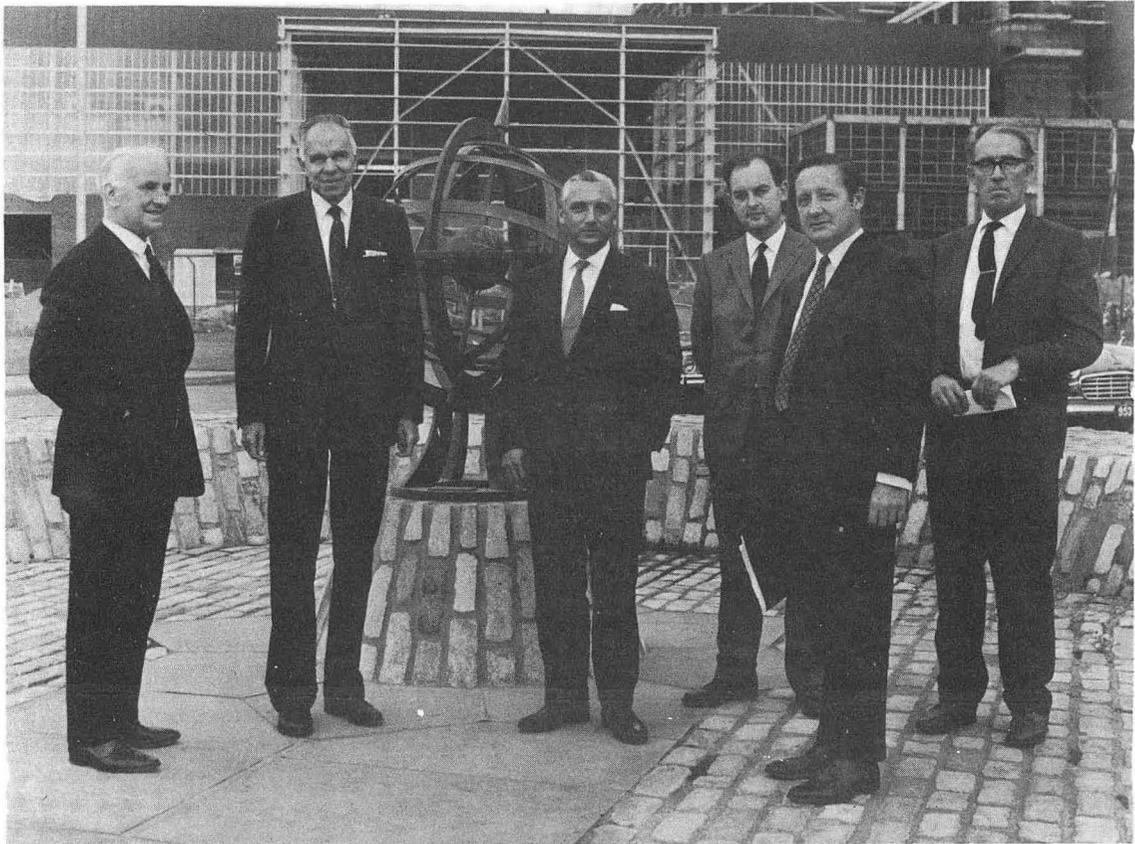
"We then visited the Prototype Advanced Gas-Cooled Reactor (PAGR), where we were met by Buckley. We could stand on the reactor loading floor while the reactor was in operation, where we observed leads and tubing going through ports into the top of the reactor for various experiments, including analysis of fission gases released to the CO₂ coolant. We also saw the turbine hall adjacent to the reactor containment shell. This kind of reactor operates with slightly enriched fuel rods inserted in graphite moderator segments; the fuel has much better performance characteristics (25,000 MWD/t) than the Magnox fuel. The active core is 15 feet across and the total core is 21 feet across. The fuel segments are very long (50 feet) and require the use of a tall refueling machine. The reactor is rated at 100 Mwt but has operated at a maximum power of 126 Mwt. The turbine produces a maximum of 38.8 MWe. The outlet temperature of the gas coolant is 480°C and the inlet temperature is 260°C.

"Following the visit to the reactor, we went to lunch at the 'factory' commissary, where a private dining room on the second floor was set up for our use. In addition to Howells, Franklin, Buckley, Hughes, Dawson and Sir John, we were joined by another Mrs. Howells (no relation), George D. Ireland, and Francis J. Woodman.

"As we were about to enter our cars, I presented AEC keyrings to Hughes and Buckley, a paper weight to Howells, and an autographed copy of *Peaceful Uses of Nuclear Energy* to Franklin.

"My party rode to Sillioth Airport where we arrived at 3 p.m. We were airborne immediately, in the same chartered plane as before, and flew to Prestwick Airport on the west coast of southern Scotland, where we arrived at about 3:50 p.m. We were met by Alan Christianson, Deputy Chairman of the South of Scotland Electricity Board. I rode with Christianson and Sir John to the Hunterston Nuclear Power Station. This is on the site of the former Hunterston Estate. The Hunterston Station photographers took a picture of Sir John and me with Christianson, F. L. Tombs (Director of Engineering, SSEB), G. A. Mears (Power Station Manager), and A. F. Pexton (Project Manager, B Station), before the other cars arrived.

"When we had all arrived, we assembled in a conference room for a short standup briefing, with the help of diagrams, during which tea and refreshments were served. We then toured the Hunterston B reactors, under construction. The two B reactors are of AGR design, both housed under the same roof and serviced by common equipment such as a spent fuel canal, gantry crane, and fuel loading machine. Each reactor-turbine combination will produce 625 MWe net, about 35 MWe additional being required to drive the gas circulators



XBB 761-7038

At Hunterston Nuclear Power Station, Sept. 29, 1970. (Left to right) Alan Christianson, Seaborg, Sir John Hill, A. F. Pexton, F. L. Tombs, G. A. Mears.

and other equipment. The building, which is almost completely finished, looks to be of the order of 200 feet tall, and is of modern, esthetically pleasing construction, with glass panels at the upper level primarily for decorative purposes. Only a few hundred feet away are the two Hunterston A Magnox reactors (150 MWe each) in separate buildings covered with glass and also very pleasing.

"The pre-stressed concrete pressure vessel of one of the B reactors had been completed, and the other was being cast. We crawled into the gas space between the reactor vessel and the concrete pressure vessel, where the steam boilers and gas circulators are located. We also climbed and rode an elevator to the upper levels of the building where the deaerator will be located and had a magnificent view of the site.

"It is interesting to note that the size of these reactors is limited by the size of the turbogenerators available. The systems will operate at an efficiency of greater than 41%.

"Moving to another building nearby, we saw large steam generators in storage, awaiting installation.

"Following the tour we assembled again for a quick cup of tea and refreshments, went outside and took some pictures and movies. We then rode with Christianson and Sir John to Abbotsinch Airport in Glasgow. We passed the Holy Loch on the way and had a good view across the Loch of the US submarine base. (Holy Loch becomes the Firth of Clyde further inland, and we drove along this also as we proceeded toward Glasgow.)

"Meanwhile Helen and Robbie, who had been picked up by Mrs. Tuohy and Mrs. Howells at 9:30 a.m., were enjoying a motor trip of the hill and lake country of northern England and Scotland.

"Helen later told me they had gone through Cumberland County and around Wastwater Lake, the source of the area's water. Mrs. Tuohy had pointed out the challenging and dangerous Scafell heights of the Green Gale mountains. They continued past Loweswater Lake and its fine hotel, The Grange, and on to lakes such as Crummock Water and Lake Buttermere.

"Honister Pass provided a panoramic view. The water here flowed milky white due to pollution caused by a slate quarry at the top. Starting down the other side was the village of Rothesaye, and trees appeared once again in the landscape. It had been an area of great appeal to Hugh Walpole, who wrote *The Harris Chronicle* about it.

"Their party had lunch at Armathwaite Hall on Bassenthwaite Lake. When this hall had been converted from a baronial residence to an inn in 1930, Walpole had written an endorsing letter, which hangs on the wall.

"Coming south, gently rolling green hills replaced the austere beauty of the northern highlands. Soon the Chapelcross Atomic Energy installation towers were in view and they crossed the border into England. On the way back to Glasgow they stopped at Dumfries, birthplace of Robert Burns.

"They joined us at the airport, and our traveling group flew to London, and returned to the Britannia Hotel."

"Wednesday, September 30, 1970 – London, Washington, D.C.

"Bloom, Friedman and I went to the US Embassy to the office of the Minister for Economic and Commercial Affairs, Stanley M. Cleveland, since Ambassador Annenberg had not yet arrived. We had a short meeting with Cleveland and Stephen H. Rogers. They questioned me about the short-term future of nuclear power and asked how long a period of time nuclear power will be based on the present generation of reactors. I replied that nuclear power cannot help in alleviating near-term shortages of electricity, since reactors are built on fixed schedules taking as much as five years. I mentioned that Sir John Hill had told me that no more coal-burning power plants will be built in the United Kingdom. I also stated that the present generation of nuclear plants will serve almost indefinitely, sharing the electric load with breeders.

"At this time, Deputy Chief of Mission Joseph N. Greene, Jr., asked us to come into his office. I gave him and Cleveland copies of my book, *Peaceful Uses of Nuclear Energy*, and was requested to send a supply of the books to Rice for use by the Embassy staff and for distribution to UK officials.

"We then discussed the selling of US reactors abroad and the problem of supplying enriched uranium to them. I was asked about the classification of US enrichment technology and the possibility of making it available to other countries, and I explained the reticence of the JCAE in releasing the information and the White House observations concerning transfer of the technology. Cleveland asked that he be given some advance notice of when the plan for transfer is to go into effect.

"On other matters, I was told that Bill Rice knows his business and works well with the Embassy staff.

"Sir Solly Zuckerman still plays a central role in nuclear policy making in the UK Government. However, problems of communication exist between the UKAEA and the political policy makers of the Government.

"It was now time for my press conference, which was arranged by Dunn and Hammond of the Embassy staff and Bill Miller of USIA. The press representatives attending were: David Fishlock (*Financial Times*), Bryan Silcock (*Sunday Times*), Roger Vielvoye (*Times Business News*), Pierce Wright (*Times*), Robert Chapman (*Sunday Express*), Anthony Michaelis (*Daily Telegraph*), K. Weisskopf (*Applied Atomic*s, Reuters), Anthony Tucker (*Guardian*), Ronald Bedford (*Daily Mirror*), and Angel Croome (free lance). Bloom and Friedman were in the room with me. I was asked first about my reaction to the death of Hans Kronberger (I had read in the morning paper that he had committed suicide), and I read the letter of condolence that I had signed earlier in the morning addressed to Sir John Hill. I was then asked to give my impressions of my visit to the UK nuclear energy sites. I said that my impressions were generally favorable. Questioned about the PFR at Dounreay, I responded that it was a sound project. When asked if there could be a fire of the magnitude of that at Rocky Flats* at the Windscale plutonium fuel fabrication plant, I explained that that was impossible, since no metallic plutonium is handled. In response to other questions I said that the AGR was a good reactor for the United Kingdom comparable to light water reactors in the United States, but that there may be difficulties in exporting it; that the US reactor development program is not static but that there has been some slowdown, even though there will be about 150 million kilowatts installed nuclear capacity in the United States by 1980; that nuclear power is the cleanest source of power; that we are making good progress in solidifying wastes and are preparing the first Federal repository in a salt mine in Lyons, Kansas; that thermal pollution will be relieved by high efficiency reactors such as the AGR, HTGR, and fast breeder; that we had not discussed the gas centrifuge in the United Kingdom.

"I also gave a lengthy explanation of how the cost of separative work is affected by additions to our gaseous diffusion capacity and answered other questions about the feasibility of small nuclear power plants, desalination, fusion, cooperation with the USSR in Plowshare, European progress on the cardiac pacemaker, and prospects for nuclear ships.

"I gave an autographed copy of *Peaceful Uses of Nuclear Energy* for Mrs. Lee Annenberg to Bob Scott (Ambassador Annenberg's Professional Assistant).

* Rocky Flats is the primary USAEC facility for the fabrication of plutonium weapons parts. A major fire occurred there on May 11, 1969, reducing the plant's production capability and causing an estimated \$45 million loss.

"I met Ambassador Annenberg as we were leaving the Embassy, which gave us a chance to say our farewell personally. He again invited me to Winfield House on a future visit and to play golf with him in April at his Palm Springs golf course.

"Bloom, Friedman, Rice and I rode to the airport together where we said goodbye to Rice. After some delay caused by the search of passengers' hand luggage for metallic objects (as a result of the recent hijacking activities) we took off for Washington an hour late. Helen and Robbie had flown from London to Washington on an earlier flight."

Upon my return, I reported on this interesting visit to the UK to the President in a letter dated October 13, 1970, which included the following comments:

"I left Vienna on September 27th for the United Kingdom where Sir John Hill, Chairman of the UK Atomic Energy Authority, accompanied me on a tour of several of the nuclear reactor facilities in England and Scotland.

"The United Kingdom early initiated an ambitious nuclear power program which has resulted in the generation, to date, of more nuclear power in the UK than in any other country in the world. Its present installed capacity of 4,100,000 kw is surpassed only by the United States' 5,770,000 kw of installed nuclear capacity. The United Kingdom has pursued a nuclear power development program based on gas-cooled reactors, which now employ slightly enriched uranium. Although the United Kingdom continues to make strong bids for foreign sales, they have not been successful other than for the sale of one reactor each to Japan and Italy.

"The United Kingdom Atomic Energy Authority is devoting much effort and financial support to the development of the sodium-cooled fast breeder reactor concept. I visited the Dounreay Experimental Reactor Establishment on the northern tip of Scotland where most of this effort is centered, including a 250,000 kw prototype fast reactor now under construction and scheduled for completion by the end of 1972. In this respect, the UK fast reactor program is ahead of that in the United States. Although a final decision has not yet been made, the UKAEA plans to begin construction in 1974 of a 1,300,000 kw commercial fast breeder reactor.*

"In response to the invitation of the Chairman of the UKAEA, I gave a scientific lecture to the staff of the

* It is worth noting (as of May 1975) that the UK's projected 1972 completion of the fast reactor and the planned start of construction on the 1,300,000 kw commercial fast breeder reactor in 1974 have been delayed by several years.

Dounreay Experimental Reactor Establishment.

"Following my visit to Dounreay, I proceeded to the Calder Works at Windscale in the north of England. Windscale is the site of the original air-cooled plutonium production reactors which were shut down following a reactor incident in 1957. There are four power reactors at Calder which started producing power in 1956 (and four more at Chapelcross) that also produce plutonium for the British weapons program. They contribute, in total, about 360,000 kw of electrical power to the national grid.

"The reprocessing plant for all of the United Kingdom commercial nuclear power plants is located at Windscale as well as the fabrication plant for the plutonium fuel for the prototype fast reactor. Windscale is also the site of the 28,000 kw Advanced Gas-Cooled Reactor (AGR) where the research and development program for this reactor concept is carried out.

"From Windscale, I flew to the Hunterston Nuclear Power Station where I visited the power reactors being built, which, when completed, will generate 1,500,000 kw of electricity.

"I returned to London where I met with Ambassador Annenberg and the principal staff of the Embassy prior to returning to the US."

The first country I visited as USAEC Chairman was also my first overseas destination in 1971, my last year in that office. This time no nuclear talks were involved, but a ceremony at the Chartwell estate of the late Prime Minister Winston Churchill.

Earlier in the summer of 1971 I had been asked to present a bust of Churchill, on behalf of the International Platform Association (IPA), to the British Empire National Trust, for permanent display at Chartwell. The IPA, founded by Daniel Webster in 1831 as the American Lyceum Association, is an organization dedicated to the art of public speaking. As such, it wished to pay tribute to one of history's greatest masters of that art. In recognition also of Churchill's role in strengthening the bonds of US-British friendship, the Association elected to present a bust replica from the statue of Churchill by William McVey (himself a long-time IPA member) that stands at the British Embassy in Washington, D.C., with one foot on British soil and one on American soil.

Fortunately, the date chosen for the presentation (to be made in the course of a tour planned by a large IPA group) was just before I was scheduled to fly to the Soviet Union to visit atomic energy facilities there; and I was able to arrange to depart from the United States in time to take part in the ceremony at Chartwell.

With most of the group that was to accompany us on our Soviet trip, Helen and I flew to London, arriving August 3. The following day we set out for the presentation at Chartwell:

"Wednesday, August 4, 1971 – London, Chartwell

"We all rode past London to Chartwell in Embassy cars, Helen and I in a car with Lom Squires (a member of the General Advisory Committee of the USAEC, and one of our Soviet trip colleagues). Heading east toward London we passed the former estate of David Garrick and also Hampton Court Palace. We then drove south through the village of Purley (in Surrey) and a number of other villages in the picturesque countryside.

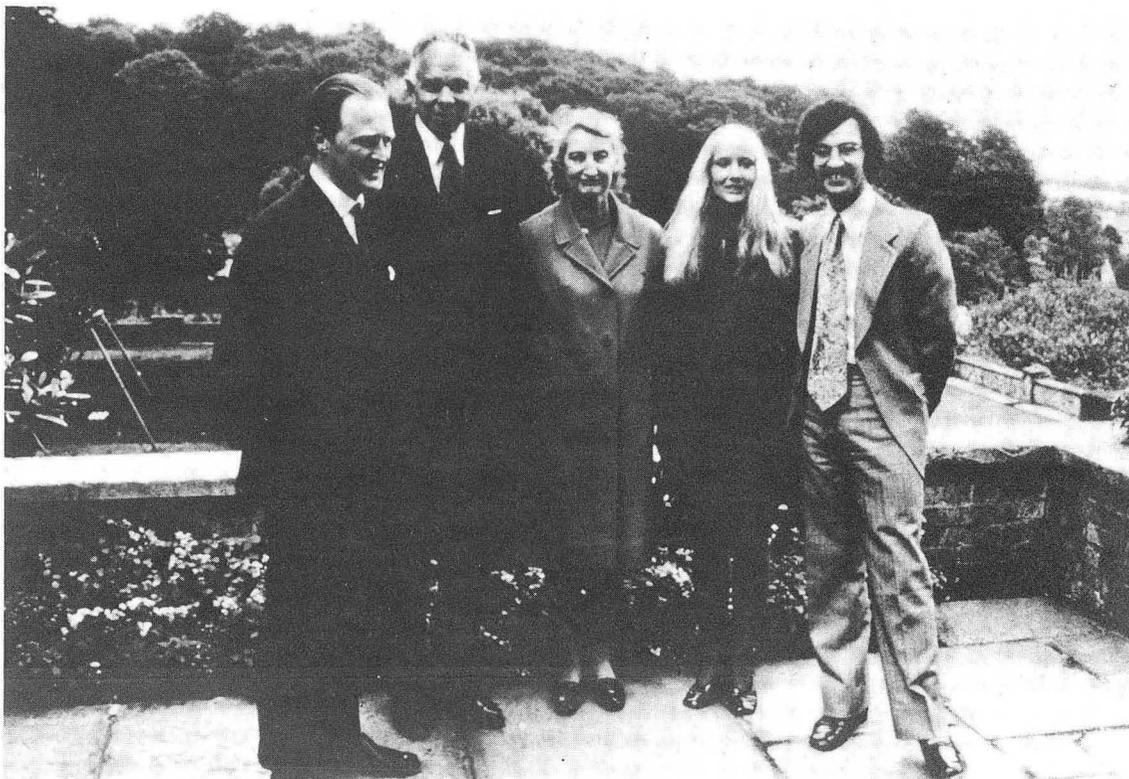
"We arrived at Chartwell in a little drizzle of rain. We found two of the three busses with the IPA group arriving at the same time. (The bus including Dan Moore, Director General of the IPA, his wife Betty, and Luvie Pearson arrived a little later). Our group and the IPA group made a tour of the gardens since it was early. As I was heading back to the car to get my raincoat I was motioned to from a window in the residence and was admitted by a lady who turned out to be Miss Hamlin, who served as Sir Winston Churchill's secretary from 1932 until his death in 1965. This was fortunate because it gave me the opportunity to make arrangements for the presentation; Miss Hamlin provided a table and Churchill's 'speaking box' for my notes. The speaking box was a rectangular box about one foot high that he used to put his notes on during his talks in many places throughout the world.

"Miss Hamlin then led me upstairs and let me visit the rooms by myself. I went through the display rooms showing Churchill's trophies, decorations, uniforms, hats, pictures, etc. I was particularly interested in his study, which is preserved much as it was when he used it. The study, about 20 feet by 30 feet, is in a wing (including Churchill's bedroom) protruding from a corner of the residence. Two of the walls are lined with bookcases full of interesting old books such as histories of England, works of English masters, etc., and a book case stands against a third wall. A large desk contained a portfolio labeled 'signature,' for his outgoing correspondence to be signed, and was covered with family photographs. A small table, about 3 feet by 3 feet and covered with green felt, where he did much of his writing (according to Miss Hamlin), includes a red, hardbacked, worn, briefcase with the initials 'W.S.C.' on it. I also saw his dictaphone, used in his later years, in one of the cabinets. His stand-up working desk, where he read galley proofs for his books, is covered with papers. The fourth wall of his study contains a fireplace with a huge painting of Blenheim Palace, Churchill's birthplace. The study has a beamed V-shaped ceiling.

"After I had looked around for about 20 minutes, Winston Churchill, Sir Winston's grandson, came upstairs and after we met he described to me a number of items in the study and showed me his grandfather's adjoining bedroom. He told me that Sir Winston lived at Chartwell, except during his two

terms as Prime Minister, and hated to leave at any time. Sir Winston said 'a day away from Chartwell is a day wasted.' Dan Moore then joined us and young Churchill showed us additional rooms. In one room there is a framed letter from Sir Winston to General Alexander, dated 10 August 1942, directing him to destroy General Rommel's army in Africa. Below this is a letter from General Alexander to Sir Winston on a memo sheet saying that this mission had been accomplished and he was awaiting further orders. I told Churchill about our planned trip to the Soviet Union. He was skeptical when I told him the Soviets have made nearly as much progress as the United States in peaceful nuclear energy.

"We then met Mr. Gore, who is in charge of Chartwell for the British National Trust. The four of us then went into the main room where the presentation ceremony was to be held. We walked among the waiting people, who were standing, to the end of the room where the Churchill bust and speakers table were located. Moore introduced me and I delivered my remarks and made the presentation of the bust on behalf of IPA to Winston Churchill who accepted it on behalf of the National Trust. Churchill responded, expressing his appreciation and then describing his grandfather's love for and life at Chartwell including some of his first-hand memories of his grandfather and his habits and activities. At the end of the ceremony Dan Moore introduced Ben Franklin to Winston Churchill as a person who had known his grandfather and had booked his speaking tour of the United States. I saw Mickey Rubenstein, brother of our daughter-in-law Jane, and his girlfriend, Yvonne Frost, who were with Helen, and introduced the three of them to Winston Churchill. Churchill then took us on a tour of Chartwell, including the lower floor where the dining room used to be. He showed us the grounds and pointed out the kitchen garden, containing the Avenue of Golden Roses; his grandfather had built the brick wall surrounding this garden. (He belonged to the Bricklayers Union.) Churchill also built many of the cottages around the kitchen garden. In one of the cottages at the lower end of the garden is Churchill's studio with his paints and easel and about 75 of his paintings still there. There is also a bust of Rudyard Kipling presented to Churchill on the occasion of Kipling's 80th birthday. There are a few other mementos in the studio including a painting of Churchill, Roosevelt, and Stalin and a huge globe of the world (nearly six feet in diameter). There were only two of these globes - this one and the one Roosevelt used. At the upper end of the kitchen garden was a croquet court, different from US croquet, with one stake in the middle. (The game starts in the middle and goes out around and then ends at the stake again.) Helen, Mickey, Yvonne and I had our picture taken with Churchill beside the residence.



XBB 761-7039

At Chartwell, Aug. 4, 1971. Winston Churchill, Seaborgs, Yvonne Frost, Mickey Rubenstein.

"We said goodbye to Churchill and Dan Moore, and then rode back in the Embassy cars to Heathrow Airport."

The visit to Chartwell was absorbingly interesting and, for me, very moving. I felt deeply privileged to be able to participate in the ceremony there. In my brief remarks on that occasion, referring to Churchill's oratorical genius, I recalled how his "inspired and inspiring speechmaking" had "brought us all not only more strength and courage during trying times but a renewed pride in the English language..." I was proud to make the presentation on behalf of the members of the IPA as well as "all those citizens of the United States for whom the echoes of Winston Churchill's words continue to span the seas as they reluctantly come to rest on the pages of history."

CHAPTER 8

SWEDEN

While all my journeys as Chairman of the USAEC contributed to the fulfillment of my responsibilities, I think that the visits to Sweden were especially useful. Sweden was one of the first nations after the war to organize programs in peaceful nuclear research and development, one of the first to participate in international nuclear projects (as a charter member of the European Organization for Nuclear Research - CERN), and one of the first with which the United States collaborated in this field.

By the beginning of 1961 Sweden had four research reactors in operation (including one partially financed by a US grant). Long-range plans had been developed for nuclear power generation, based primarily on reactors of the natural-uranium, heavy-water type (in contrast to the enriched-uranium, light-water type favored in the United States). With large uranium reserves, Sweden already had a pilot processing plant in operation and a larger one under construction. Extensive research was under way. Programs of particular interest included thermonuclear research, a project for the use of nuclear energy in district heating, and a nuclear ship project (later dropped).

An initial US-Sweden Agreement for Cooperation became effective in January 1956, leading to exchanges of unclassified information in various fields; transfers of heavy water, special nuclear materials, and radio-isotopes; education and training assignments in USAEC facilities; and the provision of consultants.

Therefore Sweden's national programs, our bilateral cooperation, and our common concerns in international nuclear organizations afforded ample reason for periodic meetings of US and Swedish officials responsible for nuclear-related activities. Perhaps even more important, Sweden's long established policy of neutrality in international affairs made personal discussions of international nuclear affairs with its leaders essential; for this reason it was also important to insure appropriate presentation and clarification of US positions in the nuclear field.

In addition to their value to me in my official capacity, the visits to Sweden were enhanced by a very personal interest and pleasure. I am, in a sense, a Swede who has been transplanted to America. My mother, Selma Erickson, was born in Sweden, in the town of Grangesberg in Dalarna; she came to the United States in 1904. My paternal grandparents were born in Sweden, coming to the United States separately about the time of the Civil War. My grandfather, Johan Eric Sjöberg - or Seaborg, as his name was anglicized - was the eldest son of a chief engineer in the iron works at Hällefors. Arriving in the United States in 1867, he was one of a growing wave of Swedish immigrants, numbering over a million and a half in the next 70 years, who came to take their places in a vitally growing country. They frequently came in ships carrying cargoes of iron to New York, and providing very cheap passage for the seven-to-eight week trip. As far

as I have been able to determine, it was on such a ship or a similar type that Johan Eric crossed the Atlantic. Since he, like his father, was a "man of iron", he headed for the iron mine country in the new land and settled in the town of Ishpeming in northern Michigan. There he met and married Charlotte Farrell, whose family had newly arrived from Örebrölan in Sweden. Thus my father, Herman Theodore Seaborg, was born in Ishpeming, where he in his turn met and married my mother a few years after her arrival from Sweden; and it was in Ishpeming that I spent the first ten years of my life.

The town had several nearly all Swedish sections, and it was in one of these that we lived. The Swedish language was spoken in my home and throughout the community, and in fact I learned that language from my mother before I learned English. (I am afraid that in the intervening years my facility in Swedish has seriously declined.) Of course, Swedish customs of all kinds prevailed. I remember especially those around Christmas time and the Swedish foods we enjoyed then, such as lutfisk, potatis korv, risgryn, lyngonberries, saffron breads, and the bountiful spread of buns and cakes and gingersnaps in the form of goblins, piglets, and stars. Even after my family moved to the town of South Gate, California, when I was ten years old, and we were no longer part of a predominantly Swedish community, our Christmas seasons retained a good deal of the Swedish flavor. My wife and I, in our home in Lafayette, California, and in Washington, D.C., during my ten years as USAEC Chairman, have continued to carry on some of the familiar customs with our six children.

To one with such a background, a trip to Sweden is not so much a visit to a foreign country as a return to a former homeland, a renewal of old associations. I experienced this first in 1949, when I made a speaking tour under the auspices of the Swedish Royal Academy of Sciences, then again in 1951, when I went to Stockholm to receive the Nobel Prize in chemistry, and on still another trip in 1957. Each time I had welcome opportunities to meet relatives in my parents' families. Since many of them live fairly near Stockholm, I was able to enjoy reunions with them during each of the visits I made to the Swedish capital in my official capacity.

During my first year as Chairman of the USAEC there was no chance or need for me to go to Stockholm. The cooperative nuclear activities between Sweden and the US continued along established lines. Nuclear-related topics of special concern were discussed with Swedish officials in Washington or, as appropriate, through the US Embassy in Stockholm. One of these topics during much of 1961 was the selection of a second Director General of the IAEA to replace Sterling Cole, whose term was to expire in September at the time of the Fifth IAEA General Conference. In view of the importance of the position and the incumbent's anticipated influence on the Agency's development and character, it was vital that a man be selected who was highly regarded both for his scientific achievement and for unquestioned impartiality. Long before the Conference, the feeling grew among many member states that a Swedish scientist meeting these qualifications would be an ideal choice. Our Government was among those sharing this view, and the matter was the subject of many official communications and conversations.

On March 9, 1961, for example, Swedish Ambassador Gunnar Jarring, with other representatives of his Government (including the Deputy Under Secretary of the Foreign Ministry, Mr. Hubert de Besche), called on me at USAEC Headquarters to discuss the question. My long friendship with several prominent Swedish scientists was known, and Ambassador Jarring was interested in exchanging ideas on possible candidates.

My journal for Friday, May 26, 1961, records: "I attended a lunch given by Sweden's Ambassador Jarring at his residence on Nebraska Avenue for Dr. Sigvard Eklund. Eklund indicated his willingness to accept the position as Director General of the IAEA; the US and other western countries are backing him. Also attending was Baron Carl-Henri Nauckhoff of the Swedish Embassy (a nephew of Sigard Nauckhoff of Grangesberg, a friend of my mother)."

At the IAEA General Conference in the fall of 1961 Dr. Sigvard Eklund of Sweden was approved as the new Director General, with a vote of 46 for, 16 against, and five abstentions. Dr. Eklund had for many years been one of the principal officers at Aktiebolaget Atomenergi, a joint government-private industry enterprise responsible for planning and implementing Sweden's nuclear energy program and operating the important Studsvik Research Station. I knew him well, having met him first in 1951 at the time of the Nobel Awards. He was an outstanding choice for the IAEA leadership. An indication of the excellence of his performance in that role may be seen in the fact that since his initial four-year appointment, he has been three times (in 1965, 1969, and 1973) reappointed, with unanimous support by the Conference. His long service as Director General has been a major factor in the IAEA's increased prestige and effectiveness.

In 1962 I was invited to be the guest of honor at Swedish-American Day, planned for September in Stockholm. I was already planning to travel to Europe in September to attend the IAEA Sixth General Conference and also to meet with nuclear officials in the United Kingdom and other European countries; and I was pleased at the prospect of including a visit to Sweden. The cordiality of my reception there was anticipated well in advance by a telephone call on July 20, 1962, from Swedish Embassy Counselor Count Lewenhaupt. He had just heard from Stockholm of my visit plans and indicated that the Foreign Ministry people were very happy about it. They wanted to show me some of the Swedish nuclear facilities and give a dinner, and had asked the Embassy to discuss possible arrangements with me. I told Count Lewenhaupt the details of my schedule, and plans convenient for my prospective hosts and myself were agreed to.

(That same day Count Lewenhaupt and I, as well as William C. Burdett for the US, participated in the signing of an Amendment to the US-Swedish Agreement of January 18, 1956, for Cooperation for Civil Uses. This was one of several amendments made during 1962 to bilateral agreements; it increased the quantity and enrichment of nuclear material provided by the US, and allowed Sweden to have third country fabrication rights.)

The visit to Sweden was thoroughly enjoyable - three full and varied days:

"Friday, September 14, 1962 - London to Stockholm

"I flew to Stockholm with my assistants Dan Wilkes, Chris Henderson, Cecil King, and Algie Wells (Director, USAEC Division of International Affairs). We were met by Ambassador James G. Parsons, Hubert W. A. de Besche, Gunnar Von Sydow (Under Secretary, Commerce Department), Harry A. B. Brynielsson (Managing Director, Aktiebolaget Atomenergi), Albin Widén (Vasa Order), Folke Lindgren and Folke Hultman (Royal Swedish Academy of Engineering Sciences - Ingeniörs Vetenskaps Akademien, of which I am a member) and others. I was interviewed for the National Broadcasting Company of Sweden and by the press. Checked into the Grand Hotel. We visited the ship *Vasa*, which sank on its maiden voyage in 1628, and has recently been raised and is now on display in Stockholm Harbor near the place where it sank.

"In the late afternoon, I gave a talk to Ingeniörs Vetenskaps Akademien entitled 'Science and Technology in the US Atomic Energy Program' at Konserthuset (where the Nobel Prizes are given). Some 500 were in attendance and the speech was well received. I talked to Arne Tiselius, who told me that the Oxford team will probably get the Nobel Prize in chemistry for x-ray detection of molecular structure and Townes will get the Nobel Prize in physics for maser-laser work. I attended a reception at six in the Ingeniörs Vetenskaps Akademien rooms. I then attended a dinner at the Foreign Office Building, hosted by Rune Hermansson (Minister without Portfolio). About 20 people attended, including Ambassador Parsons, Brynielsson, Wilkes, King, Henderson and Wells. I gave a little thank-you talk."

"Saturday, September 15, 1962 - Stockholm and environs

"Together with Henderson, Wells and King, I visited Ågesta Nuclear Power Station (near Stockholm), with Brynielsson, Ambassador Parsons, Bo Aron Albert Aler, Per Gunnar Holte, Sten Gunnar Sandstrom and others. The reactor there produces 55 MW heat to furnish hot water for Ågesta homes and also produces 10 MW of electricity. Then we went to Studsvik,* the Swedish Aktiebolaget Atomenergi development laboratory, some 60 miles south of Stockholm. Here we toured the laboratory. During the tour I was filmed in a sequence for the film 'Galaxy of the Elements' (which later received wide distribution).

*On May 16, 1962, I had lunch at the Swedish embassy in Washington, and presented a check for \$350,000 to Ambassador Jarring to help finance their R-1 High Flux Reactor at Studsvik.

"Upon my return at 4:00 p.m. I had coffee with some relatives at the Grand Hotel – Uncle Karl Adolfsson (my mother's brother), Bengt and Britta Adolfsson, Per and Karin Möller and son Göran (Karin and Bengt are Karl's children, my first cousins), Mr. and Mrs. Eric Bäcklin and two daughters, Ulla-Britt (Österberg) and Gun (Grill), and Ulla-Britt's husband Sven Österberg, Mr. and Mrs. Olof Bloom (Mrs. Bloom is another Bäcklin daughter, Eivor), Gösta and Ingrid Berglund and daughter Britt (13), Signe Lundgren, and Karl-Erik Bäcklin.

"Then I went to a reception at the Embassy given by Ambassador and Mrs. Parsons. Those present included Senator Maurine B. Neuberger, the Thai Ambassador to the Scandinavian countries and his wife, and also my Uncle Karl Adolfsson, Bengt and Britta Adolfsson, and Per and Karin Möller. Then I went to dinner given by Aktiebolaget Atomenergi group, Bo Gustaf Lindell (Chairman), Brynielsson, Ambassador Parsons, and many others (totaling 25-30), at Opera Källaren, Shipmaster's Club. I made a short speech in response to a welcoming address."

"Sunday, September 16, 1962 – Stockholm and Skansen

"I had lunch at the apartment of Baron and Baroness Fleetwood (along with Wilkes, Wells, King, and Henderson), prior to the Sweden-America Day festivities arranged by the Vasa Order at Skansen.* I sat next to Prime Minister Tage Erlander, who discussed with me whether Sweden should manufacture atomic weapons (he thinks not, and I encouraged him to maintain that position), the role of tactical atomic weapons, and Swedish approach to civilian nuclear power (he has doubts about the natural uranium approach). I responded to a welcoming speech by Baroness Fleetwood. Prime Minister Erlander also gave a short talk.

"Then our group went to Skansen where I received a gold medal and scroll as 'Swedish-American of the Year.' In response, I gave my speech, entitled 'Toward an Open Scientific Community.' There was a program of dancing and singing to Dalarna music.

"About 30 of my relatives were present, and we visited at Laxbrostugan, the home of my mother's father's

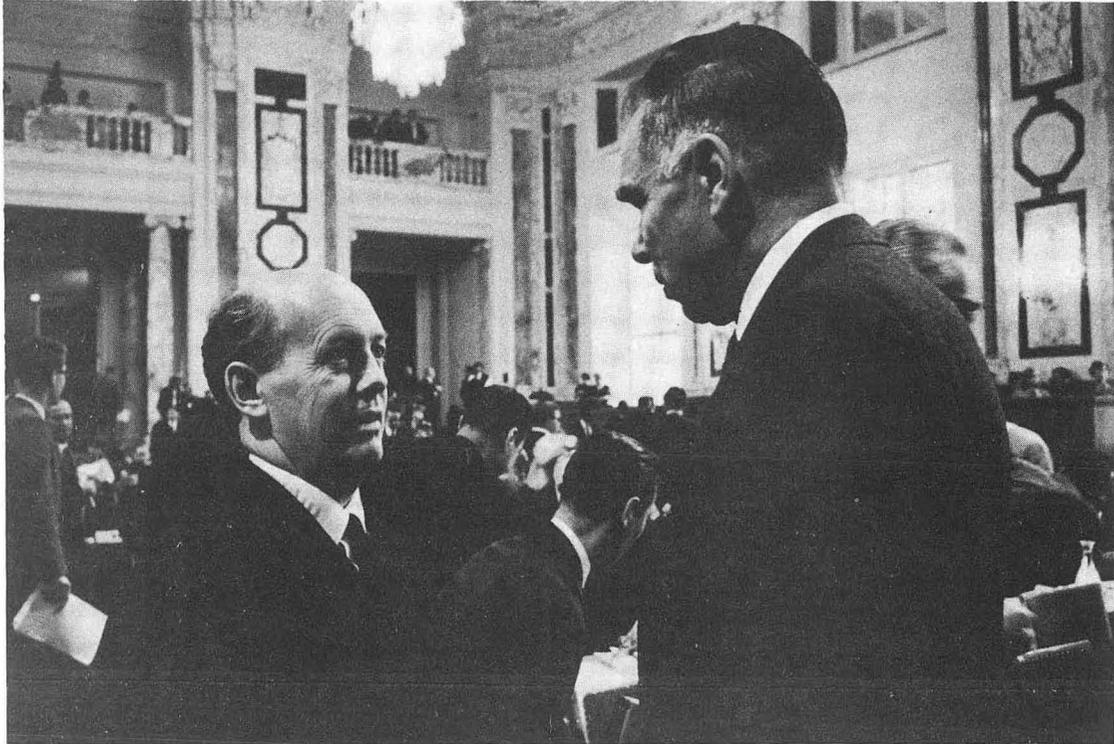
*The Vasa Order is a fraternal society composed of Americans of Swedish descent (and their spouses) who still have connections with Sweden. My parents were members of Ishpeming and Los Angeles (Inglewood) chapters. Helen and I were members of a Washington, D.C., chapter. Skansen, where the ceremonies of this day were held, is a Stockholm park that has a section containing a collection of representative old Swedish houses.

family eight generations ago (transported from Kopparberg to Skansen as representing the typical Swedish home of the 1670 era in the Dalarna region). We then went to another old house where we all had coffee. Karl Adolfsson, Bengt and Britta Adolfsson, Gösta and Irene Adolfsson and children Eva and Lena, Ruth Kjellgren, Eric and Tora Bäcklin, their daughter Eivor and her husband Olof Bloom, and their children Anita, Per, and Berit, Gun (Bäcklin) Grill, Gösta and Ingrid Berglund and their daughter Siv (attractive and intelligent), Albert and Maria Eriksson, Mrs. Inga-Britt Eriksson, Mrs. Anna-Lisa Lundell, Allej Carlsson, and Gustav Eriksson were present. Many went later to Vasa dinner where I received a Vasa booklet, which all signed. I responded to a welcome speech. This was followed by an evening of singing (by an entertainer) and dancing."

After this very pleasant conclusion to my visit, I flew on to attend the IAEA Sixth General Conference, where I again saw Harry Brynielsson. While in Vienna then and in the course of the Conferences of other years, I had numerous occasions for talks with Director General Eklund, privately and in small meetings as well as at the many "official" social gatherings. For example, my journal for September 17, 1962, notes: "Henry Smyth (US representative to the IAEA), Wells, and I called on Eklund. We discussed Eklund's hope that the United States will insist on IAEA safeguards on power reactors India might buy from a US firm. We discussed the forthcoming USAEC report to the President on civilian power and other items."

With respect to the above reference to safeguards, it seems appropriate to recall here that from the beginning the United States favored the earliest feasible substitution of IAEA safeguards for the bilateral system specified in our cooperative agreements with individual nations. By 1962, we had adopted the general practice of including in our bilateral agreements a clause looking toward eventual arrangements for safeguards responsibilities to be transferred to the Agency; and such a clause was included in our agreement with India signed the following summer (on August 8, 1963) pertaining to enriched uranium for the Tarapur Atomic Power Plant. (When the time came to implement this clause, reaching a meeting of minds with India on details of the transfer proved a lengthy task: the necessary trilateral agreement was not signed until January 27, 1971 - over a year after the completion of the Tarapur plant.)

Later in 1962, on November 2, I had an interesting conversation in Washington with Dr. Jan Rydberg, Research Director of Sweden's National Defense Research Institute, who had spent two months as a post-doctorate student in my Nuclear Chemistry Division at the Radiation Laboratory at Berkeley in 1951. Though Dr. Rydberg's call on me was essentially a social visit, we discussed a wide range of subjects. Among these were questions related to the fueling of the different types of nuclear reactors. We spoke about the Swedish power reactor program, which, as I have mentioned, was at that time based on reactors fueled with natural uranium. Dr. Rydberg was interested in discussing the revisions made a few months earlier



XBB 761-7007

Harry Brynielsson and Seaborg at Opening Session of 6th General Conference, IAEA, Hofburg Palace, Vienna, September 18, 1962.

in the USAEC's charges for enriched and depleted uranium. (The new rates resulted in a significant reduction in the cost of enriched uranium for power reactors.) The value of plutonium as a fuel was also mentioned. Dr. Rydberg informed me that Sweden was doing some open work on plutonium metallurgy directed toward the use of plutonium in reactors. He indicated, however, that they were not working on production of nuclear weapons; I expressed my satisfaction about this.

My journal entry for October 21, 1963, makes reference to an interesting matter unrelated to Sweden's nuclear energy program: "I had lunch at the Metropolitan Club with Arne Tiselius, Ambassador Jarring, and Jerry Wiesner. I discussed with Tiselius the problem of naming element 102. He is very concerned that the Swedish scientists have behaved poorly in not retracting their claim to discovery of element 102 and will talk to them about this."

The reference to element 102 concerns the announcement of the first synthesis and identification in Stockholm of the synthetic transuranium element with the atomic number 102 by an international team including Swedish scientists. This work took place in 1957 at the Nobel Institute for Physics in Stockholm and the announcement of the discovery of this new element included the suggestion that it receive the name "nobelium" in honor of Alfred Nobel, the Swedish inventor of dynamite whose fortune was left to provide for the Nobel Prizes. This work was never confirmed by work in other laboratories with the ultimate result that credit for the discovery of element 102 eventually went to other investigators who, nevertheless, decided to retain the name nobelium for this element.

In the course of 1963, consultations between the US and Swedish Governments were initiated with a view to the development of a new Agreement for Cooperation to provide for broader collaboration, including the supply of US enriched uranium for power reactors. The emphasis in Sweden's nuclear power planning was by now shifting from natural uranium reactors toward those using enriched uranium, of which the United States was the only source of large-scale supply. A draft of a new agreement, to supersede that of 1956 (as amended), was developed and submitted to the Swedish Foreign Ministry. Regarding this, I wrote Harry Brynielsson, Managing Director of Aktiebolaget Atomenergi, on January 30, 1964, to explain the reasoning behind some of the proposed clauses. I emphasized particularly the importance we placed on a proviso that the parties would endeavor "promptly" to arrange for the IAEA to administer the safeguards on fissionable materials transferred. I suggested, in fact, that a trilateral US-Sweden-IAEA agreement to this effect be signed at the same time as our new bilateral. Unfortunately, to my mind, the Swedish Government was not receptive to this idea. The primary reason, among several advanced for the Swedish position, was that the IAEA system had certain deficiencies which the Government hoped would be overcome in a planned review. Meanwhile, Sweden wished to defer action on a trilateral, though it was willing to include in the bilateral an expression of intent to arrange for IAEA safeguards. Exchanges of views on this question prolonged negotiations, making it impossible to reach a meeting of minds on the new agreement in 1964 or, in fact, the next year.

The fall of 1964 afforded several occasions for useful meetings with Swedish officials, first at the Third Geneva Conference on the Peaceful Uses of Atomic Energy, then in a very brief visit to Sweden, and finally, of course, at the Eighth General Conference of the IAEA in Vienna.

One of the most interesting times in the course of the Geneva Conference was the visit I hosted for representatives of many nations on board the USNS *Savannah*, the world's first nuclear-powered cargo-passenger ship. The *Savannah*, which was completing a tour of the Scandinavian countries, was at anchor in the port of Halsingborg. My guests, including high-ranking officials or representatives of 15 national nuclear-energy organizations, and I flew to Sweden the afternoon of September third and spent the night on board ship, preparatory to our cruise the following day. Among my guests aboard the plane from Geneva to Sweden were: Eklund, Brynielsson, Gunnar Randers (Managing Director, Institute for Atomic Energy, Norway), J. H. de Boer (Netherlands), Bertrand Goldschmidt (Director of Foreign Relations and Programs, Commissariat à l'Energie Atomique, France), A. N. Petrosyants (Chairman of USSR State Committee for the Utilization of Atomic Energy), Carlo Salvetti (Vice President, National Committee for Nuclear Energy, Italy), Siegfried Balke (Federal Republic of Germany), Oscar A. Quihillalt (President, National Atomic Energy Commission, Argentina), I. H. Usmani (Chairman, Pakistan Atomic Energy Commission), Homi J. Bhabha (Chairman, Indian Atomic Energy Commission), Sir William G. Penney (Chairman, UK Atomic Energy Authority), General Letor (President, Center for Nuclear Energy Studies, Mol, Belgium), Anton Moljk (Professor, University of Ljubljana, Yugoslavia), Luiz Cintra do Prado (Chairman, Nuclear Energy Commission, Brazil), and Sakuji Komagata (Commissioner, Atomic Energy Commission of Japan), as well as Smyth and John B. Anderson (Member of Congress from Illinois and member of JCAE), and USAEC staff members Arnold Fritsch, Les Staebler, Richard Doan, and Daniel M. Wilkes:

"Friday, September 4, 1964 – Halsingborg to Malmo

"Sailed with atomic energy group, plus a large group of Swedish industrialists, on the NS *Savannah* from Halsingborg to Malmo. Introduced the atomic energy representatives from the 15 countries to the assemblage aboard, as pictures were taken. Spoke to the group at ceremony on board at Malmo. Flew with Arnie Fritsch to Stockholm after TV interview in Malmo (which was later used on the Swedish national TV). Helen and Wilkes followed on a later plane."

The Swedish group on board the *Savannah* that day also included Professor Torsten Gustafson of the University of Lund, Secretary Gunnar Lange and Under Secretary Von Sydow of the Ministry of Commerce and Industry. I took the opportunity to urge on them, in a conversation at which Eklund was present, the desirability of having the IAEA assume responsibility for administering the safeguards currently provided for under the US-Swedish bilateral Agreement for Cooperation. Unfortunately, they appeared to resist this idea. On the other hand, discussion with Director Sune Wetterlundh of the Swedish Atomkraft Konsortiet (AKK)



XBB 761-7008

On board NS Savannah in cruise from Halsingborg to Malmo, Sept. 4, 1964.
(Left to right) A. R. Fritsch, U. M. Staebler, (back) Gunnar Randers,
(front) Harry Brynielsson, J. H. de Boer, John B. Anderson, T. Gustafson,
Bertrand Goldschmidt, Carlo Salvetti, Siegfried Balke, Richard L. Doan,
Oscar A. Quihillalt, H. D. Smyth, Glenn T. Seaborg, I. H. Usmani, Homi
J. Bhabha, Sir William G. Penney, Gen. Letor, Anton Moljk, Luiz Cintra
do Prado, Sakuji Komagata, Daniel M. Wilkes.

indicated that the Swedish utilities were inclined to favor the IAEA even to the extent of obtaining reactor fuels through the Agency channel.

"Saturday, September 5, 1964 - Stockholm

"Met from 11:15 to 11:55 a.m. with Prime Minister Tage Erlander and Cabinet and Senate member Olof Palme. I explained why the United States and Eklund want Sweden to transfer safeguards from the US-Swedish bilateral to the IAEA. I explained the safeguards system and said it wouldn't interfere with development of nuclear power in Sweden. I suggested a six-month trial on one reactor, if he didn't want to agree to immediate transfer. He said he had talked to Lange this morning (I said I had talked to him for nearly an hour yesterday), and he thought Lange is coming around to agreeing to this step. Erlander indicated he thought that he could get his Cabinet to agree to a trial basis as I suggested. We also discussed the possibility of an international accelerator."

In the course of our discussion of a possible international accelerator project, I described the USSR position, which favored US-USSR bilateral collaboration first on such an international project, with other nations joining later. I said I thought the Soviet position applied more to a 1,000 BeV project than to the 200 BeV accelerator being planned. The Prime Minister then turned to other topics:

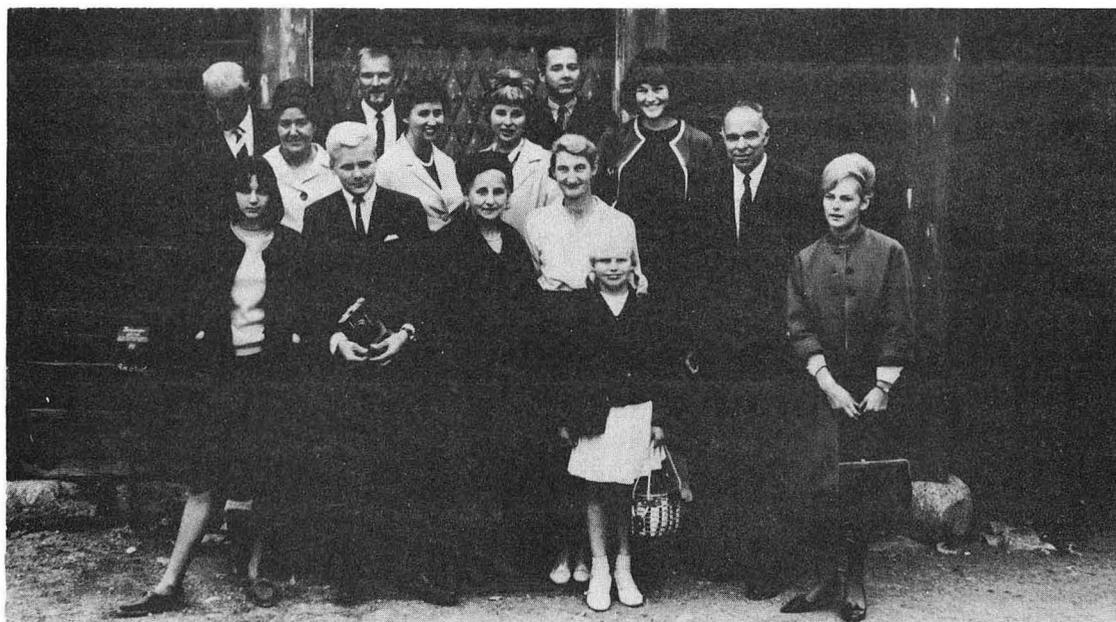
"He asked what I thought about Swedish nuclear power programs, recalling our conversation in 1962. I gave a generalized reply, saying Swedish uranium is expensive, but a Swedish type of reactor could be important in the 1970's. I explained our US reactor export policy and our private ownership legislation (which had been approved by the Congress less than a month earlier) and our guarantee of fuel availability for the life of a reactor. I extended greetings from Helen and told him about my ancestors' home in Skansen.

"Helen did some shopping for gifts. She and I gave a luncheon for our relatives (a total of 36 in the party) at Solliden Restaurant in Skansen. The group included Karl and Jenny Adolfsson, Bengt and Britta Adolfsson, Gösta and Irene Adolfsson and their children Eva and Lena, Karin and Per Möller and their son Göran, Ruth Kjellgren, Albert and Maria Eriksson, their daughter Lena, son Gustav and grandson Dan, Olof and Eivor Bloom and their children Anita, Per and Berit, Siv and Peter Lindkvist, Gösta and Ingrid Berglund and their daughter Britt, Gun and Hans Grill, Tora Bäcklin, Carl and Monica Tersmeden (Carl is a second cousin on the Seaborg side, all the others are relatives, and spouses, on my mother's side.) Then we all visited the ancestral home at Laxbrostugen in Skansen and took lots of pictures. Helen and I had dinner in our Grand Hotel room with Karl



XBB 761-7009

Visit to ancestral home, Laxbrostugan, Skansen Park, Stockholm, Sept. 5, 1964. Included are the Seaborgs, Karl and Jenny Adolfsson, Bengt and Britta Adolfsson, Gösta and Irene Adolfsson and their children Eva and Lena, Karin and Per Möller and their son Göran, Ruth Kjellgren, Albert and Maria Eriksson and their daughter Lena, Gösta Berglund.



XBB 761-7010

Additional group at Laxbrostugan, Sept. 5, 1964. Included are the Seaborgs, Eivor Bloom and children Anita, Per, and Berit, Siv and Peter Lindkvist, Tora Bäcklin, Gösta and Ingrid Berglund and daughter Britt, Gun and Hans Grill.

and Jenny Adolfsson, Per and Karin (Adolfsson) Möller and their son Göran."

I returned to Geneva somewhat encouraged about the possibility of Sweden's accepting IAEA safeguards on one reactor at least on a trial basis, as discussed with Lange (in my talks on the *Savannah*) and with Prime Minister Erlander. Unfortunately, my hopes in this matter were not to be realized at any near date.

At the IAEA's Eighth General Conference, held shortly after the Geneva assemblage, I saw Eklund several times, as usual. At lunch at his home one day, along with delegates from a number of other countries, I took the occasion to assure him of my support for reappointment the following year, when his term was to expire.

In 1965 the decision was made to broaden US-Swedish nuclear cooperation to include a technical exchange arrangement in the field of nuclear superheat. The Swedish effort in this field was to be centered in the Marviken reactor, a 200 MWe, heavy-water reactor fueled with slightly enriched uranium.

Meanwhile, negotiations on the superseding bilateral agreement went forward and by the end of 1965 were virtually complete, though final details and formalities remained to be completed. In this connection, the following excerpt from my journal is of interest:

"November 5, 1965 - Washington, D.C.

"At 8 p.m. Helen and I went to a dinner given by Ambassador and Mrs. Hubert de Besche for Prime Minister and Mrs. Erlander. Vice President and Mrs. Humphrey attended, as well as the George Meanys, Victor G. Reuthers, Walker L. Cislers, Secretary of Commerce John T. Conner and Mrs. Conner, W. T. Lippincott, former Swedish Ambassador and Mrs. Dahlman, and many others. De Besche, Humphrey, and Erlander spoke briefly and humorously. I told Erlander about Novawood and he was very interested - I said I would send him more information. I also reiterated my belief in the importance of Sweden adopting the IAEA safeguards and he said that Sweden will do so for the US-Swedish bilateral."

Giving up our attempt to persuade Sweden to enter into a trilateral US-Sweden-IAEA safeguards agreement at once, we had decided to be content for the time being with inclusion in the bilateral of the clause expressing intent to ask the Agency to assume safeguards responsibilities.* Among

* This Agreement was signed at the State Department on July 28, 1966; Walter Stoessel and I signed for the US, and Göran Bundy, of the Swedish embassy, signed for Sweden. However the hope expressed by Prime Minister Erlander in the journal extract quoted above, that the US-Swedish bilateral agreement be subject to IAEA safeguards, was not to be realized before several more years.

other things, the new agreement authorized the transfer of up to 50,000 kilograms of enriched U-235 – the estimated amount required to fuel Sweden's growing nuclear power generation program, comprising six reactors with a total capacity of 2600 MWe.

In connection with specific plans for one of those power projects, the Oskarshamn Nuclear Power Station (a 400 MWe Boiling Water facility), I was visited on September 9, 1965, by Messrs. Olle Gimstedt, President, Oskarshamn Power Group (OKG); Arvid H. E. Persson, OKG engineer; Lennart Eckerberg, First Secretary of the Swedish Embassy in Washington; and Fred Warren of the US firm Nuclear Utility Services. Dixon Hoyle, Assistant Director for Technical Implementation in the USAEC's Division of International Affairs, was with me. Mr. Gimstedt wanted to ask several questions relating to our enriched uranium supply policies. We assured him that after the new bilateral agreement, then under negotiation, came into force, the OKG project would have no difficulty in obtaining a long-term supply contract from the USAEC. We indicated that we anticipated no serious obstacles now to the successful completion of the agreement, though because of US legislative requirements we did not expect it to come into force until 1966. We assured our guests also with respect to the probable stability of our charges for, and the continued long-term availability of, enriched uranium.

Before leaving, Mr. Gimstedt said he had been asked by the Swedish Board of Power Producers to inquire whether I would be willing to address their annual meeting to be held in Stockholm April 21 or 27, 1966. My journal notes that I told him I might be going to Europe earlier in connection with the German Atomic Forum annual meeting to be held in Bonn. He said his group would look into the possibility of scheduling their meeting earlier.

On another matter of Swedish-American concern, my journal for February 14, 1966, reads:

"At 1 p.m. I had lunch with Ambassador Hubert de Besche of Sweden at the Cosmos Club. De Besche said he wanted to explore with me an idea he has for the formation of a new Swedish-American Society concerned with cultural relations between the two countries. He said that none of the present societies are up-to-date nor concerned with changes that affect Sweden and the United States. I told him I thought this would be a good idea if we could get a number of key people interested. We mentioned the people that this might be discussed with: Edgar Carlson, Johannes Newton, Amandus Johnson, Elmer Engstrom (and other Swedish-Americans of the Year), people in Government such as Senators Clinton Anderson, Magnusson and Carlson, and Vice President Humphrey. De Besche will investigate the concept with a number of people of this type and get back in touch with me."

On February 25, 1966, I was visited in Washington by Dr. Curt Mileikowsky, Executive Vice President in Charge of Sales of Allmänna Svenska Elektriska Aktiebolaget, or ASEA, a large Swedish concern involved in – among other activities – the design and construction of nuclear reactors. ASEA was one of a number of companies (including the US firms General Electric and Westinghouse) that had responded to a Finnish invitation to submit bids for a nuclear power plant. While Finland was under considerable pressure to accept a bid submitted from the USSR, there appeared to be a possibility that serious consideration would be given to bids from other countries. Dr. Mileikowsky wanted to know, in essence, whether Finland would be able to purchase enriched uranium from the United States for use as fuel if it obtained its reactor from ASEA, and if so, through what arrangements – for example, could Finland get some fuel from the United States and some from the Soviet Union, could US enriched uranium be purchased for reserve cores, etc.

In reply, I remarked that Dr. Mileikowsky had posed some very hard questions for which I could not give immediate answers. I noted that Finland could not "have its cake and eat it too" in seeking guarantees for availability of enriched uranium for the life of the reactor without entering into long-term contracts for the material – and doing this might conflict with a desire to solve political difficulties by scheduling purchases from both the United States and the Soviet Union. I suggested that Mileikowsky arrange to confirm our discussions in a letter from his company or the Finnish Government agency concerned, in order to make sure we clearly understood their questions. (As things turned out, incidentally, Finland eventually accepted the USSR bid, and – after an apparent cancellation of the project and subsequently a new decision to proceed – construction on the first of two units started in 1971. Thus the question raised by Dr. Mileikowsky in this conversation became academic.)

Schedule pressures during my very quick trip to Europe in March of 1966 prevented me from going to Stockholm to address the Swedish Board of Power Producers. In the fall, however, I was able to include a stop in Sweden on my way to the Tenth General Conference of the IAEA. On this occasion, through an invitation of a former post-doctorate student of mine (in 1956) at the University of California, Dr. Lennart Holm, I had the opportunity to visit the classified Research Institute for National Defense (of which he is Research Director and Head of the Nuclear Chemistry Division) just outside of Stockholm.

With my assistant, Arnold Fritsch, I flew to London September 16, then the next day went on to Stockholm:

"Saturday, September 17, 1966 – London to Stockholm

"We flew to Stockholm and were met by Dr. Clyde McClelland, US Embassy Scientific Attaché, Olof and Eivor Bloom, and their son Per. (Eivor Bloom is one of my second cousins.) After talking to the Blooms for about an hour, McClelland drove us to the Swedish National Defense Research Institute (FOA).

"Here we were briefed by Director General Martin Fehre, Dr. Torsten Magnusson (Chief, Division IV—Nuclear—of FOA), and Lennart Holm. According to them, the FOA is working with plutonium and nuclear weapons concepts as a civil defense measure. They showed us through the plutonium laboratory (which is under Holm's direction) where we saw work on preparation of plutonium metal and work on its metallurgy in its various phase forms. We were shown this work by Th. Sjöborg, O. Hindbeck, L. Ekbohm, L.-H. Andersson and others. They have a supply of 200 grams of plutonium furnished by the United Kingdom and also have worked with plutonium (purified it) furnished by the United States for Studsvik Laboratory."

The impression I gained from my visit to the FOA was that while the work of the institute in the nuclear field would give Sweden some advantage if it decided to proceed with a nuclear weapons effort, the advantage would not be an overwhelming one. Dr. Fehre told me that the work was being conducted for civil defense purposes (and also as an aid to understanding the disarmament issues being discussed at Geneva). This argument seemed quite plausible in view of the extensive defensive measures under way in other sectors of the Swedish economy — for example, the construction of factories in vast underground shelters.

After returning to Stockholm, I enjoyed a family reunion, followed by useful meetings with US and Swedish officials:

"When we got to the Grand Hotel I found waiting for us Uncle Karl Adolfsson, Ruth Kjellgren (my first cousin), Gösta and Irene Adolfsson and their children, Eva (7 years) and Lena (5 years), both born on June 24. (Gösta is a son of Karl, hence a first cousin.) I gave them presents, and presents for Aunt Jenny Adolfsson, Bengt and Britta Adolfsson, Per and Karin Möller, Mona and Göran. Karl gave me a present made in Mora, Dalarna and a picture of Mona (Karin's daughter) and Bo Forssling (Mona's husband). Karl had to catch a train to Kopparberg; the others (except Ruth) went on the same train as far as Eskilstuna. Ruth took a later train to Eskilstuna. They had come down to Stockholm to see me at Skansen last Sunday because we apparently gave them the wrong date. Thus I won't see Karl, Bengt, Per or Karin tomorrow but Gösta and Irene will come back.

"Fritsch, McClelland and I called on Ambassador and Mrs. Parsons at the Embassy. Then we went to dinner at the McClellands'. In addition to our host and hostess, the following were present: Fehre, Magnusson, Holm, Dr. Gothe Malmow (Deputy Managing Director, AB Atomenergi), Bo Aler (Director of Administration, AB Atomenergi), Sigvard Strandh (Technical Museum Director), and Mr. and Mrs. John A. Collins (Deputy Scientific Attaché, Embassy).

I talked with Strandh about Swedish Science Fairs – there are about five or six Regional Fairs. He expects to come to the International Science Fair in the United States with his winner next spring."

"Sunday, September 18, 1966 – Stockholm

"Fritsch and I with Embassy driver, Bengt Svensson, visited Old Town where we saw Storkyrkan, the oldest church in Stockholm. Then after visiting various areas, we went to Stadshuset, the town hall, where we took a tour and saw the Golden Room (where Nobel dinner is held), Blue Hall (where I spoke to dancing students and crowned Lucia Beauty Queen of Stockholm in 1951). Met the Gösta Adolfssons and Ruth Kjellgren at the Grand Hotel, and from my room talked by phone to Jenny, Karl, Karin, and Per up in Kopparberg. I took Gösta, Irene, Eva, Lena, and Ruth to a smörgåsbord lunch at the Grand Hotel. Then we all, with Fritsch, went to Skansen in the Embassy car where we met numerous relatives at Laxbrostugan (Bergsmans Garden) – Tora and Eric Bäcklin; Olof, Eivor, Per, Anita, Berit and Anders Bloom; Hans Lennart, Gun, Helen, Fanny and Jim Grill; Sven, Ulla-Britt (Bäcklin), Karin and Eva Österberg; Siv and Mats (2 year-old son) Lindkvist; and Jan Erik Gustafsson (Anita's fiancé).

"An inscription on the wall in Laxbrostugan reads 'Mickaël Hindersson – Maria van Gent – 1673.' After seeing inside of the house, took many pictures outside. Then we all went to Hogloftet Restaurant nearby on Skansen grounds and had coffee, tea, cakes and cookies – we spent about an hour and a half there, and then we said goodbye. The Gösta Adolfssons, Ruth, and I went to Solliden Restaurant where Britt Berglund (Siv's sister) is working and we talked to her. She and a girl friend are coming to the United States in about a year to stay a year – she said she would look us up in Washington. We dropped the Adolfssons and Ruth off at the railroad station and they took the train back to Eskilstuna.

"We drove to Arlanda Airport where Fritsch and I flew on to Helsinki."

In my report to the President of October 4, 1966, there appeared the following note:

"Swedish Interest in Nuclear Weapons – Through an invitation from a former student of mine at the University of California, Dr. Lennart Holm, I had the opportunity on September 17 to visit the classified Research Institute for National Defense (FOA) just outside of Stockholm. I met with Dr. Martin Fehre, Director of the Institute, and Dr. Torsten Magnusson, who is chief of their nuclear effort. Dr. Holm is chief of the nuclear chemistry group under Dr. Magnusson.

"Following our discussions I had the opportunity to tour their plutonium laboratory where they were studying the properties of plutonium primarily in the metallic state, with a supply of 200 grams, which they had received from the United Kingdom. They have also purified some US-furnished plutonium for the Swedish Studsvik Laboratory (their national laboratory for atomic energy.)

"My general reaction from the visit is that while the work of this institute in the nuclear field will give Sweden some advantage if it decides to proceed with a nuclear weapons effort – the advantage will not be an overwhelming one. The Swedish argument that this work is being performed for defensive purposes – as well as for understanding the disarmament issues being discussed internationally – appears plausible when one realizes the extensive defensive efforts being taken in other sectors of the Swedish economy – for example, the construction of factories in vast underground shelters."

As anticipated in my 1965 meeting with Olle Gimstedt, President of OKG, a long-term enrichment contract was negotiated to assure fuel supplies for the company's first nuclear power plant, on which construction started in September 1966. Signed in my presence on June 22, 1967, by Gimstedt and USAEC General Manager Robert Hollingsworth, the contract broke ground in two ways: it was the USAEC's first for toll enrichment (for either domestic or foreign customers), and it was also the Commission's first with a private organization overseas. (Previously, all fuel supply arrangements had been on a government-to-government basis.) My journal for June 22, 1967, reads:

"At noon I participated in the signing of the First Toll Enrichment Contract between USAEC and Swedish OKG. I made remarks as did Mr. Olle Gimstedt. Mr. Hollingsworth and Gimstedt signed. The whole ceremony was filmed. Also attending were Arvid H. Persson and Bengt Westerling (OKG lawyer), Swedish Embassy Economic Counselor Göran Bundy and Lennart Alvin (Swedish Embassy Attaché). The ceremony also was recorded by the Voice of America and USIS.

"Then I attended a luncheon with the Swedish OKG officials (hosted by Olle Gimstedt) at the Metropolitan Club. Also hosting the luncheon was Fred Warren (Nuclear Utility Services). Guests included Arvin Persson, Bengt Westerling, Lennart Alvin, William S. Balderston (Export-Import Bank), John Gray (Nuclear Utility Services), Myron Kratzer, Mr. Bourne (DIA), Glenn Bradley (DIA), and others. Gimstedt, Warren, Bundy and I gave toasts."

After my 1966 visit, three years passed before I returned to Sweden. There were, of course, many discussions at the annual IAEA General Conferences



XBB 761-7012

Signing of First Toll Enrichment Contract, between USAEC and Swedish Oskarsham Power Group (OKG). Left to right at table, Seaborg, Olle Gimstedt; standing, Samuel Nabrit, Myron B. Kratzer, Gerald F. Tape, Joseph F. Hennessey, Robert E. Hollingsworth, Bengt Westerling, Arvid Persson, Lennart Alvin.

in Vienna with Swedish representatives there, usually on Agency-related matters but also on questions of special bilateral concern. In the course of the 1966 and 1967 Conferences I was enabled to present US views for a wide Swedish audience through special interviews:

"Saturday, September 24, 1966 – Vienna

"Bo Kumlin of Swedish National Radio came by and interviewed me in Swedish and English on safeguards, nuclear power, Swedish heavy water reactor program, youth education in science, etc."

"Thursday, September 28, 1967 – Vienna

"I then went to the TV room where Svensson of Swedish National Radio and TV (he has interviewed me on previous visits to Vienna) interviewed me for Swedish TV on the NPT and IAEA safeguards and the problem that countries like Sweden have in accepting them. I said they don't inhibit peaceful nuclear developments. I concluded by stating in Swedish that Sweden could have produced nuclear weapons but was wise not to have done so."

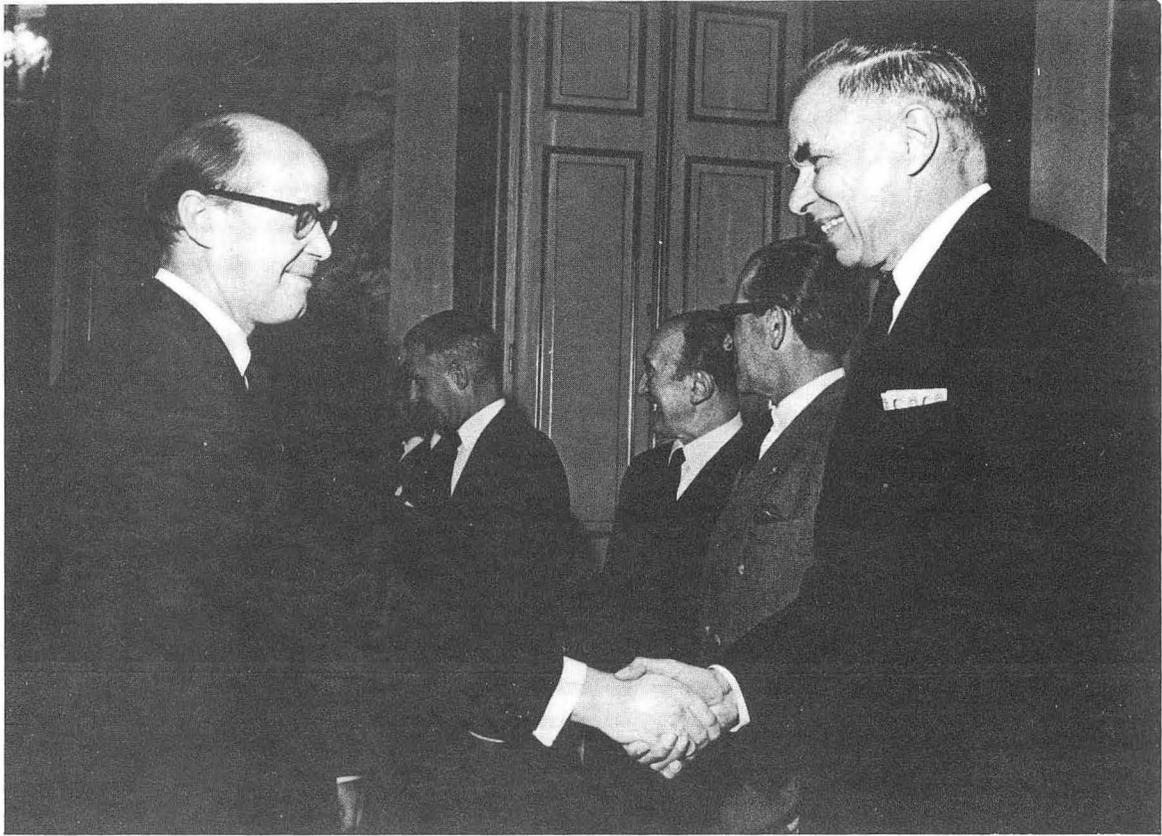
The Treaty on the Non-Proliferation of Nuclear Weapons was opened for signature on July 1, 1968. Sweden signed less than two months later, on August 19. We were gratified by its prompt accession; now we hoped that the Swedish Government would ratify without extended delay. Sweden's well-established neutrality in world affairs would, we felt, give special weight to such action in the view of any government's hesitancy about subscribing to the Treaty. We were also anxious for steps to be initiated toward IAEA assumption of responsibility for the administration of safeguards provided for in the US-Swedish bilateral agreement. A visit to Sweden in September 1969 afforded opportunities for me to clarify and emphasize our position on these questions in discussions with Prime Minister Tage Erlander and Foreign Minister Alva Myrdal.

My trip to Europe was scheduled at this time for a variety of reasons. I had been invited to attend and speak at Nobel Symposium 14 devoted to the subject "The Place of Value in a World of Facts," to be held in Stockholm starting September 15. The Thirteenth General Conference of the IAEA was to begin in Vienna on September 23. I was expected to address the Mendeleev Congress in Leningrad on September 26. And on October 1 a USAEC Atoms-in-Action exhibit was to open in Bucharest – the first such exhibit to be presented in a Soviet bloc country.

I set out early on Saturday, September 13:

"Saturday, September 13, 1969 – Washington, Stockholm

"I flew from Dulles Airport to London Heathrow Airport via New York. Here I was met by William L. R. Rice (the USAEC Scientific Representative in London) who accompanied me on a bus to the European Airways Terminal. Rice stayed



XBB 761-7011

Seaborg with Bo Aler, Director of Administration, Swedish Aktiebolaget Atomenergi, at Western Hemisphere Reception, 10th General Conference, IAEA, Vienna, September 22, 1966.

with me until it was time to board the flight to Stockholm (Arlanda Airport), which arrived at 1:15 a.m. Sunday morning. I was met by Carl-Göran Hedén of the Karolinska Institute, who drove me to Södergarn, the Conference mansion, on the island of Lidingö. Hedén, who is a member of the Swedish Academy of Engineering Sciences and the Executive Committee of the International Council of Scientific Unions, is serving as secretary of the Nobel session at which I will speak on Wednesday morning."

"Sunday, September 14, 1969 – Stockholm

"I had breakfast buffet style in Matsal, the restaurant, with Mikhail D. Millionshchikov (Vice President, USSR Academy of Sciences), Igor G. Pochitalin, his assistant, and Vladimir A. Engelhardt (the eminent Soviet biologist). I told them that I would not be able to get to Leningrad in time for Flerov's Symposium on the Transmendelevium Elements on Thursday, September 25, because of a poor plane connection in Moscow. Pochitalin said he would see if he could find a better connection.

"I rode with Stig Erixon, an Embassy driver, to Skansen for our traditional family visit to Laxbrostugan. I met Karl and Jenny Adolfsson, Bengt and Britta Adolfsson, and Carl and Monica Tersmeden and we walked to Laxbrostugan where we joined the other relatives. There were 48 of us altogether. The group consisted of Karl and Jenny Adolfsson; Bengt and Britta Adolfsson; Siv and Tomas (3½ years) Lindkvist; Gösta and Ingrid Berglund; Hans and Gun Grill, Jimmy (9 years) and Helen (5 years) Grill; Irene and Gösta Adolfsson, Eva (10 years) and Lena (8 years) Adolfsson; Olof and Eivor Bloom and Per (22 years), Berit (15 years) and Anders (10 years) Bloom; Tora and Eric Bäcklin; Anita (Bloom) and Jan-Erik Gustafsson (married a year ago today); Mona (Möller) Forssling with Carina (10 years) and Birgitta (8 years) Forssling; Sven and Ulla-Britt Osterberg with Eva (11 years), Karin (8 years) Österberg; Timo and Inga Lindås with Mats (6 years), Johan (5 years) and Sara (2 years) Lindås; Albert and Maria Eriksson and their grown son, Göran Eriksson; Lena Eriksson (daughter of Albert and Maria) and her fiancé; Carl and Monica Tersmeden; Karin and Per Möller and son Göran (15 years).

"We took movies and color snapshots ... I toured the six-room house and again saw the large portraits of Mickael Hindersson and Maria van Gent on the wall with the names and the date 1673.

"We all then went to the Vardshuset of the Solliden, where we had a large room to ourselves and were served coffee, tea, and sandwiches. Olof gave a welcoming speech, and, with the help of Siv Lindkvist as interpreter, I extended greetings

from Helen, describing the present whereabouts of our kids, describing my projected visit to eight countries on this European trip, etc. I gave them some presents, which Helen had purchased for the occasion, and Olof expressed thanks for the group. We stood around outside of Solliden for a long time, and I took more pictures.

"I said goodbye to the group, and then Karl and Jenny, and Gösta, Irene, Eva, and Lena, and Bengt and Britta rode in two cars (driven by Stig Erixson and Siv Lindkvist) to the railway station to take the train to Eskilstuna.

"Karl told me that our family's connection with Laxbrostugan was uncovered by Mother's friend, Sigard Nauckhoff, aided by subsequent research by himself, in 1958. Maria van Gent was Mickael Hindersson's second wife, and she had no children; it was one of his children by his first wife who was one of our ancestors.* Karl thinks that Laxbrostugan was built about 1650 and moved from Kopparberg about 1910.

"I rode with Siv and Tomas to the Lindkvist home in Lindingö and visited a few minutes. Siv then drove me to Södergarn, which is about a quarter of a mile from the home of her parents-in-law....Peter and Siv Lindkvist are planning to visit the United States next summer.

"Back at Södergarn I attended a buffet dinner where I sat with Arne Tiselius, Millionshchikov and Pochitalin. In the lounge I talked to a number of symposium participants, including Sam Nilsson, Harold D. Lasswell, Harrison Brown, Mr. and Mrs. Jerome S. Bruner, Arthur Koestler, Boris Pregel. Several of us went down to the movie projection room where we saw a documentary film on India."

"Monday, September 15, 1969 - Stockholm

"I had breakfast with Harrison Brown and Arne Engström; it was buffet style as apparently are all the meals except the special dinner.

"I then attended the opening session of Nobel Symposium 14 'The Place of Value in a World of Facts.' Those participating in the Symposium are: Henry D. Aiken (USA-Philosophy), Wystan H. Auden (England/USA-Poetry), Harrison Brown (USA-World Natural Resources); Jerome S. Bruner (USA-Cognitive studies), Frede Castberg (Norway-Law, Social Science), Carlos Chagas (Brazil-Biochemistry, Science Planning), Constantinos A. Doxiadis (Greece-Architecture, Ekistics), Vladimir A. Engelhardt (USSR-Biochemistry), Arne Engström (Sweden-Medical Physics), Karl-Erik Eriksson (Sweden-Theoretical Physics), Karl R. Gierow (Sweden-Literature), Ernst H. Gombrich (England-History of Arts), Wilfried

*I have since learned that this was erroneous information; Maria had many children, including a daughter, a grandparent of mine seven generations back.

Guth (Germany-Economy), Carl Göran Hedén (Sweden-Bio-engineering), Y. Hayashi (Japan-Socioeconomic planning), Alexander King (England-Science policy), Otto Klineberg (Canada-Psychology), Arthur Koestler (Austria/England-Transdisciplinary writing), T. Adeoye Lambo (Nigeria-Brain research), Harold D. Lasswell (USA-Law, social science), Joshua Lederberg (USA-Man and genetics), Konrad Lorenz (Austria-Ethology), Ivan Málek (Czechoslovakia-Microbiology), J. McHale (USA-Futurology), Margaret Mead (USA-Cultural anthropology), Mikhail D. Millionshchikov (USSR-Physics), Jacques Monod (France-Molecular biology), Gunnar Myrdal (Sweden-International affairs), Sam Nilsson (Sweden-Physics), Linus Pauling (USA-Chemistry, peace), John R. Pierce (USA-Electronic information systems), Boris Pregel (USA-Applied physics), Abdus Salam (Pakistan-Physics, science planning), August Schou (Norway-International relations), Torgny Segerstedt (Sweden-Sociology), Jehangir R. D. Tata (India-Economy), Jan Tinbergen (Holland-Socioeconomic planning), Arne Tiselius (Sweden-Biochemistry), and Conrad H. Waddington (Scotland-Genetics)."

In addition to those listed above in my journal, there was a group of outstanding university students and young graduates, invited to attend the symposium so that the views of the rising generation would be heard at this gathering composed otherwise of persons who had already achieved fulfillment and promise in their various fields.

"Arne Tiselius gave the introductory address. He described the origin and form of the symposium and the role of the young people as questioners. He emphasized the need for understanding non-scientists and the world in general in today's troubled world as well as the need for an experimental approach and an open mind.

"Next we heard a taped voice by one of the youths warning us about our complacency and the penetrating nature of their forthcoming questions. He said the average age of the symposium participants is 69.4 years, that of the youth group is 24 years.

"The first meeting was on 'The Menace and Promise of Science.' The first session was chaired by Engelhardt; he introduced Jacques Monod, who spoke on 'Molecular Biology and Human Needs,' describing the role of statistically random selection in biological evolution and extending the concept more generally to all human development. This emphasizes the needs for values in the cultures of all nations.... A value system cannot be based wholly on a system of facts — it must go beyond this.

"Engelhardt next introduced Joshua Lederberg, who spoke on 'Technical Possibilities for Remaking Man.' He questioned the universal applicability of Pauling's

axiom of minimization of human suffering and gave examples where it couldn't apply. Experimental biology puts today's hypothetical challenges and tomorrow's actual problems to man.

"While Lederberg was speaking I learned that I had an 11:00 a.m. appointment with Minister Alva Myrdal. Accompanied by Clyde L. McClelland, I was driven to the Foreign Ministry.

"In my meeting with Minister Myrdal (attended also by McClelland) after some initial remarks about my attendance at the Nobel Symposium and my meeting with relatives at Laxbrostugan yesterday, I first raised the question of Swedish ratification of the NPT. Mrs. Myrdal said it has been established as Swedish national policy to do this after the United States and the Soviet Union. I asked if this also meant such deferral of legislative action, pointing out that the United States and the Soviet Union had taken legislative action; she indicated that if the United States and Soviet Union ratification were delayed too long Sweden might go ahead with legislative action. The Swedish Government had decided to ratify. As recently as five to eight years ago the Government hadn't even decided against manufacturing nuclear weapons, but now the national position is not to manufacture nuclear weapons. I said that the United States looked to Sweden to exercise its traditional leadership and set an example for the world by ratifying the NPT - even before the United States and Soviet Union do.

"I then turned to the matter of Sweden's transferring safeguards, under the 1966 US-Swedish Bilateral Agreement, to the IAEA. I pointed out that this Agreement stated that Sweden would negotiate 'promptly' with IAEA to do this. She pointed out the problem that this would cause Sweden in connection with having nuclear fuel reprocessed at a facility in Europe where only Euratom safeguards applied. I suggested that Sweden write a letter to the Director General of the IAEA expressing its intention to transfer the safeguards function and suggesting the start of negotiations to do this, as Switzerland has done. I said this would do much to counteract problems in the United States emanating from Swedish inaction under the 1966 Bilateral. Mrs. Myrdal said that she would immediately look into the possibility of writing such a letter, expressing some surprise that it hadn't been done. She then turned to the topic of peaceful nuclear explosives. I expressed the US position that supervision of this should be under the IAEA. She agreed so far as the technical aspects are concerned but thought the broader aspects of policy and licensing should be under the United Nations to insure economic equality.

"She told us that she was going to attend the daily lunch of the 19 Cabinet Ministers with the Prime Minister (held five days a week), where all matters of policy are discussed. Presumably the issues in her conversation with me will be discussed at this meeting today. She told me that she, Minister Palme and Olof Rydberg, the head of the Swedish Broadcasting Company, were publicly advocating an international broadcasting satellite. I concluded the appointment at 11:30 a.m.

"I then returned to Södergarn to the Nobel Symposium. I had missed John Pierce's talk, 'Possibilities and Pitfalls in Electronic Information Transfer.' I heard the remainder of the talk by Carlos Chagas, 'Priorities in Science,' which was in progress. Joshua Lederberg was chairman of the second part of this session. Chagas said new methods of science education are important, especially to developing countries but also to developed countries. He described generally the importance of science to the developing countries.

"I had lunch with Joshua Lederberg. He agreed with me that biological insults of many types, such as inhaled smoke from coal burning plants, consumption of chlorinated drinking water, are much more serious than that from the low levels of radioactivity discharged from nuclear power plants. However, he thinks that the criticisms of nuclear plant effluents by biologists, even though overstated, serve a useful purpose in alerting authorities to do everything possible to alleviate the effects.

"After lunch I took a hike on some of the trails at Södergarn.

"Linus Pauling, who sat next to me at the Symposium sessions, explained to me his new ideas on orbiting alpha particle clusters in nuclei, which he claims explain certain spacings of levels in even-even nuclei.

"I attended the afternoon discussion session, presided over by Harrison Brown. Brown developed the thesis that there are many cold (earth-like) planets in the universe that have the necessary conditions to support life. He went on to raise the question as to whether the many man-made radiations from our earth might not be detected by intelligent life on such planets.

"Pauling said he thought it should be possible to improve cerebration by improving the molecular environment

of the mind and added as an example his predicted effect of large doses of vitamin C (perhaps as high as 1 gram a day instead of the recommended 30 milligrams) in improving the IQ of children.

"Arne Tiselius reviewed the high points of the talks by the day's speakers - he jokingly suggested the creation of an international organization with a dictator to decide the direction that applied research should take in countries throughout the world (i.e., he would distribute and assign the problems to be tackled). He would like this conference to express some ideas concerning a concentrated international effort on the world's problems.

"After the discussion session I took a hike on the trails to Fågelöudde and back, a total of some 3 or 4 miles. I then attended the reception with the international press, academies and learned societies. I talked to numerous members of the press, including Michael Salzer, a British national who has lived in Sweden (presently in Lidingö) for 20 years and is a correspondent for Swiss newspapers - he plans to spend a year in the United States (Santa Cruz) and will lecture on an outsider's views on Sweden; he offered to do this in Washington and I told him to write me and I would refer the matter to our Division of International Affairs to advise him.

"I had dinner at a table with some of the youth group--Gustav Ericsson, Staffan Hildebrand (who wants to interview me), and Jan Fjellander, and we had a lively discussion. Fjellander has spent about 3 months in China (in 1966) and was extremely favorably impressed with the Chinese people and life in China. Hildebrand was of the view that there was serious anti-Swedish opinion in the United States and Lederberg (who joined us) and I told him this was not so."

"Tuesday, September 16, 1969 - Stockholm

"I had breakfast with Mr. and Mrs. Boris Pregel and Frede Castberg. I reminisced with Pregel about his role as an officer of the Canadian Radium and Uranium Corporation during the war and my contacts with him, Pochan (his chemist at Port Hope), French (head of his office in Toronto) and the whereabouts of Gilbert LaBine, the discoverer of El Dorado Uranium Mine in northern Canada (he is still alive).

"I attended the morning program on 'The Teaching of Knowledge and the Imparting of Values.' Gustav Ericsson, the leader of the youth group, talked to us.

(Six of his seven colleagues were with him on the platform. Jan Fjellander was missing.) He described the activities of his group and gave us each a copy of their brochure 'To Superminds With Love.' Arthur Koestler was chairman of the program. He introduced Conrad H. Waddington who spoke on 'The Relevance of Biological Types of Thought to Modern Society.' He spoke of ethics and the choice of axioms on which this should be based.

"Koestler then called on Lambo who spoke on 'Social and Psychological Change and Human Needs in the Developing Societies of Africa.' He said his talk would include discussion of social and psychological possibilities for remaking man. He stated that young people are confused by the new civilizations, especially science and technology. He spoke of the social, economic, and educational problems of Africa and the differences in the value systems as compared with these of the West; African societies are in a state of flux - the prognosis for the future is good.

"Bruner spoke next, on 'Reason, Prejudice and Intuition.' He started by talking about the role of the nervous system in information processing. Information undergoes editing at each stage as it passes through the neural system. The contrast is between science on the one hand and personal relevance on the other. Present ferment is truly revolutionary - it is basically an attempt to resolve the conflict between purpose and neutrality. Myth that science is laissez-faire was never true and isn't true today. Understanding of relationship between social purpose and scientific activity should be one of the purposes of this conference.

"I returned a call from Professor Alexis C. Pappas at Oslo declining an invitation to speak.

"Following a coffee break there was a discussion of the preceding papers. Mikhail D. Millionshchikov compared the situation in developing countries to the anomalies in the laws of turbulence, which he has discovered, and made a plea for the use of the experimental method to help raise the level of these countries. Joshua Lederberg said the solution to our problems is not to use technology as a scapegoat but to work hard in the political arena down to the precinct level.

"Koestler called on Gombrich who spoke on 'Art and Self-transcendence.' He described the current cult of relevance among young people as nonsense. Koestler then called on Wystan H. Auden who spoke on 'Freedom and Necessity in Poetry.' He described the differences

between a crowd, a community, a society, etc., and their relations to poetry. He described the concept of speech and the role of poetry. He compared the similarities and differences between the arts and the sciences.

"In the discussion period Arne Tiselius emphasized the similarities in the thinking processes of scientists and artists, a fact that is hidden in the polished publications which do not include a description of their mistakes.

"I had lunch at a table with Torgny Segerstedt, Rector of Uppsala University. He said that student unrest at his University is not yet serious but he does note a certain anti-science attitude.

"After lunch I had a number of press interviews. Per Ragnarson of Swedish Radio interviewed me on tape for broadcast on Wednesday or Thursday. He asked about US policies in the enrichment of uranium for foreign countries (I explained our nondiscriminatory policy and plans for future expansion), the possibility of European enrichment plants including gas centrifuge (I emphasized importance of NPT safeguards), the possibility of US cooperation with Sweden in development of breeders (I said it is possible in principle).

"Harald Ericsson (Vice President) and Ingrid Sandahl (Member of the Board) of the Swedish Association of Young Scientists (50 science clubs at pre-university level) and Ungdomsåret (the Youth's Spring) interviewed me on secondary school education and changes required in areas of teaching the concept of values, etc. Lennart Lofthagen of *Syd Svenska Dagbladet* interviewed Mikhail D. Millionshchikov and me on construction of nuclear plants and nuplexes in developing countries and need for financial help in their construction (we explained when it is appropriate to build such plants, described the US and USSR and IAEA programs of cooperation in the peaceful uses of nuclear energy, and agreed that the building of nuplexes requires financial aid through methods yet to be worked out).

"I then attended the afternoon discussion session. At 3 p.m. I again rode with Clyde L. McClelland to the Kanslihuset for my appointment with Prime Minister Tage Erlander. Present during this meeting were McClelland, Ingvar Carlsson (Under Secretary of State, Prime Minister's Office), and Bo Aler (soon to succeed Brynielsson as head of Swedish atomic energy program). We began with some reminiscing about my previous meetings with the Prime Minister - our first meeting at a meeting of the Academy of Engineering Sciences in 1949, our lunch at Baroness

Fleetwood's in 1962, our meeting in this same office in 1964. I then told the Prime Minister that I wanted to talk about Sweden's intentions in connection with the NPT and the transfer of the safeguards of the Swedish-US bilateral agreement of 1966 to the IAEA. I reminded him that this agreement stated that Sweden would do this 'promptly' which is hardly consistent with Sweden's inaction. The Prime Minister took up the safeguards matter first and asked Carlsson and Aler why nothing had been done. Aler described the problem of Euratom *vs* IAEA safeguards in connection with nuclear fuel reprocessing. I suggested that Sweden follow Switzerland's example and send a letter of intention to the Director General of the IAEA. I said Mrs. Alva Myrdal seemed inclined to do this. The Prime Minister asked Carlsson to follow up on this with the Foreign Ministry - he thought it should be done. We then went on to discuss the NPT. I told the Prime Minister that ratification by Sweden would set a good example for the rest of the world and was considered by the United States to be very important. This seemed to impress him very much and he asked Carlsson to explore the possibility of pushing ratification by Sweden. The critical role of West Germany in asking for simultaneous ratification by the United States and the Soviet Union was recognized since this had led to delays of ratification. We concluded our conversation with my description of my Sunday meeting at Laxbrostugan with my 47 relatives and my description of the historic place of this house in my mother's family.

"After this interview McClelland and I went on to the Swedish Academy (of literature) where I joined my fellow participants in the Nobel Symposium to hear the public lectures. The meeting was opened with a few words of welcome by Karl R. Gierow (Permanent Secretary of the Swedish Academy). The Chairman of this afternoon's lecture session, Segerstedt, then introduced Frede Castberg, who spoke on 'Evolution of Values.' The next speaker was Gunnar Myrdal on 'Causes and Effects of Biases in Research.' He spoke about the biases in social science research, not natural science. This was followed by a discussion session in which Margaret Mead emphasized bias in natural science research whenever it reached a level of public involvement.

"On the way out of the Swedish Academy lecture hall (a beautiful room) I talked to Gunnar Myrdal and told him that I had seen his wife and tried to convince her that Sweden should ratify the NPT. To my surprise he blew up and began to speak to me in a loud voice

(almost shouting), berating the posture of the United States in disarmament, resolutions on biological warfare, etc. - I was amazed at his instantaneous highly emotional reaction, making it totally impossible to continue our conversation.

"I rode back with the Symposium group on the bus, sitting next to August Schou, Director of the Norwegian Nobel Institute (which gives out the Nobel Peace Prize) - he told me about their difficulty in finding suitable candidates.

"At dinner I sat at a table with Arne Tiselius and Lambo (Rector of the university located near Lagos). When Lambo learned of my forthcoming trip to Africa next January, he invited me to visit his university. I tried to feel out Tiselius concerning the recipient of this year's Nobel Prize in chemistry but I got no indication. In response to a request from Tiselius for a suggestion for a resolution that might come out of the Symposium, I suggested that we call on our political leaders to recognize the direction in which the world is going and to take steps to turn it to a better direction by better utilization of science and technology."

"Wednesday, September 17, 1969 - Stockholm

"I had breakfast with Y. Hayashi (of the Institute of Technology in Tokyo). He invited me to lecture at his institute during my visit to Tokyo next March.

"I attended the sessions on 'The New Republic - Scientist, Humanist and Government.' Salam presided over the first session and called on Málek who spoke on 'Creativity and Social Change.'

"The next speaker was Segerstedt who spoke on 'Facts, Values, and the Future.' He made a case for the importance of predicting the future. It is important to recognize the role of science in determining our future and to attempt to influence it to our advantage.

"After the coffee break, Chagas as Chairman of the second part of the session called on Pauling who talked on 'Scientists in Politics.' He estimated the world's nuclear stockpile at 600,000 megatons which at 0.4 ton per person killed is enough to kill the people of the world many times over. He described the contributions of scientists to the Limited Test Ban Treaty, and to government in general (where he cited me as an example). He also mentioned need for scientists in legislatures and parliaments but he said those who have succeeded are negligible in number. He described the role of

scientists in the ABM fight in the United States. He thinks decisions should be made in such a way as to minimize human suffering. He gave statistics on the maldistribution of the wealth among the people of the world. There should be a transfer of the world's wealth from the unconscionably rich to the miserably poor.

"Next I gave my talk on 'Science, Technology and the Citizen.'"

In my talk that day, after outlining the principal problems confronting mankind, I gave my views on how to approach them. I first discussed certain widespread negative attitudes, asserting then that:

...we must counteract these three negative forces - despair, distrust of technology and anti-intellectualism - by reemphasizing the potential of man, the contributions and potential benefits of science and technology and the supreme importance of knowledge and intellectual development allied with human sensitivity.

I went on to speak of the potential promise of technological breakthrough in solving problems, citing the 'Fusion Torch' concept of using ultrahigh-temperature plasmas as a means to reduce solid wastes to basic elements for separation and reuse. As an example of important tools already available to mankind, I mentioned the computer and the tremendous contribution it can make in avoiding future problems. In conclusion, I stressed the evident need for a new relationship between scientist and layman, the need on both parts for a greater maturity and sense of responsibility in applying technological advances, and the importance of achieving unity of will and purpose if mankind is to survive.

After I finished, there were some questions. I was asked to defer my answers until the afternoon discussion period, in order to give the balance of the morning period to a scheduled interview:

"Millionshchikov and I were then interviewed on tape by Hildebrand on the value of increasing the degree of cooperation between Soviet and US scientists (we both agreed that this should and could be done and gave a number of examples of present cooperation).

"I had lunch with Joshua Lederberg, followed by a walk by myself. At the afternoon discussion session I answered a question by Carl-Göran Hedén concerning his concept of a Statesman's Club (I said it would be good but impractical), from Henry David Aiken on whether scientists should be resistant to their government's policies (I said yes if they produce good arguments, but not just because they are scientists), by J. O. Schill of the youth group on my evidence for anti-technology attitudes, anti-rationalism, and anti-intellectualism

(I mentioned exaggerated worry about environmental problems and other negative effects of technology, the attitude of Crozier, and the hostile attitude of nonscientist university professors).

"I then rode with Pauling, Málek, Nigel Calder (honorary press secretary), Segerstedt, Chagas, Hedén and Fjellander to the Swedish House, where we participated in a press conference, presided over by Calder. Among the press representatives present were: Alfred Friendly (Washington *Post*), Daniel Greenberg (*Science* magazine), Daniel Lang (*New Yorker*), Robert Cowen (*Christian Science Monitor*), Robert Skole (McGraw-Hill World News), Richard Litell (*Medical Tribune*), Alan Simon (NBC Radio News), Michael Davie (*Observer* - London), Anthony Tucker (*Guardian* - London), Stephen Croall (Reuters), Erwin Schuhmacher (various German magazines), H. Sinding-Larsen (*Aftenposten* - Oslo), Torsten Bergman (Finnish radio), Sandberg (*Dagensnyheter* - Stockholm), Wickström (Swedish TV) and E. H. Linder (*Gotebergs-Posten*). After Pauling had answered a question in a way that seemed to derogate the honesty of members of the US Congress, Greenberg asked me if I agreed and I responded by emphasizing the intelligent and conscientious work of many members of Congress in exploring the effects of technology on society. Friendly asked me to explain the Fusion Torch concept, which I did. In answer to another question I stated that scientists should be concerned with the sociological aspects of their work. Pauling was very critical of the US ABM program, the maldistribution of the wealth in the United States, etc.

"I told Málek about my forthcoming trip to Czechoslovakia.

"I checked with Clyde L. McClelland the cable and aerograms covering my appointments with Mrs. Myrdal and Prime Minister Erlander preliminary to their dispatch to the US State Department, various embassies, etc. I then walked to the Swedish Academy with McClelland where we heard the afternoon public lectures. Margaret Mead was Chairman and she called on Koestler who spoke on 'Rebellion in a Vacuum' (in place of Ralph Bunche who couldn't attend the Nobel Symposium) and Klineberg who spoke on 'Alternatives to Violence.' In the discussion period two members of the youth group and two other young people severely criticized Klineberg's paper on the basis that they thought it was much too conservative and should have dealt with the avoidance of the violence of wars.

"Our group then traveled by bus (I sat next to Monod, and Lederberg) to the Svenska Handelsbanken (across the street from the Grand Hotel) where we attended a reception and dinner in the executive dining area. I met and talked to Rune Höglund (President) and E. Lindström (Vice President) of Svenska Handelsbanken, a private institution with more than 500 branches throughout Sweden. At dinner I sat next to the hostess, Mrs. Höglund. Dr. Anders Osterling, a Swedish author and member of the Swedish Academy, sat on the right of Mrs. Höglund so I had the opportunity to talk to him. Nils Stahle spoke the traditional Swedish word of greeting at the beginning of the meal and near the end Mr. Höglund gave a little talk on behalf of the Svenska Handelsbanken, which included a discussion of the Swedish economy. After the dessert, because of my position to the left of the hostess, I gave the traditional little talk, 'Tak för Matten' (Thanks for the food) on behalf of the guests. I attributed my assignment for this task to my Swedish background, thanked the officials of Svenska Handelsbanken for their hospitality and recalled their role in handing out the checks to Nobel Prize Winners, thanked them for the table gift to each of us (a charming hourglass), and thanked those responsible for the Nobel Symposium and suggested that the addresses of the participants be circulated so we could keep in touch with each other. We then rode back to Södergarn on the bus. I sat next to and became better acquainted with the poet, Wystan H. Auden."

"Thursday, September 18, 1969 - Stockholm

"At breakfast I sat at a table with Salam and Doxiadis. Doxiadis described to me his huge urban planning organization, which has 700 employees, is centered in Athens, and has offices in cities all over the world with a second center in Washington.

"I attended the morning session on 'Free or Directed Research - A Choice for the Individual and for Society.' Pregel was Chairman. The session opened with the playing of a satirical tape (criticizing the staid, rigid form of the Symposium) by the youth group.

"Hayashi spoke on 'Conscious and Unconscious Innovation' and King spoke on 'Science Policy - Changing Concepts.' King said he thought no country had a good working science policy, but each only did the best it could under a makeshift operation. Central allocation of resources for science does not seem to work. He referred to and described the Club of Rome. He called for a World Academy, consisting of leaders in the natural sciences, social sciences and humanities with emphasis on multidisciplinary backgrounds.

"Tata then spoke and emphasized the need to get down to cases and deal with the world's problems, perhaps by issuing an appropriate statement. He emphasized the plight of people like those in Bombay and Calcutta and the need to deal with it.

"During the coffee break I was interviewed (on tape) by Richard J. Litell of the US biweekly newspaper *Medical Tribune*. I described the Fusion Torch concept and summarized the highlights of my talk on 'Science, Technology and the Citizen.'

"At the next part of the session, with Harrison Brown as Chairman, Salam spoke on 'The Advancement of Science for the Developing Countries' and Lasswell spoke on 'The Prospects of a World University.' He described this proposal. He also commented on the proposal for a 'World Academy of Arts and Science' and indicated it was consistent with a World University. The World University would not have a single campus - it would have many campuses and would utilize special commissions to help mobilize and utilize knowledge. It would involve many fellowships and the participation of developing countries. Present proposals are interim steps to the ultimate goal of integrating the potential of man.

"In the discussion period Gunnar Myrdal said the real aim of American students is to reform US universities because much of the present research is supported by the State Department, DOD, and CIA and concerns chemical and biological warfare, etc. He is skeptical of the World Academy concept. All research is directed against the interests of the developing countries, e.g., the development of coffee substitutes. (Myrdal seems to be developing an increasingly strong anti-US attitude.) He doesn't favor a World University, thinks we should work within our existing institutions.

"I met at lunch and after lunch with a group to discuss coordination between the Nobel Symposium and the New York conference, 'Environment and Society in Transition,' to be held in April 1970 - present were Hedén, Bruner, Lasswell, Málek, Margaret Mead, Nilsson, Pregel, Tinbergen, and Waddington. There will be 100 attendees, 40 still to be chosen, and we will receive letters asking for suggestions. An honorary chairman is to be chosen and the names of David Blackwell and Carl Von Weizsacker have been suggested and we are to make suggestions. The problem of student participation needs to be worked out.

"I gave Arne Tiselius a copy of a suggested draft for a Symposium statement.

"I met and talked to Professor Sven Brohult (Managing Director of the Swedish Academy of Engineering Sciences). He invited me to their anniversary meeting on October 24, but I told him that I would be unable to attend.

"I participated in a taped interview for Swedish radio by Per Ragnarson, involving Mikhail D. Millionshchikov and Professor Bo Lehnert (Royal Institute of Technology in Stockholm) on the Fusion Torch concept and the progress in controlled fusion research in the United States, the Soviet Union and Sweden.

"I then attended the afternoon discussion covering especially the concept of World University. Lambo felt his people would not favor it because of need to solve local problems; i.e., put more international spirit into local universities first. Doxiadis spoke in favor of the World University. Gombrich spoke eloquently about a need for focus for the Symposium, and he criticized the students' omnibus opposition to defense efforts, citing the Israeli-Egyptian problem as an example. Salam said birth control in poor countries is held back by need for children to support their parents in old age - he did say, however, that these people would use the birth control pill if it were available. Myrdal then rose to say he is not against the World University but we shouldn't avoid the real issues which are the concentration of power, etc. - we should take up the fight to change the universities.

"I was interviewed on tape by Mrs. Langren of Swedish Radio on the US military-industrial complex, military control of research in the United States, etc. - I said that this is a much exaggerated and misleading view.

"I took an hour's hike on the Södergarn trails to Fågelöudde.

"I read AEC papers before and after dinner, which I ate in the more or less deserted dining room - most of the participants had gone in to Stockholm to attend the Opera performance at the Drottningholm Court Theater."

"Friday, September 19, 1969 - Stockholm to Washington

"I rode to the Arlanda Airport for the flight home. Olof Bloom was at the airport to see me off. He had a present for Helen (purchased by Eivor, Tora, and Ingrid), which I asked him to mail. He gave me a present for Eric

(my son) - a knife with a hand-tooled case purchased from a Lapp-Gubbe (old Laplander). He told me that Tora's mother was a sister of my grandfather, Adolph Eriksson. He recalled our first meeting at a gathering of relatives at a restaurant in Stockholm on December 13, 1951. He is a friend of Lars Aldrin, a cousin of the US astronaut, 'Buzz' Aldrin."

Upon my return to the US, I sent my customary trip report to the President in a letter dated October 7, 1969, which included the following remarks on this visit to Sweden:

"The Nobel Foundation symposium on 'The Place of Value in a World of Facts' was attended by 45 invited scientific leaders from all over the world, including many who have been critical of United States policies. The conference sessions were closed, but were followed by daily press briefings. In addition to the presentation of a paper, which I am enclosing, I was frequently called on to defend US policies both in the conference sessions and in the outside press briefings. My participation along with that of some other sympathetic Westerners helped avoid the adoption by the conference of resolutions criticizing US policies and actions.

"In my discussion with Prime Minister Erlander, I expressed our hope that Sweden, as a leading neutral nation, would complete its ratification of the Non-Proliferation Treaty, as an example to others. The Prime Minister expressed interest in the view that Swedish moral leadership could exert a significant influence on the actions of some other nations, and requested that the matter of accelerating Sweden's ratification be reviewed. The Prime Minister also agreed to my request that Sweden initiate trilateral negotiations with the IAEA and the United States for the transfer to the IAEA of safeguards over nuclear materials which we supply for Sweden's peaceful nuclear program. These negotiations have been delayed for some time, despite Sweden's agreement in principle to such a transfer, because of Swedish concern that IAEA safeguards would interfere with its nuclear trade with the Euratom countries."

The Nobel Symposium was a stimulating and rewarding experience, and I felt fortunate indeed that I could participate. The time in Stockholm was rewarding also, I think, from the point of view of US policies. I believe that the clarification of our positions I was able to provide in my conversations with Erlander and Mrs. Myrdal contributed constructively to their thinking on the questions of NPT ratification and IAEA safeguards. Not long after my visit, Sweden did decide to go ahead with ratification of the Treaty, as we had hoped, without waiting for such action by the United States and the Soviet Union. The Swedish instrument of ratification

was deposited on January 9, 1970 - almost two months before those of the United States and the USSR.

With respect to IAEA administration of the safeguards covered by the US-Sweden bilateral agreement, matters did not progress so fast. However, after the NPT came into force on March 5, 1970, it was evident that Sweden was giving greater consideration to the matter. Active negotiations were initiated that led finally to a trilateral agreement (signed in Vienna March 1, 1972) providing for the application of Agency safeguards on nuclear materials and equipment transferred from the US to Sweden under our bilateral. Meanwhile, Sweden had indicated its intention to negotiate an agreement with the Agency pursuant to Article III of the NPT, the article which commits non-nuclear weapon states party to the Treaty to accept IAEA safeguards.

The Agreement committing Sweden on the safeguards matter was signed on October 22, 1970. Two more occasions for interesting contact with Swedish dignitaries in Washington presented themselves prior to its signing, as my journal records:

"Sunday, June 7, 1970 - Washington, D.C.

"Helen and I attended a reception given by Ambassador and Mrs. Hubert de Besche in honor of Prime Minister Olof Palme at the Swedish Embassy Residence. In my brief conversation with Palme he said he hoped that I was satisfied with the progress that Sweden had made in furthering the cause of safeguards to prevent nuclear weapon proliferation; I said I was. I told him I thought he had done a good job on 'Meet the Press,' a show that I had seen this afternoon, which seemed to please him. Among those we saw at the reception were: Judge and Mrs. Luther Youngdahl, Blake and Deanna Clark, the Carl Bagges, the Horace Josephsons, Ambassador Dobrynin, Phil Handler, Bo Jonsson, and the Rolf Andreassons (Scientific Attaché, Swedish Embassy). We had a very interesting talk with the Youngdahls, reminiscing about his role in performing Lynne and Bill's marriage ceremony (their second anniversary will be a week from this coming Monday). I talked to Ambassador Dobrynin who urged me to accept Chairman Petrosyant's invitation to visit the Soviet Union this summer or fall."

"Saturday, October 3, 1970 - Washington, D.C.

"Helen and I went to the Swedish Embassy to attend a reception for Crown Prince Carl Gustaf. I had a rather long talk with him about my visit to Sweden last September to participate in the Nobel Symposium. I described my Swedish ancestry and general contacts with Sweden. I told him I would send him a copy of my booklet, 'Peaceful Uses of Atomic Energy.' We were entertained by the Royal Uppsala University Chorus of Sweden, the Orphei Drangar, which is on a US tour, with

Eric Ericson conducting. I also spoke with Karl Öbrink, Managing Director of the Orphei Drangar, the Luther Youngdahls, the Robert F. Woodwards (former Ambassador to Spain), the Bo Jonssons, the Edward Days, Julie Hehns, Karl Gruber (Ambassador from Austria), the Chalmers Robertses, the Richard Harknesses, and Fred Singer."

"October 22, 1970 - Washington, D.C.

"At 4:30 p.m. I went to the State Department (office of Assistant Secretary Martin J. Hillenbrand) to participate in the signing ceremony for the Amendment to the Agreement for Cooperation in the Civil Uses of Atomic Energy with Sweden. Those signing included Ambassador Hubert de Besche for Sweden, Martin J. Hillenbrand (Assistant Secretary of State for European Affairs) and myself. Others present were John P. Trevithick (Acting Director, Office of Atomic Energy Affairs, Bureau of International Scientific and Technological Affairs, State Dept.), Charles I. Bevans (Legal Adviser/Treaty Affairs, DOS), George M. Ingram (Country Director) and William Bodde, Jr. (Swedish Desk) of the State Department, Anders Olander (Second Secretary, Swedish Embassy) and Bill Yeomans (DIA)."

By this Amendment, the Agreement increased the amount of U-235 that the US was authorized to transfer to Sweden from 50,000 kg to 122,300 kg; it also provided that the IAEA would be asked to assume responsibility for applying safeguards to the transfer of nuclear materials, and this would "be accomplished either by means of an agreement among the two Parties and the Agency or by means of arrangements made a part of an agreement between the International Atomic Energy Agency and the Government of Sweden pursuant to Article III fo the Treaty on the Non-Proliferation of Nuclear Weapons."

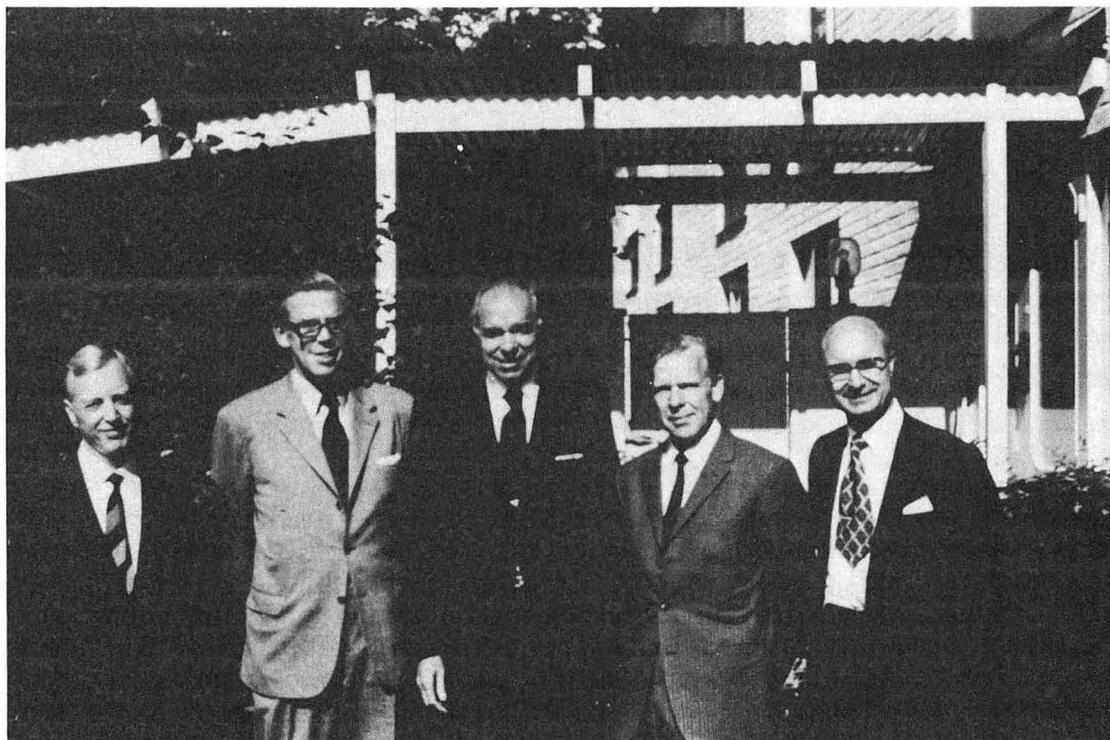
The 1969 trip was my last to Sweden as USAEC Chairman. At the IAEA General Conferences of that and the following years, of course, I had opportunities for talks with Swedish representatives in Vienna; and when serving as President of the Fourth Geneva Conference on the Peaceful Uses of Atomic Energy, in September 1971, I often spoke with Eklund several times daily. It was in Geneva, in a conversation with Bo Aler, that the subject arose of another visit to Sweden:

"Monday, September 13, 1971 - Geneva

"I met with Bo Aler (Director, the Swedish Atomic Energy Company) from 4 p.m. to 4:30 p.m. He invited me to come to Sweden next year to give a lecture on nuclear energy at Studsvik and lectures on scientific subjects (e.g., transuranium elements) at universities. I mentioned September, the time of my visit to Moscow, and June, the time of the International Symposium on the Environment in

Stockholm (in case I wind up going there) as preferable dates if I accept his invitation. I said I would let him know in a few months. We also discussed the problems, not as serious as in the United States, that nuclear power is having with environmentalists in Sweden. He said Sweden is interested in concept of multinational European enrichment enterprise (gaseous diffusion) and said he has discussed this with our people..."

As it turned out I visited the Studsvik Laboratory on September 11 and 12, 1972, when I made a tour of the various experimental areas and delivered the annual Studsvik Lecture. This also gave me the opportunity to have a reunion with three Swedish nuclear chemists who had worked with me in the Radiation Laboratory at Berkeley during the late 1940s and the 1950s - Jan Rydberg, Lennart Holm, Gosta Rudstam (now working at the Studsvik Laboratory), and with Wilhelm Forsling, another long time nuclear chemist friend who has paid me a visit in Berkeley.



XBB 761-7013

At Studsvik Hotel, Sept. 12, 1972. (Left to right) Jan Rydberg, Lennart Holm, Seaborg, Gösta Rudstam, and Wilhelm Forsling.

CHAPTER 9

JAPAN

Since launching its atomic research program in the mid-fifties, Japan has advanced rapidly to a place among the leaders in peaceful nuclear applications.

When I became Chairman of the USAEC in 1961, Japan already had numerous nuclear organizations and well-equipped laboratories engaged in extensive research and development programs. Nine research reactors and two critical assemblies were in operation or under construction; two power reactors were under construction. The many activities under way included heavy water production research, thermonuclear research, an atomic ship project, long-range nuclear power planning with a view to the installation of 7 million kilowatts by 1975, and excellent training facilities, such as a radioisotopes techniques school in Tokyo, which was open to participants from other countries in the Far East and Southeast Asia.

Cooperation with the United States under our country's Atoms-for-Peace program has been a major factor in Japan's impressive advances in nuclear technology. An initial Agreement on Cooperation in Civil Uses came into effect on December 27, 1955. This was superseded by a comprehensive research and power agreement which became effective December 5, 1958. A US research reactor grant of \$350,000 was committed in 1957 for a reactor at Japan's Atomic Energy Research Institute at Tokai-Mura; and US consultants assisted in the development of Japan's research programs. By late 1960 material transfers from the United States included four shipments of research reactor fuel, small quantities of other special nuclear materials for research, and 1,120 shipments of radioisotopes. A US depository library had been established in Tokyo. Taking full advantage of training opportunities offered by the United States, Japan had sent more participants and observers than any other nation to our atomic energy installations and facilities.

Our peaceful nuclear cooperation with Japan was well advanced, then, at the time I assumed my USAEC responsibilities. This cooperation continued and expanded in the succeeding years. In 1962 arrangements were made for technical exchanges in the field of ceramic nuclear fuels. Also, on December 12, 1962, I was paid a courtesy call by officers of the Japan Atomic Power Company – R. Sagane (Managing Director, and an old Berkeley friend), Dr. Ipponmatsu (President), Mr. Shimoyama (Legal Staff), Mr. Yoshicka (Director and Manager of Engineering), and Mr. Imai (Dept. Chairman, Research and Scientific Engineering) – and Mr. Haginoya, Atomic Energy Attaché of the Japanese Embassy.

The following year an amendment to our 1958 agreement was signed that gave greater flexibility to the materials provisions of that agreement. Meanwhile, Japan's research and development programs progressed rapidly. In 1963 its US-built Power Demonstration Reactor (JPDR) achieved criticality – the first reactor to supply nuclear-generated electricity to the Japanese grid. That same year, during the period of the Seventh IAEA General Confer

ence in Vienna, I attended the signing on September 23 of the first US-Japan-IAEA trilateral agreement providing for Agency administration of safeguards applicable under our bilateral agreement.

During these years I was able to meet with Japanese representatives not only at the annual IAEA assemblies, but also at Geneva in 1964, at the Third International Conference on the Peaceful Uses of Atomic Energy, and in the United States. In the course of the Geneva meeting, it was my pleasure to have Japanese AEC Commissioner Sakuji Komagata among my guests on the US nuclear ship *Savannah* on September 3, 1964. His participation on that occasion seemed particularly appropriate in view of Japan's own progress in the field of nuclear maritime propulsion; the Japanese exhibit at Geneva included a model of its first nuclear-powered ship, then in the design stage.

A few months later, in Washington, I had an opportunity for a brief talk with Japan's Prime Minister Eisaku Sato, who had formerly headed the Japanese Atomic Energy Commission and had represented Japan at the 1963 IAEA General Conference. The setting for our conversation was a reception in the Prime Minister's honor given on January 13, 1965, by the Japanese Ambassador and Mrs. Takeuchi. Among the topics we touched on were the arrangements being made to hold the IAEA's Ninth General Conference in Tokyo the following fall. This would be the first such conference held elsewhere than in Vienna. I was of course eager to attend; but as I indicated in response to a question by the Prime Minister, I could not be sure this would be possible. Fortunately, plans did work out as hoped, and my first visit to Japan took place in September 1965.

In the meantime I had another opportunity for contact with Japanese nuclear officials when I hosted a luncheon, on April 30, 1965, for Commissioner Kinichi Aoki of the Japanese Atomic Energy Commission, including Otajimi of Tokyo Electric Power Company, at the International Club in Washington. Others present were Ambassador Ryuji Takeuchi, the Commissioners, and staff.

The IAEA Conference in September, like other such gatherings, permitted useful personal discussions with delegates from many countries. Naturally, however, I was especially eager on this occasion to take advantage of the location to meet with Japanese officials concerned with nuclear matters, visit some of their facilities, and see something of their country. Also, I had agreed to address Japan's Atomic Industrial Forum, whose annual meeting was scheduled to take place during the period of the IAEA Conference. My time was, of course, limited by IAEA concerns in Tokyo and a schedule of post-Conference visits in other countries, but I managed to achieve my principal objectives. Here are some excerpts from my journal account of that 1965 trip, which started with my first visit to a distant part of my own country:

"Friday, September 17, 1965 - Washington to Anchorage

"After saying goodbye to family, spent a couple of hours in H Street Office and then went to Baltimore Airport. My assistant Arnold Fritsch and I flew to Chicago, and then,



XBB 761-7025

Sukuji Komagata with Seaborg on NS Savannah in Sweden, Sept. 4, 1964.

with Assistant Secretary of Interior Ken Holum, to Anchorage, Alaska. Fritsch and I were driven around Anchorage to see the areas of the March 1964 earthquake. Most of the damage has now been repaired. Plane was 2½ hours late in take-off waiting for connecting plane from Seattle. Left 8:30 p.m."

"Saturday, September 18, 1965 – to Tokyo

"Arrived Tokyo about 11:00 p.m., September 18, after crossing international date line.... Met by Peter Morris (USAEC Scientific Representative in Tokyo), Minister John K. Emmerson (Deputy Chief of Mission, US Embassy), Frank Scott (USIS Press Representative), JAEC Commissioner Komagata, Tohru Haginoya (former Scientific Attaché to Japanese Embassy, Washington), and Algie Wells of USAEC. Checked into Hibiscus Suite, Tokyo Prince Hotel."

"Sunday, September 19, 1965 – Tokyo

"...Morris drove Fritsch and me on a sightseeing trip. First we visited the Great Buddha (built in 1252 AD, 44 feet tall, 121 tons) at Kamakura. Drove to Hakone National Park and drove up mountain where we had picnic lunch at Ashimoko Country Club, 4,000 ft altitude (a golf club with spectacular views, including view of Mt. Fuji). Took movie with Mt. Fuji in background. Drove around beautiful Lake Ashi (also known as Lake Hakone) and then to Hakone Shrine (Shinto). Hakone National Park about 60 miles from Tokyo. Had dinner at Sanno Hotel in Tokyo (a US Forces Headquarters and site of PX, etc.)."

"Monday, September 20, 1965 – Tokyo

"Had meeting in US Delegation Quarters, 4th floor of Prince Hotel, with Henry Smyth, Verne Lewis, Isidor Rabi, John Hall, and Fritsch to discuss plans for US Delegation meeting and for IAEA Conference in general. At 10:00 a.m., presided over meeting of US Delegation. Ambassador Edwin Reischauer spoke on situation in Japan.

"Gave well-received talk to Japan Atomic Industrial Forum on 'US Civilian Nuclear Power Program – Status and Program' at 3:45 p.m. Received gift of tie clasp with pearl from Mr. Reinosuke Suga, President, Japan Atomic Industrial Forum, and obi (sash for kimono) from Mr. Seinosuke Hashimoto, Senior Managing Director of Japan AIF. Symposium at which I spoke was held at Tokyo Metropolitan Festival Hall in Ueno Park. I heard Sir William Penney speak just before me – Andronik M. Petrosyants spoke before I arrived.

"We passed the Imperial Palace and the National Diet Building on the way back to our hotel. Went to garden party given by Japan AIF at Chinzanso Garden, and then to dinner given by Koichiro Asakai (former Japanese Ambassador to United States, who will be elected President at the 9th

General Conference of the IAEA) at Hilton Hotel; only about eight at dinner including Minister Emmerson, Professor Takashi Mukaibo (University of Tokyo), and Haginoya."

"Tuesday, September 21, 1965 - Tokyo

"After spending an hour in our Delegation Office went to TV station NHK, Japanese Broadcasting Corporation, where after meeting NHK President Maeda, I participated in taping of an hour show with Professor Mukaibo, moderator; Hassan M. Tohamy, Vice Chairman of the Board of IAEA Governors, from the United Arab Republic; and Gunnar Randers, Norway, on peaceful uses of nuclear energy. For broadcast on Channel 28, 9:00 p.m. Wednesday. Petrosyants cancelled his scheduled appearance. I emphasized contributions to peace by our international program of cooperation. Then attended opening session of IAEA in Providence Hall on 3rd floor, where outgoing President H. F. Eschauzier of the Netherlands opened the 9th General Conference and gave a short speech, followed by a speech by Japanese Prime Minister Eisaku Sato. Then came the election of Asakai as President of 9th Conference, followed by a short speech by Asakai...."

"Wednesday, September 22, 1965 - Tokyo

"....Met in my rooms with Kiichi Aichi (former Minister of Education and former Director of the Science and Technology Agency, and a friend of Prime Minister Sato) and his associates, along with USAEC Commissioner John Palfrey, Myron Kratzer (Director, USAEC Division of International Affairs), Charles Thomas of the Department of State, and others, to discuss Japan's role in non-proliferation...."

In this meeting Mr. Aichi was accompanied by Professors Keichi Oshima and Mukaibo of Tokyo University's Nuclear Physics Department and Mr. Okita of the Japanese Economic Development Bureau (a non-governmental agency). With me, in addition to those mentioned above, were Peter Morris and William H. Bruns, First Secretary at the US Embassy in Tokyo.

Emphasizing the fact that he was speaking as a private citizen, Aichi stated that since China's explosion of an atomic bomb on October 16, 1964, some Japanese believed that Japan should develop nuclear weapons. Aichi said that he personally thought this would be a mistake, but he was interested in my view whether Japan had the ability to do so. I replied that Japan definitely did have the technical ability to produce a weapon over the next five years or so, but that I admired the country's decision not to take that step, which I felt would contribute to the possibility of nuclear war.

After a discussion of various aspects of safeguards application and its significance in relation to the ultimate objective of a comprehensive test ban with adequate inspections, Aichi asked what Japan could do to collaborate with us. In view of the Soviet proposal (for a resolution to outlaw nuclear weapons) made in the IAEA General Conference that morning, Aichi felt that Japan should do something dramatic. In response, I said

that in my opinion his country had taken the first step by transferring to the IAEA safeguards responsibilities pertinent to its bilateral agreements with the United States, the United Kingdom, and Canada. I suggested that the next fruitful step would be for Japan to submit its entire atomic energy program to Agency safeguards. My colleagues and I expressed the view that this would be a very dramatic and important move indeed. Aichi did not say whether he favored such a step, but he seemed glad of the opportunity for our talk. Neither of us had reason to anticipate that 4½ years later we would be discussing safeguards again in a different context, when he received me in his capacity as Japan's Foreign Minister in 1970.

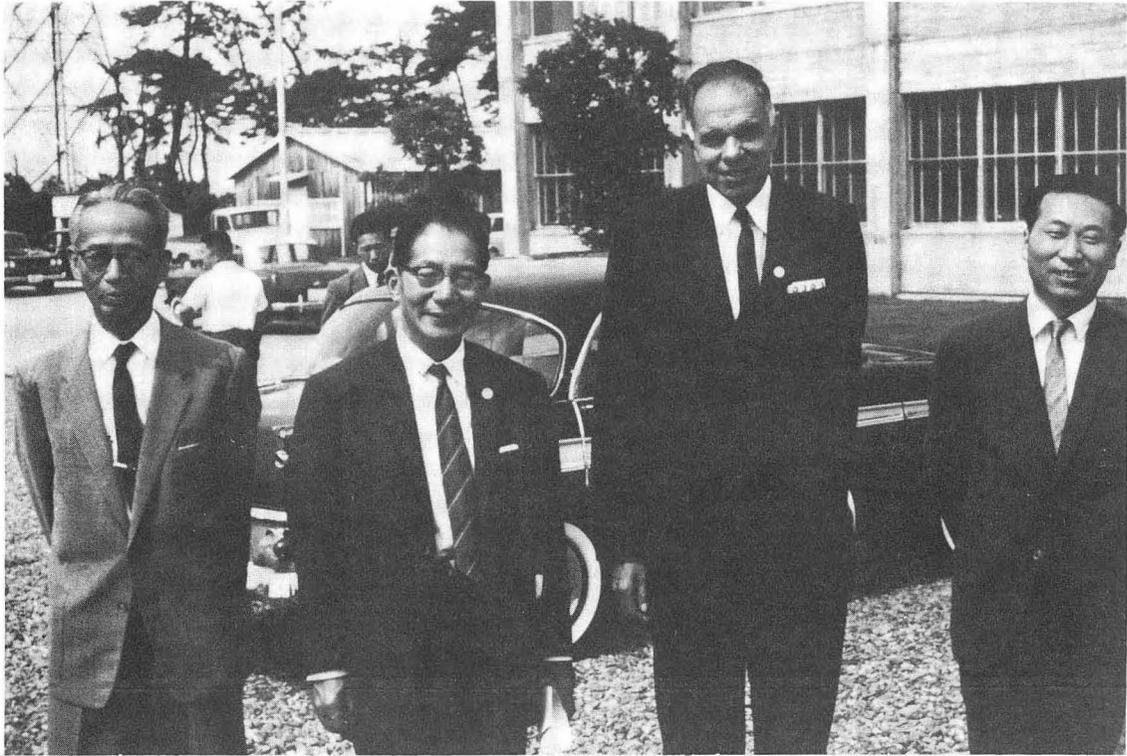
The day following our meeting with Aichi, my colleagues and I had an opportunity to visit Japan's principal research center. Here I had the pleasure of seeing my friend Ryokichi Sagane, whom I had known during his stay at the Radiation Laboratory at Berkeley in the late 1930s.

"Thursday, September 23, 1965 – Tokyo

"Went by two helicopters – I flew in small four-seater – to Japan Atomic Energy Research Institute at Tokai-Mura along with Jim Ramey (USAEC Commissioner), Palfrey, Fritsch, Bob Hollingsworth (General Manager, USAEC), Morris, John Vinciguerra (Hollingsworth's Executive Assistant), Kratzer, Hall, and others. Flight passed over heart of Tokyo and then flew about 50 miles northwest to Tokai-Mura at seacoast. Upon arrival met Seiri Kawabata, General Manager of Tokai Construction Office, Japan Atomic Power Corporation (JAPCO), and Ryokichi Sagane. Visited Japan Research Reactor 2 (JRR2, a CP-5 reactor – this is the reactor assisted by a US grant); JRR3 (first reactor built by the Japanese, by a group of five companies – 10 MW, natural uranium metal fuel, heavy water cooled and moderated); Plutonium Laboratory, where Keiji Naito, who worked with Cunningham in Berkeley in 1958, showed me his dry actinide chemistry lab and other labs (I promised to send them some Cm-244; they believe they have produced Cm-VI using Cm-242 tracer); the Japan Power Demonstration Reactor (General Electric Boiling Water Reactor, 12.5 MWe); Plutonium Fuel Development Lab, operated by Japan Atomic Fuel Corporation, to make uranium-plutonium oxide when it opens in December 1965 (they are hoping to get plutonium from United States).

"Attended dinner given US group (Commissioners and staff) by Japanese AEC. Chairman Shokichi Uehara was host. I gave a short speech in response to his. We discussed the Japanese program and extension of our bilateral agreement...."

With respect to our bilateral agreement, Japan was interested not simply in extending it but, especially, in expanding its scope to assure fuel supplies for the large Japanese power reactor program. Rather than extend or amend the 1958 agreement, the decision was made to conclude a new bilateral. Negotiations in this connection went forward during 1966 and 1967. Meanwhile our established cooperative activities continued, augmented by a technical exchange arrangement in the area of reactor safety.



XBB 761-7027

Visit to Japan Atomic Energy Research Institute, Tokai-Mura, Sept. 23, 1965 (Left to right) Seiri Kawabata, Ryokichi Sagane, Seaborg, Keiji Naito.

Upon my return to Washington, I reported to the President in a letter dated October 7, 1965; this letter gave the following summary of the Ninth IAEA General Conference:

"This is to report on highlights of the Ninth General Conference of the International Atomic Energy Agency, held in Tokyo, September 21-28, at which I served as the United States' Representative...

"The General Conference adopted a US-originated resolution to note with approval a revision of the international safeguards system which prevents the diversion to military uses of nuclear materials and equipment which are supplied for peaceful uses and subject to IAEA safeguards. The revised system adheres substantively to the system earlier approved but is cast in simpler and more straightforward language. The resolution, which was adopted without vote by the General Conference, had been earlier approved by the Conference's Administrative and Legal Committee by a vote of 54 for, 1 against (Indonesia) and 2 abstentions (Nigeria and Pakistan). Indonesia said, in explaining its vote, that although it had opposed the resolution, as a member of the IAEA in good standing it would abide by the decision of the Committee. Following approval by the Conference, the system was put into effect by the IAEA's Board of Governors on September 28.

"A US-sponsored resolution was approved, as part of the 1966 budget, requesting the IAEA Director General, in concert with the United Nations and specialized agencies, to study ways in which the IAEA might strengthen its efforts in the development of desalting, and calling on member states to continue to inform the IAEA of all significant developments relating to the use of nuclear energy in desalting.

"Dr. Sigvard Eklund of Sweden was reappointed by acclamation to serve as Director General of the IAEA for another four years.

"The Soviets introduced a politically-inspired resolution in the Conference calling for prohibition of nuclear weapons and total disarmament. The US Delegation, in anticipation of this move, had arranged for a US resolution also to be introduced pointing out that the IAEA, a technical and scientific agency, should not discuss political issues that were more appropriate for consideration in the United Nations and other international organizations. After extensive negotiations with several delegations from Asia and Africa, the Indian delegate proposed that since the IAEA was not a political organization the two resolutions should be postponed. The Soviet delegate agreed, but made a strong anti-American speech in which he commented on the failure of the negotiations in Geneva and specifically charged the US with considering the use of nuclear weapons once again. Ambassador Smyth made an effective statement for the US in which he categorically denied

the Soviet charges and pointed out the long and consistent history of US support for general and complete disarmament under effective international control. The Conference then adopted the Indian proposal to postpone consideration of both resolutions.

"Despite these political difficulties with the Soviets, my personal relations with the Soviet representatives continued to be open and friendly, and there was general agreement, including the Soviet representatives, that the Agency was carrying out its programs in an effective manner. Moreover, the Soviets have continued to give their support to the Agency's more important substantive activities, including safeguards."

My next contact with the Japanese was on another matter: In March 1967 I was visited in my Washington office by a Japanese utility delegation. My journal records:

"Wednesday, March 15, 1967 – DC Office

"At 10 a.m. I met, along with Julie Rubin, Myron Kratzer, and R. Glenn Bradley, with Naojiro Tanaka (Managing Director, Tokyo Electric Power Company, Inc.), Masayoshi Iida (General Manager, Kansai Electric Power Company), and Tohru Kiruchi (Japanese Embassy). Tanaka expressed greetings from Commissioner Kinichi Aoki, of the JAEC, and explained that a group of Japanese utility representatives is touring the US, Canada, and Europe in connection with their interest in nuclear fuel for power stations. He indicated that he would talk through Mr. Kiruchi as interpreter. A number of items were discussed as outlined: (1) The status of the US/Japanese Agreement – they understood that a new agreement was being negotiated for the one that expires in June 1967. Kratzer and Bradley explained that discussions had already been held and it appears that a new agreement will be available in a timely manner. In answer to a specific question, Mr. Tanaka was assured that the new agreement will provide for direct negotiations between Japanese utilities and US industry for nuclear power plants and fuel. (2) Mr. Tanaka referred to statements that the US had a five-year stockpile of nuclear fuel, and inquired about long-term commitments after this. He stated that Tokyo Electric had purchased a 460 MWe reactor from GE and had also contracted for the first and second core, but after this the company would be interested in long-term contracts for the fuel. I indicated that this is a complicated subject, but we are confident that sufficient fuel will be available for their long-term needs. Kratzer stated that this particular subject will be discussed in considerable detail during the day. (3) Tanaka inquired as to how long I thought \$8 uranium will be available. I responded that probably for a few more years in the US, but since Japan has access to Canadian and other

foreign markets, they may find a more favorable picture from these sources. (4) I stated that we are looking forward to development of advanced reactors, including breeders and near breeders, which would minimize or eliminate concern about a rise in ore price. Tanaka indicated that prior to his departure from Japan his government announced the formation of a new organization to study advanced reactors, and that assistance from the US would be appreciated. Kratzer stated that we are already exchanging information in a number of areas of reactor technology. I indicated that it may be worthwhile providing for specific exchanges in advanced reactor technology in the new agreement."

To return to the matter of our bilateral agreement with Japan, the JAEC's desire to expedite the completion of a new bilateral was one of several subjects discussed at a 1967 meeting in Vienna, the day after the opening of the 11th General Conference of the IAEA:

"Wednesday, September 27, 1967 - Vienna

"...Commissioner Gerald Tape, Herman Pollack of the State Department, Jack Vanderryn of our mission to the IAEA, Myron Kratzer, and I then met in the conference room of the Hofburg with Susumu Nikaido, new Chairman of the Japanese Atomic Energy Commission, Minister of State, and Director General of Science and Technology Agency; Japanese Ambassador to Austria Shinsaku Hogen; and Hiroshi Murata, Atomic Energy Bureau of Japan. We discussed the following items:

"1. They are in the process of negotiating with us the renewal of the US-Japan Bilateral Agreement. Their team will come to the United States next month (October) for the negotiations. They want to move as fast as possible in order to get the approval of their Diet in time to have it go into effect by the end of the year, or by the end of January 1968.

"2. They need five tons of plutonium, two tons to come from their own reactors, and three tons, they hope, from the United States, beginning in 1969. They would like to have this covered by the new bilateral agreement. We said they should state the smaller amounts needed by 1970 and we would try to include these in the bilateral agreement.

"3. With respect to the non-proliferation treaty, they feel safeguards should apply to nuclear powers as well as non-nuclear powers. I said this wasn't feasible now for all nuclear powers but the United States could contemplate this for its peaceful nuclear facilities. The extension of safeguards to peaceful nuclear facilities should follow the NPT, which is urgently needed before this could be effected.

"4. Regarding gaseous centrifuge enrichment technology, they haven't yet used UF_6 ; their work is in the early stage. Next year they will build bigger stages that will use UF_6 We noted that the present NPT text doesn't prevent developing gaseous centrifuge for peaceful purposes.

"5. They proposed periodic meetings between the United States and Japanese Atomic Energy Commission, alternating between the two countries as sites for the meetings. Meetings might be held at the rate of one every year or year and a half. We agreed, and I suggested that the first meeting be in the United States at the time of the signing of the new bilateral agreement. Nikaido will discuss this with their Foreign Ministry and let us know. We said we also need to confirm this arrangement with the US Government.

"Murata, acting on behalf of his group, gave me a beautiful little table screen (cloisomé)."

Negotiations on the new US-Japan Agreement for Cooperation were completed soon after the Vienna discussion reported above, and the Agreement was signed in Washington on February 26, 1968 (to become effective July 10). The Japanese Ambassador in Washington, Dr. Takeso Shimoda, signed on behalf of his Government while Secretary of State Dean Rusk and I signed for the United States, in a ceremony at the US Department of State, witnessed by USAEC Commissioners W. E. Johnson, G. F. Tape, and J. T. Ramey, Congressman Chet Holifield, and Charles Bevans (of the Department of State).

The first USAEC-JAEC meeting took place not at the time of the signing of the new bilateral, as was first considered, but in mid-July of 1968, a few days after that agreement came into force. Apart from the need for an overall review of our established cooperative activities, many developments of the previous months made our meeting then particularly timely. In the spring of 1968 a third technical exchange arrangement with Japan had been initiated, this one in radiation chemistry. Consideration was being given to the feasibility of exchanges also in the field of fast breeder reactor development and other areas. Other topics of current interest included such matters as a Japanese request for a large additional supply of heavy water, Japanese concern regarding the US price of plutonium, and questions related to IAEA safeguards application under the NPT.

The group that came from Japan to attend the meeting, held July 15 and 16, at our H Street Headquarters in Washington, DC, was headed by Dr. Naotsugu Nabeshima, who in November 1967 had succeeded Nikaido as Minister of State in charge of the Science and Technology Agency and Chairman of the JAEC. He was accompanied by Hironori Itoh, Counselor from the Japanese Embassy; JAEC Commissioner Tasaburo Yamada; Japan Atomic Energy Bureau Director Tsuneo Fujinami; Minister Nabeshima's secretary, Takashi Ishikawa; and three officials of the Government-owned Power Reactor and Nuclear Fuel Development Corporation (PNC); Director General Goro Inouye, Director Hiroshi Murata, and Secretary Kunihiko Uematsu. Representatives of the USAEC attending some or all of the sessions were Commissioners James T. Ramey, Gerald F. Tape, Wilfrid E. Johnson, and I; Deputy General Manager



XBB 761-7027

Signing Ceremony for US-Japanese Bilateral Agreement for Cooperation, US Department of State, Feb. 26, 1968. (Left to right) at table Japanese Ambassador Takeso Shimoda, Secretary of State Dean Rusk, Seaborg; standing, Commissioner W. E. Johnson, Congressman Chet Holifield, Commissioner J. T. Ramey, Commissioner G. F. Tape, Charles Bevans.



XBB 761-7028

USAEC Commissioners meeting with Japanese AEC officials, Washington, D.C. headquarters, July 15, 1968. (Left to right) Hironori Itoh, Tsuneo Fujinami, Tasaburo Yamada, Naotsugu Nabeshima, Seaborg, Goro Inouye, Hiroshi Murata, J. T. Ramey, W. E. Johnson, G. F. Tape.

Edward J. Bloch; Assistant General Manager for International Affairs Myron B. Kratzer, and certain Division Directors and staff members as appropriate to the various subjects taken up.

As expected, our discussions were extremely useful. In the course of the first day's meeting, Minister Nabeshima and I initiated a draft "agreement in principle" to work toward a technical exchange arrangement in fast breeder development. The two Commissions agreed also to plan future cooperation in food preservation by irradiation and the utilization of plutonium in power reactors.

During our joint meeting, we exchanged views and information on our respective nuclear power programs and a broad range of subjects as well as on specific current concerns. The discussions were particularly useful in affording an opportunity for clarifying US policies regarding materials supply. For example, we explained that while we could probably fill Japan's request for 23 tons of heavy water to be supplied by 1969, we could not commit ourselves on the additional 110 tons requested by 1973: we had already received other advance requests and, in accordance with our first-come-first-served policy, we would have to wait and see how the supply situation developed. Regarding plutonium, we explained that our policy, in effect at the time, of authorizing purchase from private US suppliers of no more than 50% of the total quantity obtained from the United States (with the balance purchased from the USAEC at \$43/gram) enabled our various cooperating partners to buy at the market price as the material became available. We indicated our belief that eventually plutonium supplies would be such that our 50-50 proviso would no longer be necessary. (This proviso was, in fact, eliminated at the end of 1970.)

As anticipated, the Japanese delegation raised the question of safeguards, expressing interest in moving toward a simplified IAEA system. Commissioner Tape stated our view that the system should be a continually evolving one, that the United States was fully committed to achieving the simplest and best safeguards system possible, but that we felt we should not delay what had already been achieved by waiting for further refinements. Regarding the NPT, Minister Nabeshima noted that Japan agreed in principle and that his Government was moving toward signing the Treaty eventually.

In personal conversations on July 15 with Minister Nabeshima - Myron Kratzer and Mr. Ishikawa were also present part of the time - I expressed the US concern with problems that had arisen with respect to the entry of US nuclear-powered warships into Japanese harbors. (In May 1968 there had occurred the "Sasebo" incident, when a Japanese monitoring boat reported abnormal readings near a US nuclear submarine at the US Naval Base in Sasebo Harbor. We were convinced that no radiation discharge from the submarine had taken place.) Mr. Nabeshima showed understanding of our concern; he seemed hopeful that a satisfactory solution to the present difficulties would be reached. Later the same day, at a press conference held on his behalf at USAEC Headquarters in Washington, the Minister responded to a question on the Sasebo incident by noting that the matter was now within the jurisdiction of the Foreign Ministry and not that of the Science and Technology Agency.

Pursuant to the understanding Minister Nabeshima and I initialed during the July 1968 meeting, plans were developed for exchanges in fast breeder reactor (FBR) technology. This "arrangement" was signed in Tokyo on March 4, 1969, by USAEC Commissioner Francesco Costagliola and Mr. Goro Inouye, whose company (PNC) was given responsibility for implementing the arrangement on behalf of the Japanese Government. The exchanges agreed on were initialed promptly in the four specific FBR areas and included: reactor physics, nuclear safety (information in this category would supplement that covered by our existing nuclear safety exchange arrangement), fuels and materials, and sodium technology. During the 12 months after the signing of the arrangement, an active two-way exchange of technical reports started; several PNC-sponsored specialists were assigned to USAEC facilities; and a "Specialists' Meeting on Reactor Physics" was held at our Argonne National Laboratory on December 10-11, 1969.

A second USAEC-JAEC meeting was held in Tokyo on March 24-25, 1970. As on the occasion of our first joint meeting, a number of matters made the opportunity for personal high-level discussions particularly welcome at this time. First, Japan had by now greatly expanded its nuclear power plant program. When our 1968 Agreement for Cooperation was signed, 13 plants using enriched uranium fuel were scheduled for construction starts by 1972. Based on this program, our bilateral agreement contemplated the transfer from the United States of a maximum of 161 tons of enriched U-235 (whether or not Japanese-owned natural uranium was supplied for toll enrichment), of which 154 tons would be for power reactors. Now, in the spring of 1970, the expanded Japanese program called for start of construction of a total of 17 units by December 1972 and another 28 units of which construction was tentatively scheduled to start over the years 1973-1979. The estimated total U-235 required to fuel these plants amounted to over 681 tons! The Japanese were understandably anxious to obtain assurances regarding the availability of this material. Committing ourselves to meeting the total long-range requirements indicated was not feasible in the light of our existing enrichment capability. We did not feel able to consider supply commitments with respect to reactors that would start construction by 1973.

In addition to uranium requirements, heavy water and plutonium supplies continued to be of special interest. With respect to plutonium, it appeared that we could now give serious consideration to the possibility of supplying large quantities of this material from USAEC stocks at prices below our established \$43 per gram. However, the heavy water situation was still uncertain in view of other requests for this material.

Foremost among other concerns was the subject of safeguards administration under the NPT. Japan had finally signed the Treaty on February 3, 1970, but seemed unlikely to ratify in the near future. A principal reason for delay was Japanese dissatisfaction with the Article III proviso for IAEA safeguards administration over source and special fissionable material in all peaceful nuclear activities of non-nuclear-weapon states party to the Treaty. The Japanese still objected to the IAEA safeguards system as too complex and probing; they argued that it represented a threat to the security of proprietary information and an interference with industrial

operations, as well as considerable extra expense. They felt that their own national verification system should be regarded as sufficient. Knowing that the European Atomic Energy Community (Euratom) was negotiating with the IAEA concerning the possible future relationship between the Euratom and IAEA safeguards systems, Japan was inclined to await the outcome and insist on treatment equal to that of Euratom.

These, then, were some of the principal nuclear matters of mutual US-Japanese interest as I set out for Tokyo. However my visit to Tokyo was preceded by interesting visits to the Mihama and Tsuruga Nuclear Power plants and to the Expo 70 at Osaka:

"Friday and Saturday, March 20-21, 1970 – Washington, Cleveland, Chicago, Anchorage, Tokyo, Osaka

"Julius Rubin (my Special Assistant), Myron Kratzer, and I left Dulles Airport at about 9 a.m. We said goodbye to Joe Gibson, my driver, as he would be leaving the AEC while we were away and moving to South Carolina. On the way to Chicago, with a stop at Cleveland, I worked on forthcoming speeches. On the way to Anchorage, I worked on the text of my Japanese Atomic Industrial Forum speech and after a short stop in Anchorage I read the briefing material on Japan and our meeting with the Japanese Atomic Energy Commission on the way to Tokyo. On the Anchorage to Tokyo leg, I worked on my text for the Japanese AIF speech.

"We arrived in Tokyo at 5:05 p.m. (after nearly 20 hours travel time) having crossed the international date line between Anchorage and Tokyo so the date was now March 21. We were met by Dr. Hiromi Arisawa (Deputy Chairman, JAEC), Mr. Shigeru Yosano (Commissioner, JAEC), Mr. Yoshio Kawashima (Head, International Cooperation Division, Japan Atomic Energy Bureau), Mr. Hiroyoshi Kurihara (Deputy to Mr. Kawashima), Mr. Mamoru Sueda (Deputy Secretary General, JAIF) and others who helped us avoid delay in passport control. On the way to the Northwest VIP lounge to await our flight to Osaka, we met Whittie J. McCool (Jack), the Scientific Representative for the USAEC in Tokyo, William A. Beach (Assistant to Whittie McCool), Woodford B. McCool (Secretary to the USAEC from Washington who had arrived in Tokyo earlier in the week). We all went to the special lounge room where we met (USAEC Commissioner) Clarence and Jane Larson and were served refreshments. While in the lounge, I met Don C. Burnham (President of Westinghouse) who was on his way to Expo 70 with a small group.

"The Larsons, Rubin, Kratzer, Whittie McCool, W. B. McCool, Sueda, and I flew to Osaka, arriving at about 8:15 p.m. We were met by Rodney Armstrong of the American Consulate and Tetsuhiro Fujii, Deputy Manager, Nuclear Power Department, Kansai Electric Power Company (KEPCO). I rode with the Larsons in one of the Kansai Electric

Power Company cars along an elevated expressway through busy Osaka to the Plaza Hotel. The others followed. At the hotel we were met by Yoshio Tanaka, Deputy Director, Japanese Atomic Energy Bureau. I checked into a room overlooking an interesting scene of downtown Osaka, including the expressway and an elevated train. On the desk in my room was a large bowl of flowers from Yoshishige Ashihara, President and Director, Kansai Electric Power Company."

"Sunday, March 22, 1970 - Osaka, Tsuruga, Mihama, Kyoto

"Our party, including Masashi Odashima (Advisor for Foreign Affairs, KEPCO), who joined us this morning, rode to the Osaka National Railway Station for our trip to the Mihama Atomic Power Project. Here we were joined by Toshio Ito (Senior Managing Director, KEPCO) and we all caught the Hakucho Express for Tsuruga, which left at 8:40 a.m. We had a good view of a residential section of Osaka with its small individual homes crowded together, each with a TV antenna. We traveled through the outskirts of Kyoto, through a number of small cities, villages and countryside hamlets with their tile-roofed homes, and through a mountainous region with patches of snow and higher snow-covered mountains (the Japanese Alps) in the distance. There were many rice fields in surprisingly large open land areas. We passed through Nagahama. As we approached Tsuruga, located on the Japan Sea, we passed through a snow-covered mountainous area.

"In Tsuruga we were met by Mr. S. Miyamoto (Assistant Plant Superintendent of Mihama), Mr. Kimoto, Mr. Shunichi Hamaguchi (Manager, Nuclear Power Department), Mr. Toshio Yoshioka, Mr. Furukata, and Mr. Ishida. The drive to Mihama (Beautiful Seashore) Atomic Power Project was through mountains (across the Tsuruga Peninsula) and then along the Japan Sea. We were welcomed by Hiromi Kato (Executive Vice President, KEPCO), Eiichi Takeda (JAEC Commissioner), and others when we arrived at the Mihama Information Center. We went to a specially set-up meeting room, where Kato gave some welcoming remarks in Japanese (translated by Mr. Ito) which made a plea for more enriched uranium from the United States. We were served tea as he spoke. A kit of material was at each table that included a pamphlet, 'Nuclear Power Development Program of Kansai,' a copy of Kato's remarks, a schedule of KEPCO's nuclear power construction plans and the related enriching service requirements, and a pamphlet, '1969/Current Information - KEPCO.'

"Mr. Miyamoto then made some remarks in Japanese, with translator, describing the Mihama Nuclear Power Reactors, Nos. 1 and 2. Unit No. 1, 340 MWe, was 90% complete and was scheduled for synchronization in July and completion of the 100 hour acceptance test in October. Unit No. 2, 500 MWe, was 37% complete with the air containment test of the main structure recently completed.

"A description of the general plant layout was given, using large pictorial diagrams on a display board. An interesting statement was made that granite rock in the foundation at the site gave a high natural background radiation level which was three times the Tokyo level and twice the Osaka level. The background level was quoted as 25-30 microrem per hour which is equivalent to 200 millirem per year.

"We walked from the conference room to a balcony overlooking the bay and the reactor site and shot a lot of pictures and movies.

"We then boarded a bus and drove across the bridge to the Power Plant site. Hard hats and white gloves were provided. We circled the reactor buildings for Unit No. 2 but did not get out of the cars as we were behind schedule. At Unit No. 1 we entered the building and went to the turbine hall and observed the reactor control room through an observation window. Upon entering the building, we met the Westinghouse resident engineer (Mr. Schmidt). Mr. Kato particularly pointed out that the turbine was built in Japan under license to Westinghouse.

"While alongside the turbine I was asked by a reporter (Asao Yoshioka of the Mainichi Shimbun) what I thought of the site. I described it as very beautiful and well designed.

"On leaving the building each person was handed a small plate containing a little pink mirror and comb. At first this appeared to be a gift, but then we realized that they were for combing our hair after removing the hard hats. The US flag was flying at the site. We toured the rest of the site by car, I with Kato and Odashima, and the others following in a bus.

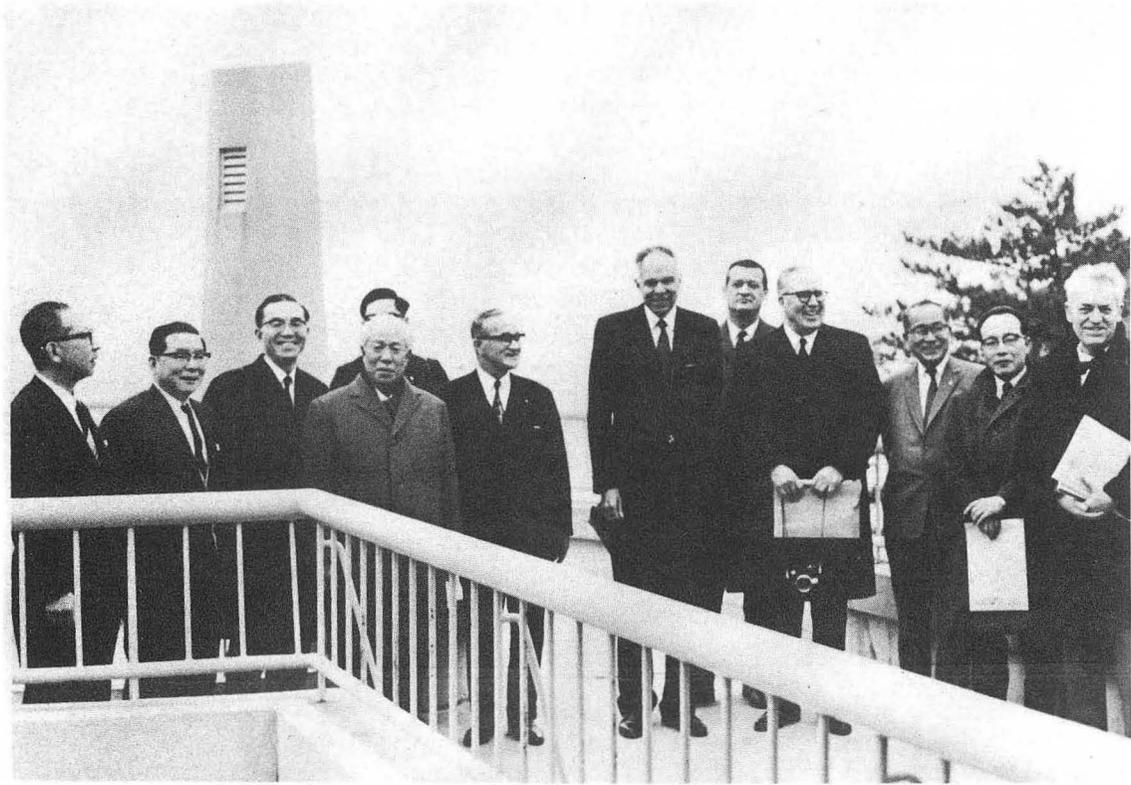
"At the completion of the tour we drove to the Kansai Guest House for luncheon. Here we were joined by Dr. Tamaki Ipponmatsu (President, Japan Atomic Power Company, JAPCO), and Mr. Toshio Yoshioka (Managing Director, JAPCO). After lunch I presented to Kato and Ipponmatsu each a plastic-enclosed signed USAEC seal.

"I then rode with Ipponmatsu and Mr. R. Imai, Manager of JAPCO's Fuel Section, with the rest of the group in five other cars, to the Japan Atomic Power Company plant back at Tsuruga. During the ride Ipponmatsu gave me a memorandum and read a handwritten statement which covered uranium enrichment requirements and mentioned problems with IAEA safeguards.... They mentioned embarrassments brought about by safeguards, which must be minimized. I explained our insistence on the international aspect, our conviction that mere verification of national safeguards is not sufficient. They said this may depend on definition of verification -

they must have 'equal treatment.' I expressed appreciation for Japan's signing of NPT and expressed hope they would ratify it soon. They said the safeguards difficulties must be overcome to insure ratification. I emphasized that the United States is serious about its offer to place its peaceful nuclear facilities under IAEA safeguards.* They expressed concern about our planning for increased enrichment capacity; they felt we were not moving ahead fast enough and therefore, they need to plan to have other capacity somewhere, perhaps in Japan. I explained that they need have no concern about US plans, that starting our Cascade Improvement Program (CIP) work next year is soon enough and they shouldn't take our US public budget arguments too seriously. They said nevertheless they feel that they should enter the enrichment field and need the cooperation of the United States. They then brought up their plans for advanced reactors, including Fast Breeders, and said JAPCO hopes to enter this field and emphasized they have close relations with utility people. Concerning light water reactors, they feel that the experience they have had, although there have been some problems, gives them confidence to go ahead with a national program in this area.

"We arrived at the Tsuruga Power Station (JAPCO plant) at about 2:20 p.m. Here we met in a conference room with Dr. Ipponmatsu, Mr. Yoshioka, Mr. Imai, Mr. Ito, Mr. Hamaguchi, Mr. Miyamoto (KEPCO), Mr. T. Nomoto (Deputy Superintendent, JAPCO), Mr. N. Emori (Station Superintendent, JAPCO), and others. Ipponmatsu gave introductory remarks emphasizing the key role of the late Dr. Ryokichi Sagane in the building of the plant. Yoshioka, who took Sagane's place, then described the Tsuruga plant in more detail. The plant was authorized in April 1966, the contract signed with GE in May 1966, and fuel loaded in the completed plant in September 1969. The 100-hour test was completed earlier this month, on March 14. The plant design rating is 322 MWe, and there is a stretch capability of 357 MWe. There was a specific mention that the problem at Jersey Central and Tarapur with sensitized stainless steel had been avoided at Tsuruga. This 41 months from authorization to plant completion is an outstanding achievement. Imai then described the successful 100-hour warranty run (without a scram) and the subsequent successful operation at 330 MWe compared to design rating of 322 MWe. He described typical Boiling Water Reactor (BWR) problems with the control rod drive system and 'in core' instrumentation that were observed. The initial fuel was manufactured at GE, San Jose, but reload fuel will be manufactured in Japan under contract to GE.... They reported compensating about 100 fishermen in the area

*Originally declared by President Johnson on December 2, 1967, this offer was reaffirmed by President Nixon when he resubmitted the Non-Proliferation Treaty to the US Senate on February 5, 1969.



XBB 761-7029

*Visit to Mihama Nuclear Power Station, Tsuruga, Japan, March 22, 1970.
(Left to right) Masashi Odashima, Eiichi Takeda, Yoshio Tanaka, unidentified
in back, Toshio Ito, Hiromi Kato, Seaborg, M. B. Kratzer, C. E. Larson, un-
identified, Mamoru Sueda, W. B. McCool.*

at ten times their annual income to offset possible effect of the reactor on local fishing operations.

"Following the briefing we rode, in a bus, up to a point above the reactor building, at the 28 meter level, to get an overall view. A stack was pointed out on top of the hill, behind and above us, that was connected by pipe to the reactor building. This stack was reported to be over 300 meters high, but we actually saw only a 30-40 foot section on top of a tall hill. We next visited the control room, which was quite conventional, and then returned to the main building. This reactor site uses a small total land area and is partly carved into the side of a hill. It also has an unusual deep water intake in a channel leading to the reactor, with the discharge area at the surface only a short distance away from the intake point.

"We left the Tsuruga Power Station at about 3:40 p.m. I rode with Ito and Odashima, followed by many others, including those who had come on the train this morning to the Tsuruga Railroad Station. We drove on a road along the Japan Sea - it had started to rain just before lunch and continued to rain during our visit to the Tsuruga Power Station and during our ride back to the station to catch the train to Kyoto.

"The train left Tsuruga at 5:05 p.m. and arrived in Kyoto at about 7 p.m. Aboard were Larson, Kratzer, Rubin, W. B. McCool, and Whittie McCool and I, and Ito, Tanaka, Sueda, Odashima, and Hamaguchi. Rubin, Kratzer, and I rode to the Oriental Hotel and proceeded immediately to dinner at the Kyoyamato (a private club) with W. B. McCool, and the Larsons. Here we met Kato, our host, Ito, Shigeo Okano (General Manager, Nuclear Power, KEPCO), Masami Iida (General Manager and Superintendent of Takahama Nuclear Project), Hamaguchi, Odashima, Tanaka, and Sueda, and had a Japanese-style dinner, shoes off, sitting on the floor, with nine geisha, entertainment by the geisha, help with the meal by the geisha, etc. The dinner consisted of an almost endless number of dishes with each serving containing a variety of interesting items. Sake, beer, and mixed drinks were served all during the dinner. Here is a description of the courses:

- | | |
|------------|----------------------------------------------------------------------|
| 1st Course | Small eggs
Bamboo shoots
Duck slices
Cherry blossoms |
| 2nd Course | Soup with cherry blossoms, small eggs and
bean cake in consome |
| 3rd Course | Tempura with pork, egg plant, lotus root,
onion, and green pepper |

on some notes prepared by Whittie McCool the previous evening. My remarks were repeated in Japanese by Odashima.

"Following our statements, we signed the contract documents that will provide \$80,000,000 in uranium enriching service to KEPCO for the Takahama plant. I was presented one of the two pens used in signing the document. Photographers and TV film recorded the ceremony. The usual hot towels and hot tea service (repeated many, many times during our trip) were provided during the meeting.

"I presented a gift to Ashihara of the Uranium Chain and a copy of my book, *Elements of the Universe*.

"Following completion of the ceremony, I was interviewed by a large press group. Ito made a brief statement and I summarized our discussions and described our present trip plans. Mr. Taizo Kitamura of KEPCO acted as an interpreter and director of the press conference.

"The questions by the press included: (1) What is being done to solve the problems of supplying enriched uranium to Japan...? I explained I was aware of the problem and there would be no difficulty in resolving it. I also expressed satisfaction that Japan has turned to US enriched reactors. (2) Are we prepared to increase the amount by written agreement? (3) Will we continue to supply enriched material to Japan if their own program for establishing a capability is successful? (4) Does the United States intend to support enrichment technology development in Japan? (5) When will breeder reactors be available? The press conference was concluded at 10:15 a.m.

"I then rode with Kratzer, Odashima and Kikuo Matsumoto (Chief of Secretariat Section, KEPCO, and our guide at the Expo) to Expo 70, followed by Rubin, Whittie McCool and Tanaka. We arrived at about 10:45 a.m. and joined the Larsons and W. B. McCool, who were waiting for us. After a brief stop in the main administration building, the group was taken in electric cars for a tour of the Expo grounds. We were accompanied by Yukio Yamanouchi, (Assistant to Odashima), Michiko (Michi) Itoh, Expo Hostess assigned to be with our party for the day, Kikuo Matsumoto, and our Osaka police escorts.

"The various buildings were described by Michi and were all very colorful and uniquely designed. The crowds were quite large and a very catchy special Expo tune was played almost continuously by a tape deck in each car to warn the crowds of an approaching electric car. The lyric in Japanese was the Expo theme, 'Human Progress and Harmony.'

"Our first stop was at the US pavilion where we met Ambassador Howard Chernoff, who was the senior US official for our exhibit. He explained that the intent of its design was to relate Japanese culture to similar features in America. The Japanese press was reported to have given the US exhibit very favorable attention, while the US press had not been as kind.

"We were escorted by Steve Elbrecht and Vivian Takeru of the US staff at the exhibit to a special entrance. The normal waiting period to enter the exhibit was running about two hours and had been as long as six hours over the recent holiday weekend.

"In the US exhibit we saw our space exhibit which featured a large lunar rock; the baseball lockers and uniforms of Babe Ruth, Walter Johnson, and Joe DiMaggio, from Cooperstown; several movie screens with one-minute scenes of exciting sporting plays in baseball, basketball, auto racing, and ice hockey; a valuable collection of art from one of the New York museums; an assortment of pictorial scenes and interesting items from the Pennsylvania Dutch of our country; and a photographic exhibit.

"A Japanese newspaper photographer took a number of pictures while we were touring the exhibit and promised to send me some prints.

"Following the tour of the US pavilion, we rode in the electric cars to the American Park. This is an area of leased space for US commercial use. Mr. Veach, of the American Park Company, met our group for refreshments and then I hosted a lunch in the American Steak House. Present were Odashima, Tanaka, Michi Itoh, the Larsons, W. B. McCool, Whittie McCool, Rubin, and Kratzer.

"After lunch Rubin, Odashima and I rode in the same KEPCO car to nearby Osaka University for my visit with Seishi Kikuchi, who did work with Kinichi Aoki and Koki Husimi at Osaka University in 1937 on the scattering of neutrons similar to the work of David C. Grahame and I were doing at Berkeley at the same time. (Our results at that time were contradictory so far as their interpretation was concerned; Grahame's and my interpretation, that the observed effects were due to the inelastic scattering of fast neutrons, was later proved to be correct.) Kikuchi had come from the Institute of Science in Tokyo (he is its President) to play host to us at his old post at Osaka University. We met Professor Hiroo Kumagai (now residing in Tokyo), a member of the 1937 team who built the Cockcroft-Walton 300 keV high voltage apparatus — he was known as Aoki at that time. We also met Tetsuo Wakatsuki, Dean of the Faculty of Science and the present Head of the Physics Department at Osaka University and hence

Kikuchi's successor there; he was at Osaka University in 1937 and helped in the neutron experiments. In addition, we met Professor Kenzo Sugimoto of Osaka University. Kikuchi told me he is now heading the Japanese effort on development of the gaseous diffusion process for the enrichment of uranium-235. Husimi, the other member of the 1937 team of Kikuchi, Aoki, and Husimi, is now head of a nuclear fusion laboratory in Nagoya University. We met first in Wakatsuki's office where they showed me a picture of Kikuchi, Aoki, Husimi, Wakatsuki, Professor Eiichi Takeda, Okamoto, and another student of the 1937 era, and pictures of their high voltage and other apparatus of that era. Aoki had been able to preserve these because his house was not bombed; he will send me copies.* Aoki also showed me his handwritten notes on Gibson, Grahame and Seaborg, and Grahame and Seaborg papers of 1937 and 1938; and of Livingood and Seaborg papers on induced radioactivities of that era. I gave Kikuchi a copy of *Man-Made Transuranium Elements*, Aoki a copy of *Elements of the Universe*, and Wakatsuki and Sugimoto each a pen-pointer.

"We then went to visit the 4 MeV Van de Graaf accelerator, taking movies and still photographs of the group outside the building. Inside the building we saw the original 1937 Cockcroft-Walton high voltage apparatus. Our hosts and two newspaper men took pictures of the group with the apparatus - copies will be sent to me.

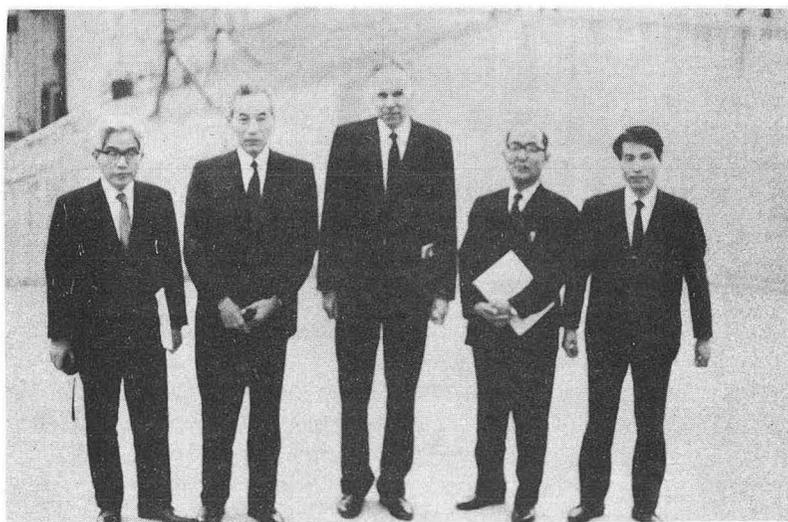
"We all returned to Expo 70, arriving there at about 2:50 p.m., and soon joined the other members of our party who had toured the Electric Power and Canadian exhibit while we were visiting Osaka University. We all then toured the Japanese exhibit accompanied by a USIS photographer, Mr. Masaki Nishimoto. We met Yoshihisa Arada, Deputy Commissioner General of the Japanese Section for the 1970 World Exposition, who arranged for two girl escorts (Hiromi Takamura and Mariko Yamaguchi), in very attractive white uniforms with red caps, to take us through the exhibit. The exhibit was housed in three large spheres reached by escalators and connecting tunnels. Most of the display was fairly abstract.

"Following this we toured the Soviet Pavilion. Our guide was a young Russian student named Andrei Koloshen. The Soviet exhibit was very large and contained a large section on space activities in which a model of a space station was featured. The items displayed were plastic models that did not compare favorably with the actual equipment used in many cases in the US exhibit. One of the hand-outs at the Soviet exhibit was a pamphlet, 'Science Serves

*These were sent me, as promised, by Hiroo Kumagai (Aoki) in May, 1970.



Picture of Kikuchi group taken in 1938 or 1939. (Left to right) standing Tetsuo Wakatsuke, Eiichi Takeda, Seishi Kikuchi, Hiroo Kumagai (Aoki), kneeling K. Husimi, Okamoto, unidentified.



XBB 761-7030

Outside Van de Graff Accelerator building, Osaka University, March 23, 1970. (Left to right) Hiroo Kumagai (Aoki), Seishi Kikuchi, Seaborg, Tetsuo Wakatsuki, Kenzo Sugimoto.



XBB 761-7032

Visit to Japanese Pavilion, Expo 70, Osaka, March 23, 1970. (Left to right) Hostess Mariko Yamaguchi, M. B. Kratzer, Seaborg, Hostess Hiromi Takamura.

Man.' We also saw a large photographic exhibit, folk art, a model of the Serpukhov accelerator, and a large display about Lenin.

"The building housing the Soviet Pavilion was the tallest structure at Expo and had a red hammer and sickle at the top of a 325-foot-high spire. This was quite a contrast with the US Pavilion, which was largely underground with an air-supported translucent roof about six feet above the street level.

"At about 6 p.m. we went to the Expo Club. On the way, we stopped briefly outside the KEPCO exhibit and met the manager (Koichi Kishida), but did not go in due to lack of time. It was getting increasingly cold, and riding in the open electric cars with only light plastic sides made the cold very bitter and penetrating.

"Odashima hosted a dinner for us at the Expo Club, which included our seven, Odashima, Michi Itoh, and two other KEPCO hostesses for Expo 70 (Setsuko Hosokawa and Kyoko Hibino). I gave Odashima a pen-pointer. We got a view of Expo 70 at night from the Expo Club – a beautiful sight.

"Odashima, Rubin, the Larsons, Kratzer, and two KEPCO girls and I rode to the Osaka Airport to return to Tokyo. Odashima and the two girls saw us off. Whittie McCool and W. B. McCool returned to Tokyo with us as well. We had a spectacular aerial view of Expo 70 as we left Osaka. In Tokyo we were met by William Beach and Mr. Yoshio Kawashima."

"Tuesday, March 24, 1970 – Tokyo

"Kratzer, Larson, Rubin, Whittie McCool and I went to the nearby Sanno Hotel at 8 a.m. and had breakfast with a number of members of the American and other non-Japanese press – Ed White (Associated Press), Tom Pepper (Baltimore *Sun*), Takashi Oka (New York *Times*), George Crabbe (United Press International), Jonathan Kandell (*Newsweek*), John Fujii (Fairchild Publications), Don Shannon (Los Angeles *Times*), Lee Casey (Reuters), Selig Harrison (Washington *Post*), Stewart Griffin (Foreign News Service), and John Paynter (*Stars and Stripes*).

"After a brief introduction by Francis T. Donovan, Press Attaché, US Embassy, Tokyo, and his statement to the reporters that all comments were for the record unless otherwise specified, I was asked (1) whether the Japanese are doing creative work in the nuclear field or just copying what the United States and others are doing, (2) my views on Japan converting to IAEA safeguards versus the bilateral with the United States and also Japan's desire for a simpler safeguards system, (3) whether safeguards inspections will interfere with industrial operation and also permit industrial espionage, (4) if

Japan can develop a nuclear weapons capability, (5) what area of research could Japan excel in, (6) if there is any hope for satisfying Japan's concern on regional versus national safeguards (i.e., Euratom versus Japan under NPT), (7) when the IAEA safeguards system will become effective, (8) whether the Soviets will permit safeguards inspection, (9) if not, how would we know they are not giving nuclear weapons to another country, (10) whether we will increase the amount of enriched uranium service for Japan as they have requested, and (11) since the United States has a surplus of physicists, whether some could be loaned to Japan.

"Larson, Kratzer, Rubin, Whittie McCool, W. B. McCool, and I rode to the Tokyo Prince Hotel for our scheduled talks with the members and staff of the Japanese Atomic Energy Commission and Atomic Energy Bureau, the main purpose of our trip to Japan. A large number of photographers were present as we entered the room and greeted our Japanese hosts.

"Minister Shinichi Nishida, JAEC Chairman, opened the meeting by welcoming our group and made a few general statements about the value of US cooperation, Japan's increasing electrical power demand and the need for nuclear power in Japan. He introduced the members of the JAEC and other high level industrial and government officials sitting at the table. There was simultaneous translation of all remarks at the meeting through headsets available at each seat.

"In response to Minister Nishida's welcoming remarks, I expressed appreciation for his welcome and the hospitality shown us during this visit and during my 1965 visit. I spoke of the history of the US-Japanese cooperation in peaceful uses of nuclear energy and stressed the value of these joint meetings and of visits such as we had had to Mihama, Tsuruga, and Expo 70. I mentioned Japan's rapid growth in nuclear power. Noting the coming into force of the NPT, I expressed satisfaction over Japan's signing. I also introduced each member of the US delegation at the table (Larson, W. B. McCool, Kratzer, and Rubin of USAEC-Washington; W. J. McCool and Beach of USAEC-Tokyo; William J. Cunningham and John M. Gregory of our Embassy's Political and Economic/Commercial Sections, respectively).

"Nishida left at 10:30 a.m. to be present for a session of the Diet. Dr. Arisawa chaired the remainder of the meeting. He referred to the planned agenda and reviewed Japanese nuclear power projections and their enriched uranium requirements. He made frequent reference to data in a paper, 'Nuclear Power Generation in Japan,' dated March 24, 1970.

"I summarized the present US status and projections for nuclear power, highlighted our advanced converter and breeder objectives, noted the reactor safety program, uranium reserve

picture, and mentioned the planned uranium enrichment directorate, the Cf²⁵² program, the regulatory operations of the USAEC, SNAP activities, our international program and some of the USAEC research activities.

"This was followed by JAEC Commissioner Tasaburo Yamada's statement on Japan's long-range plans for nuclear power and reference to the public acceptance problem in the United States and the recently released analysis of electricity generation problems made by Phil Sporn at the request of Chairman Chet Holifield of the Joint Committee on Atomic Energy.

"I talked about the public acceptance problem in the United States and promised to send to the JAEC some USAEC papers that summarize and clarify the environmental issues. I identified what I deem to be basic errors made by Drs. Gofman and Tamplin, the Lawrence Radiation Laboratory scientists whose statements about radiation dangers of nuclear power plants have raised worry and uncertainty in the United States. I also cited the recent court decision in the Rulison Plowshare case, ruling against environmental groups who sought to prevent post-detonation 'flaring' of gas from the Rulison cavity. We promised to send a copy of the Rulison court decision.

"Mr. Goro Inouye, in his capacity as President of Power Reactor and Fuel Development Corporation (PNC), reviewed the plans for the new power reactors and the new nuclear engineering center recently established by the PNC at Oarai, 60 kilometers north of Tokyo in Ibaraki Prefecture. He referred to a PNC pamphlet in the kit of material provided for each US delegate.

"Dr. Eiji Munekata, President of the Japan Atomic Energy Research Institute, talked about the use of thermal energy for the steel industry. This industry uses 20% of the total energy in Japan. He expressed interest in the HTGR and asked questions about the operating temperature for Peach Bottom and UHTREX* and the problems in using thermal energy from nuclear plants for steel production.

"I was asked by Arisawa to outline our LMBFR program and I mentioned EBR-2, SEFOR, Sodium Components Test Facility, Hot Fuel Examination Facilities, FFTF, and our plans for demonstration plants.

*Munekata was referring here to two gas-cooled reactor projects in the US; Unit #1 of the Peach Bottom Atomic Power Station, in Pennsylvania, and the Ultra High Temperature Reactor Experiment at the Los Alamos Scientific Laboratory.

"The meeting adjourned for lunch at noon in the Peony Room of the Tokyo Prince, which was hosted by Minister Nishida. There were about 30 people present. I sat opposite Minister Nishida, with Professor Kikuchi on my left. Others present were those that attended the meeting in the morning. At the conclusion of the lunch, Minister Nishida made some cordial remarks. I thanked him for myself and the US delegation and presented him a gift of the Uranium Chain. Our luncheon remarks were interpreted by Miss Kyoko Matsubara.

"Arisawa opened the afternoon session, called on Inouye, who made a plea for more heavy water from the USAEC. I mentioned the importance of their giving us information on their requirements and schedule, to help us determine priorities. They said they will do so. Takeda then took up the problem of plutonium supply and I replied with mention of the possibility of reduced price, etc. JAEC Commissioner Toshinosuke Muto asked about increasing the supply of enriched uranium. I said this should be possible. (Muto sat diagonally across from me at lunch and I learned he was at Berkeley working with Oppenheimer in 1940 and later worked at Princeton.)"

On this subject of increased supply of enriched uranium, we did not go into great detail during this particular discussion. Muto stated that Japan would probably propose increasing the maximum mentioned in our 1968 Agreement by about 180 tons – enough to fuel 11 additional reactors with a total additional capacity of approximately 15,000 MWe. In response, I indicated that I did not see any serious problem. It was agreed that a specific proposal would be worked out later so that the necessary procedures could be started to permit modification of the governing bilateral agreement.

We went on to speak of related matters:

"Muto asked about US future enrichment capacity, the US policy for use of enriching technology abroad, the effect of the proposed new directorate* management on the price of enriching service, and I tried to answer each of these questions. Arisawa asked if we had any questions concerning enrichment, and I asked about Japan's plans in the uranium enrichment field. Inouye said they were studying gaseous diffusion and centrifuge methods and will make a decision by 1972 regarding which method to pursue; they are doing research on materials and components.

"Arisawa then called on Mr. Shuichi Sasaki, President of the Nuclear Ship Development Agency, to propose the exchange

*Consideration was being given to establishing a semi-autonomous directorate under the jurisdiction of the USAEC to manage enrichment operations; ultimately, practical considerations led to abandonment of this idea.

of information on nuclear ships. In response I raised the question of our nuclear ship *Savannah's* entrance into Japanese ports, citing the concern about this on the part of the US Maritime Administrator, Admiral Andrew E. Gibson, and the US Congress. JAEC Commissioner Yosano responded to this, explaining the legal problem concerning liability, the problem that was delaying authorization of *Savannah's* entry. I explained the urgency of solving this problem during *Savannah's* lifetime, if the Japanese want their nuclear ship *Mutsu* to be able to enter US ports during *Mutsu's* lifetime -- Congress must be satisfied. Arisawa elaborated on the legal problem of changing the law...."

It seems appropriate to interrupt my journal account here to supply some background information on this matter of the nuclear ships. Over the years prior to the March 1970 meeting reported above, numerous representatives of Japan had participated in training programs and visits to both the *Savannah* and the facilities used in its development and support. Furthermore, the United States had made considerable additional technical assistance available to the Japanese in connection with their nuclear ship program. The possibility of a formal technical exchange arrangement on nuclear propulsion had been first considered some time before the March 1970 meeting, and in 1969 the USAEC submitted a draft arrangement as a basis for discussion. This proposal of ours contained two provisos to which the Japanese took strong exception. One was that Japanese reports sent to us as part of the contemplated exchange of information should be in English; we simply did not have the capability for translating large volumes of Japanese. Secondly, in view of the difference in status between the United States and Japanese progress (the *Savannah* had been in operation for several years, whereas the *Mutsu* was still under construction), we felt that the arrangement should extend for three years after achievement of full power in the *Mutsu*, in order to assure a reasonably balanced exchange of information. As a result of further US-Japanese staff meetings and exchanges of view, the Japanese appeared ready by March 1970 to accept our position on these points. A more serious difficulty persisted, however, in our inability to obtain authorization for entry of the *Savannah* into Japanese ports. As indicated in the above brief mention of my discussion with Arisawa and Sasaki, the difficulty lay in the question of liability. Japan wished us to agree to absolute and unlimited liability if the *Savannah* should be involved in a nuclear accident while in Japanese waters. This we could not accept. By the end of 1969 the *Savannah* had visited a total of 24 maritime nations. In every instance where agreement had been reached for entry of the *Savannah*, the subject of liability and liability limits had been resolved to mutual satisfaction by reliance on the US "Price-Anderson Act," which permits the law of the country being visited to determine legal liability up to a ceiling amount of \$500,000,000. If the *Savannah* were to visit Japan, the Japanese would have to take whatever legislative or other steps necessary to allow entry on that basis. The responsible Japanese officials seemed well aware of this, and at the time of our March 1970 meeting were engaged in studying the matter, but had not yet prepared the necessary legislation for submission to the Diet. Speedy action seemed important, because consideration was being given to discontinuing the operation of the *Savannah* as a commercial vessel. If that occurred, there would seem to be no basis for the technical exchange agree-

ment. Furthermore, when the time came to consider legislation to permit the entry of foreign nuclear ships into US ports (no such legislation yet existed, as there had been no occasion for it), the US Congress would not be likely to overlook the fact that the *Savannah* had in effect been barred from Japanese ports.

From the matter of nuclear ships, Mr. Arisawa moved on to the last item on our agenda – a review of existing technical exchanges and then discussion of other areas in which such exchanges could be considered at this time:

"I suggested safeguards technology. Arisawa agreed and suggested staffs work on this. Mr. Susumu Kiyonari, PNC Vice President, suggested expanding exchanges in fast reactors beyond the basic program and I said we would discuss it. Munekata raised the question of radiation chemistry – he wants the next meeting to be held in Tokyo. Arisawa and I mentioned our next joint meeting in the United States and then we recessed for coffee and tea. When we reconvened, we agreed on the wording of a joint communiqué. The communiqué summarized our discussions briefly and stated our intention to hold the third of these periodic meetings in the United States.* Arisawa then made a concluding statement emphasizing the value of the meeting and of our exchange of information. I responded by congratulating him on his effective chairmanship of the meetings and emphasizing the mutual advantages, especially in the long run, of the cooperation between our two countries in the peaceful uses of nuclear energy.

"After the meeting Sasaki told me that he thought that the Diet would make the necessary changes in Japanese law next October or so to make it possible for the *Savannah* to enter Japanese ports.

"At 5 p.m. I participated in a press conference with Arisawa along with Larson and Kratzer. Whittie McCool was also present. Reporters present at the meeting included Koichi Yoshimoto (*Asahi Shimbun*), John M. Hataye (Fairchild Publications), A. E. Cullison (The Journal of Commerce), Jun Tanabe (Kyoda News Service), Takayuki Kido (*Nikkan Kogyo*, Industrial Daily News), Hinoyuki Torii (*Nippon Keizai*, Japan Economic News), Yasuo Nakagawa (Reuters), Masao Nakamura (Yomiuri Newspapers), Michinosuke Kayaba (FUJI-TV), Hisao Yoshikawa (NET-TV), and Mitsugu Kajikawa (NHK-TV, Radio and TV). The main questions were on our promise to increase the allotment of enrichment services to Japan and the touchy situation with respect to the lack of authority for the *Savannah* to enter Japanese ports.

*The time was later set for early November 1971.

"After the press conference we went directly to the reception, also in the Tokyo Prince Hotel, hosted by the Japanese Atomic Energy Commission. Among those present were those attending the meeting, plus Dr. Takayuki Somiya (Member of the Japan Academy, University of Tokyo), Dr. Tsuneo Harada (Senior Managing Director, Tokyo Shibaura Electric Company, Ltd.), Kunihiko Uematsu (PNC), Hidezo Inaba (President, The Research Institute of National Economy), and Kiichiro Satoh (Director and Counsellor, The Mitsui Bank, Ltd.). Also, a number of the Senior Staff of Japan's Atomic Energy Commission were present. Among those I talked to were Kikuchi and Harada. As mentioned before, Kikuchi is working on the gaseous diffusion method of uranium enrichment, and Harada, one of Kikuchi's former students, is working on the gas centrifuge method at the Tokyo Shibaura Electric Company (where he is Senior Managing Director), the same company that built the Cockcroft-Walton high voltage equipment for the Kikuchi group in the 1937 era, at which time Harada was already working at Tokyo Shibaura Electric."

"Wednesday, March 25, 1970 - Tokyo

"I had a buffet breakfast in the Hilton Hotel Tea Lounge with Professor Yasushi Nishiwaki (Deputy Director, Division of Health and Safety, IAEA), together with Kratzer and Rubin, to discuss the forthcoming IAEA-AEC Conference at the United Nations headquarters in New York in August on Environmental Affairs.

"I then rode with Kratzer, Rubin and Bill Beach to the American Embassy to meet with DCM Richard L. Sneider preparatory to our call on Minister of Foreign Affairs Kiichi Aichi. In our talk with Sneider, Bob Hiatt (Scientific Attaché), and Herman Barger (Economics Officer), the local attitude on the safeguards issue was reviewed (i.e., treatment of Euratom versus Japan and protection of industrial secrets).

"I then rode with Sneider and James J. Wickel (Special Assistant to the US Ambassador) in an Embassy car to the Ministry of Foreign Affairs (located in Kasumiki, Chiyo-Ku section of Tokyo), followed by Kratzer, Rubin and Beach in another car. Mr. Atsuhiko Yatabe (Head of Science Section, Foreign Ministry) escorted us to the office of Aichi. A number of photographers were present at the start of our conversation. I explained the background of my trip to Japan and Aichi noted his former position as head of the JAEC. He also noted that Japanese law prohibited use of nuclear power for war. Aichi stated he personally had wished to sign the NPT earlier, but signature had been delayed by the need to reconcile conflicting views. He said also that the feeling in Japan about equal treatment with Euratom and a simple inspection system on safeguards is delaying ratification. He added support for the JAEC request for assurance of a

future supply of enriched uranium.

"I expressed recognition of Aichi's key role in Japan's signing of the NPT. I emphasized the fact that US facilities are being inspected by IAEA and that we also are interested in a simple safeguards system. I stated that the JAEC request for additional enriching service from the US is being satisfactorily resolved.

"Aichi repeated Japan's concern about IAEA safeguards being complex, bothering industrial operations, and posing a financial burden. He suggested greater reliance on the national safeguards system. I stated we need an international system of verification and made it clear it was not a matter of mutual distrust. Aichi's position was that there has to be trust between the parties, and he stated the United States should recognize the importance of the nuclear industry to Japan's future. I agreed that trusting one another was necessary and said this was the reason the United States had felt free to provide enriched uranium to Japan, but I stressed the fact that an international safeguards program was still needed to demonstrate that all countries throughout the world were equally treated.

"Aichi digressed from nuclear matters at this point and noted that following high level discussions in Washington last fall, their general elections reflected a strong friendly attitude toward the United States and political stability in Japan. The textile problem was noted, with the hope that it would soon be resolved.

"I gave Aichi a signed USAEC seal and an autographed copy of *Elements of the Universe*. At the end of the meeting Yatabe escorted us back to the entrance of the Ministry.

"I next rode with Rubin to the Toshi Center to attend the meeting of the Japan Atomic Industrial Forum (JAIF). We were met by JAIF Deputy Secretary General Sueda and Whittie McCool. Sueda took us to the auditorium where Nishida was in the process of making his speech; at the conclusion of this Inouye introduced me and I gave my talk, 'A World Outlook for Nuclear Power,' with simultaneous translation by Uematsu. Sueda promised to send me the display sheets on the stage, in large Japanese characters, that informed the audience about each speaker on the program."

In my address to the Forum, I reviewed the overall progress and existing situation of nuclear power and its potential role in meeting the increasing demand for energy throughout the world. Without going into detail on the US program (about which Commissioner Larson was to speak the following day), I tried to put into perspective the adverse circumstances currently affecting nuclear economics (such as increased construction costs and environmental concerns) and the many positive factors, including lowered fuel costs, the nuclear energy industry's enviable safety record, and the

promise of future breeders as an answer to nature's limitations on fuel resources. I took the occasion to emphasize particularly our conviction regarding the vital importance of the NPT and to clarify (as I had in my conversation with Aichi and at the USAEC-JAEC meeting) our position on safeguards.

After my talk we all went on to the JAIF luncheon at the Matsuya Salon:

"On the way to lunch I presented the Uranium Chain to Mr. Reinosuke Suga (84 years old), President of JAIF.... I sat at a table with Suga, Seinosuke Hashimoto (JAIF), Mr. Shomwra (Electric Council), Commissioner Kazue Kitagawa (JAEC), Inouye (PNC), Inaba (National Economy), and Satoh (Mitsui Bank). After lunch Suga gave a short talk. Then I too gave a short talk describing the importance of the roles played by Japanese AIF, USAIF, and those in other countries, especially in the area of public information in connection with the environmental controversy. My remarks were translated by Dr. Uematsu. Hideo Shima (President, Space Development Agency) gave the main talk on his role in developing the New Tokaido Line.

"After lunch Hashimoto and Suga gave me a tape recording of my talk this morning and a gift of a tape recorder. I gave Arisawa an autographed USAEC seal, and Uematsu an autographed copy of *Man-Made Transuranium Elements* and a pen-pointer.

"Rubin and I then went to an upstairs room in the same building where I was interviewed on tape (about ten questions) by Junnosuke Kishida, editorial writer of *Asahi Shimbun*. Also present from *Asahi Shimbun* were Yoshio Murakami and Tamotsu Nagashima, foreign news reporters.

"The questions were: (1) My comments on Japan's position to trust the national system for safeguards and have the IAEA inspect only when there is a reason. (2) Will the US offer to have IAEA inspect its facilities continue, and will we make the same agreement with IAEA as other countries are being asked under NPT? (3) Will we provide enriching technology to Japan and under what terms? (4) Are we concerned over proliferation aspects of UK-Dutch-German centrifuge project? (5) Was US decline in nuclear power plant orders last year due to thermal pollution, rising costs, Rocky Flats fire -- is it temporary? (6) When do I think fast breeder reactors will be utilized? (7) Will the United States have the first economic fast breeder or will it be the United Kingdom, USSR, or another country? (8) When will economic controlled thermonuclear reactors be available? (9) Is the USSR Tokamak the best machine? (10) Will cost effectiveness and concern for public safety prevent use of plowshare even if the United States and USSR reach an agreement in their

discussions? (11) For an effective NPT, must the United States and USSR go further in arms control? Can Japan help by seismic detection? (12) Is there any area of development to ask Japan to pursue in the nuclear field?

"Rubin and I then rode to the US Embassy to join Sneider preparatory to our meeting with Vice Minister of Foreign Affairs, Nobuhiko Ushiba (rumored to be the next Japanese Ambassador to the United States). We were a little early and walked up and down the stone steps between the Embassy and residence several times for some exercise. Rubin, Sneider, Herbert Levin (Political Officer, US Embassy), and I rode to the Ministry of Foreign Affairs, where we joined Kratzer and Beach, and met with Ushiba and Yatabe in Ushiba's office. Ushiba stated the NPT safeguards system should be simplified and that Japan should not be placed at a disadvantage with other countries after ratification. I stated we have the same interest as Japan in a simple system. Ushiba pointed out that Japan may have more concern about proper treatment than Germany in light of special treatment for Euratom. He noted some Japanese concern about security due to China's having the bomb, but placed this issue behind the more tangible safeguards problem. I emphasized that there was still a need for more than a national inspection system. I mentioned the discussion with the JAEC about increasing cooperation in developing safeguards technology, my visit with Kikuchi at Osaka University, and the public opposition to nuclear power in the United States versus Japan. I gave Ushiba an autographed copy of *Elements of the Universe* and an inscribed Parker pen.

"Rubin and I returned to the Hilton. At 5 p.m. I was interviewed by Mr. Yoshitatsu Tsutsumi, of *Nihon Keizai Shimbun*, along with Francis T. Donovan and Rubin, over a cup of tea in the Tea Lounge of the hotel. *Nihon Keizai* was described by Donovan to be the Japanese version of our *Wall Street Journal*.

"At 6:15 p.m. Rubin and I rode to the residence of DCM Sneider where he and I co-hosted the Embassy-USAEC reception. The Sneiders, Larsons and I received the guests.

"I talked to Mr. R. Imai, Manager of the Fuel Section of JAPCO. He told me that the key to Japan's ratifying the NPT was (1) a proper use and interpretation of national safeguards, and (2) US support in making some required changes in the IAEA safeguards document. He mentioned Australia's insistence that the US share enrichment technology as a part of the arrangement for purchasing nuclear power reactors from the United States, hinting that Japan had also considered this approach. He asked that the United States consider cooperating with Japan in the field of enrichment technology and I promised we would take this possibility under consideration.... I gave inscribed Parker pens to Sueda and Inouye.

"Sneider, Larson, Kratzer, W. B. McCool, Rubin, and I rode to the restaurant Kanetanaka, where we participated in a Japanese-style dinner with all the trimmings, hosted by Vice Foreign Minister Ushiba. We sat on the floor, with our shoes off, and in the course of the evening some 25 geisha were involved in helping to serve and entertain us (Japanese dancing, singing, playing of stringed instruments). Others at the dinner included Nishida, Ipponmatsu, Inouye, Tsunekawa, Ambassador Muto Ogiso (Japanese Ministry of Foreign Affairs)."

The next day, Thursday, March 26, Myron Kratzer, Julie Rubin, Whittie McCool, and I flew on to Seoul for talks with Korean nuclear officials. Commissioner Larson stayed several days longer in Japan, not only to give his JAIF address and participate in additional discussions and visits there, but also in order to present a citation to Dr. George B. Darling, Director of the Atomic Bomb Casualty Commission (ABCC). This organization, which has been conducting studies in the delayed effects of radiation, is another instance of US-Japanese cooperation. Since the Commission's establishment in the late forties, the major share of administrative responsibility and operational costs has been sustained by the United States; in recent years, in the light of our increasing budget restrictions and the importance of avoiding interruption of the vital biomedical research under way, we have sought to pave the way for progressively greater Japanese participation. The important contributions being made by the ABCC have been recognized by both Japanese and American scientists, and many tributes have been paid by officials of both nations to Dr. Darling's leadership and accomplishments. It was, therefore, with deep respect and appreciation that the USAEC elected to present him with its Citation for Outstanding Service in the nation's atomic energy program.

Upon my return to Washington, I reported on the details of this trip in a letter to the President dated April 10, 1970:

"At the invitation of Mr. Shinichi Nishida, Minister of State for Science and Technology and Chairman of the Japanese Atomic Energy Commission, I visited Japan from March 20 - 24. The principal purpose of this visit was to lead the United States' participation in the second joint meeting of the United States and Japanese Atomic Energy Commissions, the first of which was held in Washington in July 1968. I was accompanied by Commissioner Clarence E. Larson and members of the AEC staff.

"While in Japan, in addition to participating in the joint meeting of our two Commissions, I addressed the Japan Atomic Industrial Forum, which held its annual meeting to coincide with our visit, and met with Foreign Minister Kiichi Aichi, and the Vice Minister of Foreign Affairs, Mr. Nobuhiko Ushiba (who is rumored to be the next Japanese Ambassador to the United States). At the conclusion of my discussion with the Foreign Minister, he expressed his deep appreciation for the understanding attitude which you displayed toward Japan

last November and I promised to convey his sentiments to you.

"I also visited Japan's first US-built nuclear power station, and two additional US-type power reactors now in an advanced stage of construction, and paid a visit to Expo '70. In addition, I signed a long-term fuel supply contract with the Kansai Electric Power Company – our sixth such contract in Japan – which provides for our furnishing of uranium enrichment services valued at more than \$82,000,000 over the life of the contract.

"I was especially pleased to have had the opportunity during this visit to pay a visit to three distinguished Japanese scientists at Osaka University, with whom I had corresponded on a research project of mutual interest before World War II. This reunion attracted favorable Japanese press interest, as did our visit as a whole.

"Japan is rapidly becoming a world leader in the use of nuclear power, with 24 plants, totaling over 16 million kilowatts of electric power in operation, under construction or to be placed under construction through 1974. By 1985, conservative estimates indicate that Japan will have 40,000,000 kilowatts of nuclear electric power in operation. If this estimate is exceeded by a modest margin, as seems likely, Japan will surpass both Great Britain and Germany in the application of nuclear power, and will be second only to the United States in this field.

"Following the purchase of a British nuclear reactor for its first nuclear power station, Japan has turned exclusively to US light water, enriched uranium, reactor technology to meet its nuclear power needs. This has resulted in a major US market for nuclear power equipment and enriching services. To date US sales of reactor equipment and services other than enrichment to Japan total \$320 million and the enriching services provided for at present under our Agreement for Cooperation are valued at approximately \$530 million of which \$295 million are already firmly contracted for under the six contracts I have already mentioned.

"As Japanese industry gains experience in the construction of nuclear power plants, direct US equipment exports will become small. However, licensing arrangements with US industry will continue to provide important revenues. The sale of US enriching services can be greatly extended beyond the presently authorized level, as discussed in more detail below.

"During my visit I discussed with Japanese officials two issues which I believe to be of major importance to the United States: first, the question of assurances for the supply of additional enrichment services to meet Japan's

growing nuclear power requirements; and second, the need to develop safeguard arrangements between Japan and the IAEA which will lead to Japanese ratification of the non-proliferation treaty.

"1. Fuel Assurances

"Japan is almost totally lacking in economic fossil fuel resources, and has nearly exhausted its hydroelectric capabilities. It is currently importing fossil fuel for power generation valued at approximately \$500 million annually, a figure which will grow to \$2.5 billion annually, by 1985, even with the major nuclear power program to which I have referred. For Japan, therefore, nuclear power is perhaps more important and advantageous than for any major industrial nation in the world.

"At the contract signing ceremony to which I have referred, I pointed out that foreign exchange savings to Japan through avoidance of oil imports resulting from this project alone amounted to more than \$300 million over the life of the contract. Foreign exchange savings for the entire program of reactors to be started through 1974 can be estimated at \$8 billion. The signing of this contract during my visit to Japan received widespread favorable press coverage and provided a dramatic demonstration of the value and importance to Japan of US cooperation in the peaceful uses of nuclear energy.

"Our current Agreement for Cooperation with Japan, which was concluded in 1968, provides for the supply of 161,000 kilograms of U-235, covering the long-term requirements of the nuclear power plants which Japan then planned to start building through 1971. As I have already indicated, the value of these enriching services at current charges is approximately \$530 million. Our policy and procedures call for the periodic revision of these agreements for cooperation to cover the long-term fuel needs of additional reactors which cooperating countries expect to build, since the agreements were last updated.

"In the past, we have been willing to consider the inclusion of fuel for plants for which construction is to be started within a period of up to five years from the date of the agreement or amendment, although, in practice, allocations have often covered less than five-year programs since realistic power planning is not always available for periods as long as five years ahead. This approach has allowed long-term program planning by the consuming country, thereby improving the likelihood of continued selection of US-type enriched

uranium reactors, and has also been valuable to our own production planning.

"In preparation for the Japanese meeting, the Commission concluded that further allocations of enrichment services abroad under agreements for cooperation should be limited to plants for which construction would begin within about three years, i.e., through 1973, rather than up to five years ahead as in the past. This approach would result in providing assurances of fuel availability for plants scheduled to be completed through about 1978, the last year for which enriching capacity is clearly adequate in the absence of the cascade improvement program.

"During our discussions with the Japanese, we received a formal request to provide fuel for 11 additional Japanese reactors now scheduled to be built through 1974, totaling nine million kilowatts. Enriching services corresponding to this additional increment of fuel would have a value of \$700 million at current charges. In addition to this specific request, both Japanese Government and industrial leaders stressed the importance which they attach to the continued readiness and capability of the US to meet all Japanese enrichment requirements as they arise. This point was forcefully made to me by Foreign Minister Aichi, and was also the subject of a 'petition' presented to me by the Federation of Electric Power Industries, representing the entire Japanese electrical utility industry.

"We advised the Japanese of our readiness to initiate the steps necessary to provide additional enriching services to cover the eight more reactors to be built in Japan through 1973, totaling six million kilowatts, but not the three additional plants scheduled for a 1974 construction start. I believe that our explanation to the Japanese of our inability to commit enriching capacity which is not yet in being or firmly authorized was accepted as a reasonable position under the circumstances. Nevertheless, the Japanese were disappointed by our inability to provide firmer assurances that future needs arising beyond the capacity of our existing plants will be met.

"A related issue which arose frequently during our discussions was the possibility of cooperation with Japan in its own efforts to achieve a uranium enrichment capability. Japan is devoting a significant effort to research and development on both the gas centrifuge and gaseous diffusion process. In the long run, it is not realistic to expect that Japan will be willing to remain dependent on a single outside source of supply for enriched uranium, which will account for 25% of its

total electric power needs by 1985, and an increasing proportion thereafter.

"I informed the Japanese that our policy in regard to cooperation in the enrichment field was under study, and that I was not certain what decision we would reach. I noted, however, that if we should decide to cooperate in this field, our ability to do so with specific countries might well take into account the status of their adherence to the non-proliferation treaty.

"While the continued supply over the indefinite future of all of our partners' needs for uranium enrichment would be a most fortunate circumstance for the United States, it is not achievable. I believe, therefore, that it is in our interests to cooperate in this field abroad under carefully worked out arrangements which both protect our security interests and preserve our direct export market to the maximum feasible extent. Japan and our other partners are seeking not to displace the US as a supplier of enrichment services, but, rather, to diversify their sources of supply. Thus, the objectives of cooperation on the one hand and continued supply of enrichment services on the other are consistent. Positive recommendations concerning US cooperation in uranium enrichment abroad, based on a joint study by the Commission and the Department of State, were recently forwarded to you by Under Secretary Richardson.

"2. Non-Proliferation Treaty

"The other principal issue in our discussions in Japan was that of safeguards under the non-proliferation treaty. Japan has conditioned its ratification of the treaty on the development of satisfactory safeguards arrangements, and this problem was the principal subject of Foreign Minister Aichi's discussion with me, as well as that of Vice Minister Ushiba. Japan's concerns with the safeguards are twofold: first, that they be simplified as far as possible, and second, that they be applied to Japan on a basis which does not place it under any disadvantage in relation to the Euratom member states.

"These issues are of direct concern to Japanese industry, and Foreign Minister Aichi told me that the Japanese Government would find it impossible to ratify the treaty if industries' concerns are not met. This point of view was confirmed in a conversation which I had with Mr. Tamaki Ipponmatsu, President of the Japan Atomic Power Company, a pioneering and influential member of Japan's nuclear industry, who has been largely instrumental in Japan's adoption of US-enriched uranium reactor technology.

"In my responses to these statements, I stressed that the United States was not rigid in its attitude toward safeguards, and that, on the contrary, it too favored the maximum possible simplification of safeguards procedures consistent with their continuing effectiveness. I pointed out that we are conducting a substantial and promising research and development program directed toward the goal of simplification of safeguards. Most importantly, as I reiterated, the US has offered to place its own peaceful facilities under the same safeguards as will be applied in Japan and elsewhere, thus assuring a common interest on our part in the maximum possible simplification of IAEA safeguards.

"While providing these assurances of our flexible attitude, I stressed that we could not accept safeguards based merely on a determination of the effectiveness of national safeguards systems, since this would depart from the principle of independent international verification clearly called for by the NPT.

"In addition to explaining our position in these terms in private conversations, I took the opportunity of making US views clear in my address to the Japan Atomic Industrial Forum, in view of the crucial role of Japanese industry in the safeguards issue.

"I believe that considerable progress was made in these discussions in satisfying both Japanese Government and industry of the reasonableness of our position, and in obtaining constructive clarifications of Japanese views. For example, Vice Minister Ushiba informed me that Japan would not seek to replace international with purely national controls, while other Japanese officials indicated that Japan would not object to distinctions in the detailed application of safeguards in the Euratom countries, provided the principle of independent verification was also enforced there.

"As a result of our discussions, I am optimistic that the problem of safeguards, while remaining extremely difficult and complex, can be satisfactorily resolved, thus opening the way for Japanese and other important ratifications of the treaty. I believe the Atomic Energy Commission has an extremely important contribution to make in finding the way to this solution.

"Our meeting with the Japanese Atomic Energy Commission covered several other items relating to our cooperation in the peaceful uses of nuclear energy. Principal among these was our relationship in the field of nuclear merchant ships.

"Japan is now building its first nuclear merchant ship, the NS *Mutsu*, which, on completion about 1972, will be the

third such ship in the free world (preceded by the NS *Savannah* and the recently completed German ship, the *Otto Hahn*). The NS *Mutsu* follows the NS *Savannah* by ten years, and we believe that design and operating results obtained from it can, therefore, be of considerable utility to the United States at such time as we find it desirable to build additional nuclear merchant ships. During our discussions, the Japanese agreed to a US proposal of a year ago to furnish NS *Mutsu* operating information in exchange for the comparatively minor amount of similar information concerning the NS *Savannah* which is not already publicly available.

"As a related matter, we discussed the problem of the Japanese inability so far to allow entry of the NS *Savannah* into Japanese ports under realistic indemnity arrangements. I pointed out that the NS *Savannah* has already visited the ports of twenty-four nations under satisfactory arrangements, and that, unless Japan is able to provide a similar opportunity, we may face great difficulty in arranging for the entry of the *Mutsu* and future Japanese nuclear merchant ships into US ports. The Japanese difficulty arises out of the lack of legislative authority to make satisfactory indemnity arrangements. I believe that our discussions were helpful in assuring that the Japanese Government will now proceed seriously to seek this authority.

"The Japanese officials pointed out to us that under current US legislation, the entry of foreign nuclear merchant ships is completely barred, and they expressed the hope that our own authority would be granted in the near future. Legislation providing for the entry of foreign nuclear merchant ships was recommended by the Commission last year, and is under consideration by the concerned agencies.

"We also covered in our meetings the prospects of nuclear power in both Japan and the United States. We agreed that in both cases the prospects are extremely favorable. As in the United States, Japan is suffering severely from air pollution and they look to nuclear power to aid significantly in alleviating the problem. We discussed our technical cooperation in a number of areas of the peaceful uses of nuclear energy, and agreed that it is mutually beneficial and proceeding well. In addition, we discussed the supply of other important nuclear materials, especially heavy water and plutonium. We gave the Japanese some encouragement that heavy water critically needed by them in 1974 for a demonstration advanced converter reactor will be available, and suggested that an arrangement providing US access to the results of this developmental program could be helpful in assuring this availability.

"I believe that our visit and the joint meeting of our two Commissions served significantly to advance our already close cooperation with Japan in the peaceful uses of nuclear

energy. This cooperation, especially in the supply of enriching services, is likely to be more intense than that with any other nation, and overwhelmingly serves US political and economic interests."

Later in April I was visited on two different occasions by official Japanese delegations, and the issue of the *Savannah* and *Mutsu* was discussed further, as well as the safeguards question:

"April 13, 1970 - Washington, DC

"From 11:00 to 11:15 a.m. I met with Shuichi Sasaki (President), Sumio Hori, and Hirofumi Ochi of the Japan Nuclear Ship Development Agency. Takao Nakajima from the Japanese Embassy, Myron Kratzer, Les Staebler and Julie Rubin were also present. Sasaki told me that this was essentially a courtesy call. He asked whether we had any plans for a future nuclear merchant ship, and I said that our plans had not yet been formalized - that is, whether it would be a government ship or a privately-owned ship, or whether it would be preceded by a land-based prototype. He said that because of the new Diet, which now has a majority of his liberal Democratic party, the views of the Socialist Party aren't as important as they were, and he feels confident that legislation to permit the *Savannah* to enter Japanese ports might be passed this fall. If that is the case, they would be interested in an agreement for cooperation in the nuclear maritime field and he asked my opinion on this. I agreed that this would be a good idea. I emphasized again the importance that we attach to getting an early agreement for the entry of the *Savannah* to Japanese waters because of its short operating life and, if the agreement comes after it has stopped operating, the Congress might not be very inclined to allow the *Mutsu* into US harbors.

"I raised the question of whether the matter of their receiving reports translated into English had been resolved, and Kratzer indicated that he thought this, as well as the extension of the agreement for a three-year operation period of the *Mutsu*, as we had required, had both been resolved. Sasaki said that he was meeting with Gibson and his staff this afternoon at 3:00 p.m. and that at that time he will discuss this matter of the *Savannah* entry into Japanese ports and the matter of an exchange agreement."

"Friday, April 24, 1970 - Germantown

"At 9:30 a.m. I welcomed the members of the Japanese Atomic Industrial Forum Industrial Mission who are here to attend a meeting on the Non-Proliferation Treaty International Safeguards. The Japanese delegates present were: Saburo Seno (Leader-President, Mitsubishi Atomic Power Industries, Inc.), Hiroshi Murata (V.P., Japan Atomic Energy Research Institute),

Kikuo Takahasi (Director, Japan Nuclear Ship Development Agency), Yasuji Nakamura (Manager, Nuclear Fuel Division, PRNC), Kotaro Wake (General Managing Director, Furukawa Electric Co., Ltd.), Shiro Hoki (Managing Director, Sumitomo Electric Industries, Ltd.), Kazuhisa Mori (Secretary General, Japan Atomic Industrial Forum, Inc.), Osamu Sato (Assistant Manager, Atomic Power Department, Chubu Electric Power Co.), Takashi Waraya (Director, Japan Nuclear Fuel Co., Ltd.), Kiichiro Watanabe (Manager of Planning, Japan Atomic Power Co.), Tohru Haginoya (Assistant Manager, Metallurgy Dept., Mitsubishi Metal Mining Co.), Shinichiro Asao (First Secretary, Japanese Embassy), and Takao Nakajima (Second Secretary, Japanese Embassy). Other presents were: John P. Trevithick (Deputy Director for Programs) and Robert C. Liimatainen (Science Officer) of the State Department; Charles Van Doren (Deputy General Counsel) and Lorin R. Stieff (Physical Science Officer) of ACDA; Commissioner Larson, Bob Hollingsworth, Myron Kratzer, Del Crowson, Allan Labowitz and others.

"I said that we are especially happy to have them visiting us for discussions on international safeguards under the NPT because this is a matter of uppermost importance to all of us. I said I wanted to personally assure them that the United States is vitally interested, as they are, in the maximum possible simplification of the safeguards system. I said we feel that the fundamental principle of safeguards is that of independent verification by an international inspectorate. So long as this principle is maintained, we in the United States will welcome any improvements in safeguard techniques which have a sound technical basis. We are making strong efforts to hasten these improvements by conducting a major research and development program on safeguards techniques. I said we see safeguards in an affirmative way - not primarily as a means for detecting violations but rather as a means by which countries can demonstrate to the world at large that their peaceful programs are indeed peaceful. Without this means of demonstrating, especially under a Non-Proliferation Treaty whose partners necessarily include many nations with adverse interests, much of the benefit all of us hope to realize from the Treaty would be lost. I said that I hoped that the result of today's talks will be a better understanding of the issues involved and the means to assure a workable system that will be satisfactory to all participants.

"Mr. Seno responded by introducing each of the members of his Mission. He then described how seriously the problem of IAEA safeguards was taken in Japan and that they still had problems with them. He said he would be interested in hearing the detailed discussion of how these could be simplified. He went on to say that he had heard people say, during the visit to Europe which included Brussels, West Germany, the Netherlands, and Sweden, that Japan and West Germany intended to produce nuclear weapons. He rather emotionally described

his pre-war residence in Nagasaki and his knowledge of the devastation wreaked by the US atomic bombs in Nagasaki and Hiroshima and said that the Japanese people remember this and were in no mood to further such destruction by the development of nuclear weapons. I made a short response, emphasizing that this Japanese Mission had no precedence among other nations and indicated the extreme consideration with which the Japanese were approaching this serious subject. I said I thought that Mr. Seno's conversations regarding Japanese intentions in the nuclear weapons field was not representative of world opinion and that, on the basis of my recent visit to Japan and my discussions with the Japanese, I could detect no intention on the part of the Japanese to produce nuclear weapons."

The continued high-level interest of the Japanese Government in the nuclear questions discussed during our Tokyo meetings was reflected by a visit paid us in Washington less than three months later:

"Monday, June 15, 1970 - Germantown

"At 10:00 a.m. Commissioner Larson and I, together with Del Crowson (USAEC Director of Safeguards and Materials Management), Abe Friedman, Bill Yeomans, Julie Rubin and other staff, met with the following Japanese Diet members: Maseo Maeda, Director of the Special Committee on Development of Science and Technology (SCDST), House of Representatives; Yoshikazu Kitagawa, Chairman, SCDST; Committee Directors and Members Haruo Kino, Yoshitake Sasaki, Hironori Inoue, Mikio Ohmi, and Tsugio Ishikawa; Takao Fujimoto, Parliamentary Vice-Minister, Science and Technology Agency, Prime Minister's Office; and Masaoki Terashima, Specialist, Planning Bureau, Science and Technology Agency.

"I gave the opening remarks. The group's leader, Maseo Maeda, responded, as did Sasaki and Ishikawa. Ishikawa emphasized Japanese dissatisfaction with the degree of guarantee against nuclear attack provided by the Non-Proliferation Treaty. They all spoke of their concern with the intrusion of the IAEA safeguards in their nuclear industry. Fujimoto asked about the additional enriched U-235 that they will require soon, and I said that our staff is prepared to negotiate this question immediately. Fujimoto gave me a little transistor radio as a token of his appreciation for my visit to Japan in March. He participated in our joint meeting at that time."

The report that Vice Minister of Foreign Affairs Ushiba would be assigned to Washington proved correct, and in the months that followed we had opportunities for useful discussions of major topics of mutual concern. On November 12, 1970, for example:

"Myron Kratzer and I had lunch at the Metropolitan Club with the Japanese Ambassador, Nobuhiko Ushiba, and Takao Nakajima (First Secretary and Atomic Energy Attaché of the Embassy). This was in return for the dinner the Ambassador hosted for me when I visited Tokyo last March. We discussed the safeguards problems that bother Japan and expressed appreciation for their cooperation in the current discussion on this subject in the IAEA Committee that Kratzer has been attending. We reiterated the importance of international verification of the safeguards and our intent to keep the safeguards as simple as possible. We also discussed the progress of fast breeder reactor development in the US and the general problems of reactor siting in the US and Japan. I said that we would send him a reprint of my article on fast breeder reactors appearing in the current issue of *Scientific American*. We also discussed the current textile negotiations between Japan and the United States in which he is representing Japan...."

And two months later, on January 13, 1971:

"I attended a luncheon hosted by Ambassador Nobuhiko Ushiba of Japan at his residence. Also present were Minister Mizuo Kuroda, Shinichiro Asao (First Secretary for Information), Takao Nakajima, and Chihiro Tsukada (First Secretary for Political Affairs) of the Japanese Embassy; and Commissioner Larson, Myron Kratzer, and several members of our Division of International Affairs; Dixon Hoyle, Bill Yeomans, Sam Tatalovich and William Hill. The main business discussed involved the questions of our formally approving an additional amount of enrichment services (174,000 kilograms of U-235) for reactors scheduled to start by the end of 1973. We said that this was being considered in the context of our overall supply situation but that we thought we could meet these requirements and that an agreement could be drawn up within about six weeks."

In connection with Japan's desire for a US commitment to supply additional quantities of enriched uranium, it may be recalled that at the time we met with the Japanese Diet group in June 1970 we anticipated speedy action on this matter. Various considerations slowed negotiations, however. A major reason for delay, as indicated in the above report of our discussion at the Japanese Embassy, was the US decision to review our policies in this area in the light of expected world-wide requirements *vis-à-vis* our enrichment capability. On June 1, 1971, we were able to inform the Japanese of our readiness to resume active negotiations on the matter. On the basis of these negotiations, a proposal was developed for an amendment that would raise the maximum quantity of U-235 transferable under the 1968 Agreement to 335,000 kilograms – enough to assure fuel for a total of 26 Japanese nuclear power projects.

Following the USAEC-JAEC meeting in Tokyo, staff consultations and negotiations on technical exchanges were conducted in line with our discussions there. In June 1971 agreement was reached on details of a technical exchange arrangement in the field of safeguards, and plans were made to initiate cooperation in this field with a Japanese team's visit to the United States that fall. The previously established exchanges in ceramic fuels and fast breeder reactor development continued to be active — especially in the fast breeder area. Exchanges in radiation chemistry, on the other hand, came to an end; the USAEC had terminated its research in the areas included in our arrangement, and the Japanese did not appear interested in engaging in areas in which we had no ongoing projects.

Circumstances prevented the proposed exchange arrangement in the field of nuclear ships. The years 1970 and 1971 passed without Diet approval of legislation to permit the entry of such ships into Japanese ports; and meanwhile, as had been contemplated, the decision was made to suspend commercial operation of the US ship *Savannah*.

Japan's concern about adequate supplies of enriched uranium was one of the topics raised with me by JAEC Commissioner Akira Matsui in a conversation on June 2, 1971. Mr. Matsui, a diplomat, had only recently been appointed to the JAEC. He had come to the United States to attend the second meeting, at UN Headquarters in New York, of a group of experts asked to study the economic and social consequences of the arms race and military expenditures. He called on me in Washington, accompanied by Messrs. Takao Nakajima and Ryohei Murata of the Japanese Embassy. Present with me were Abraham Friedman, Deputy Director of the USAEC Division of International Affairs (DIA), my assistant Julie Rubin, and Billy Hill of DIA.

Commissioner Matsui wished to discuss three important problems he believed confronted Japan with respect to its nuclear power plant program. The first, he said, was that of uranium ore supplies. On this point, I told him there should be no problem. Julie Rubin pointed out that known reserves were sufficient for power needs for several decades; and I mentioned our confidence that breeder reactors would come into operation during the period 1985 - 1990, leading subsequently to a leveling-off of uranium requirements. Mr. Matsui next spoke of enriched uranium supplies; and Dr. Friedman advised him of our action taken the previous day regarding resumption of negotiations. Mr. Matsui expressed the belief that in the future Japan might need to develop its own enrichment facilities.

Turning to the third problem he said faced Japan — nuclear safety — Commissioner Matsui mentioned specifically the concern that had arisen regarding the emergency core cooling systems (ECCS) in light-water reactors, which had been reported in both the US and Japanese press. The ECCS, part of the defense-in-depth concept of power reactor engineering, are designed to mitigate the consequences of the highly unlikely failure of both the normal safety systems and the additional accident prevention devices built into light-water power reactors. The USAEC and the nuclear industry conduct continuous studies of reactor safety, including ECCS technology. In the spring of 1971 some tests at our National Reactor Testing Station (NRTS) in Idaho indicated that the margins of ECCS performance, in the case of a postulated, improbable loss-of-coolant accident, might not be as large as

previously predicted. Therefore, although the tests involved simplified models and there are significant differences between these semi-scale experiments and large power reactors, our Regulatory Staff undertook a review of the systems to determine whether improvements were needed.

Probably partly because press information was incomplete and therefore readily misinterpreted, the Japanese newspapers made big news of the matter, creating the impression that there was a serious safety problem. Under the circumstances, especially in view of Japan's large nuclear power program based on light-water reactors, the concern expressed by Mr. Matsui was understandable. I was glad of this opportunity to clarify the problem in personal discussion with a member of the JAEC. I emphasized the fact that the theoretical defect had been detected in a mock-up system, and I assured Mr. Matsui that there was no need for any operating reactors to be shut down. He expressed the belief that a visit by a Japanese team to NRTS would go far in dispelling fears.

As a matter of fact, preparations for such a visit were already being explored, pursuant to telegraphic exchanges between USAEC Headquarters and our mission in Tokyo. The Japanese ECCS study group came to the United States in mid-June, visited NRTS, and consulted with USAEC regulatory and reactor experts. On July 1, after receiving the team's report, JAEC Chairman Nishida released a statement in Tokyo giving the background on the matter and declaring that after careful review the JAEC had concluded that it was not necessary to shut down operating reactors or impose additional restrictions on their power level.

Even though the extent of concern sparked by the ECCS model tests seems unfounded, no sensible person would deny that many difficulties remain to be mastered now and at every future stage of nuclear power's striking advance. Whatever the problems, I am confident that Japan will be among the leaders in solving them, because Japan is strongly committed to nuclear power. A Japanese position paper distributed at the 4th International Conference on the Peaceful Uses of Atomic Energy, held in Geneva in September 1971, predicted that 40 percent of Japan's power would be nuclear by 1990, and 50 percent by the year 2000. A Japanese delegate at Geneva declared that atomic energy is linked to the entire industrial future of Japan. Small wonder that, as indicated in this account, Japan has been pushing research in advanced reactor concepts, fast breeder development, and processes for enriching uranium for use in reactor fuel. Regardless of how much enriched uranium can be obtained from the United States, Japan knows that its anticipated requirements, when combined with those of the United States and other nations who wish to purchase from us, will in time exceed our enrichment capacity. In addition to conducting research in this area, therefore, Japan — like the Euratom countries, Canada and Australia — has periodically expressed interest in obtaining access to US enrichment technology, which has remained highly classified. When we finally announced, on July 28, 1971, that we were prepared to explore the idea of sharing the advantages of this technology with nations cooperating with us in peaceful nuclear applications, Japan was quick to accept our invitation to participate in discussions to this end.

With a nuclear research budget of \$140 million a year and a research force of almost 4000, Japan clearly intends to remain in the forefront in nuclear technology. The views expressed to me by Japanese leaders indicate that they will continue developing this technology exclusively for peaceful purposes. Japan has not yet (as I write) ratified the NPT,* but no nation has better reason to forestall the spread of nuclear weapons and increased danger of nuclear war.

*As reflected in various discussions reported above, Japan decided to await the outcome of Euratom-IAEA negotiations on NPT safeguards administration before initiating ratification procedures. The April 5, 1973, approval (by the Council of Ministers of the European Communities) of the EC-IAEA Safeguards Verification Agreement seemed to pave the way for Japanese action. But delay continued for various reasons, particularly Japan's desire for treatment equal to that accorded Euratom and the resultant need to establish a domestic Japanese safeguards system able to perform the function exercised by the Euratom system. Finally, on Monday, May 24, 1976, Japan ratified the NPT.

CHAPTER 10

INDIA

Among the earliest proponents of international nuclear cooperation was the brilliant Homi Jehangir Bhabha. I first met this outstanding physicist, the "father of nuclear science in India," at the 1955 Geneva Conference on the Peaceful Uses of Atomic Energy, at which he officiated as President. During the ensuing years I came to know him well, and we saw each other many times before his tragic and untimely death in January 1966.

Under Bhabha's energetic direction, the Indian nuclear program launched in 1948 had made tremendous strides by 1961, when I became Chairman of the USAEC. At the Atomic Energy Establishment near Bombay, installations already in operation included a thorium nitrate plant, a uranium refinery, a fuel element fabrication facility, a radiochemistry laboratory, a facility for the manufacture and repair of electronic instruments and two research reactors. Construction was under way or soon to start on other important facilities, including a plutonium separation plant. At Nangal, a heavy water production plant was under construction. Furthermore, plans were being made for India's first nuclear power plant. In fact, although the Indian program was concerned with atomic science applications in such fields as medicine and agriculture, as well as fundamental research, a major goal was the nuclear generation of electricity. Long before the establishment of India's Atomic Energy Commission, and even before the end of World War II, the far-sighted Bhabha had envisioned the day when atomic energy would help meet India's vast power needs (and possibly, in his view, her defense needs).

While in 1961 no formal Agreement for Cooperation had been signed between India and the United States, effective cooperation was under way. For example, the United States had supplied heavy water for the research reactors at Trombay; a technical depository library had been provided; numerous Indians had participated in USAEC training courses; and over a hundred shipments of radioisotopes had been made from the United States to India.

My first meeting with Bhabha in my capacity as USAEC Chairman took place in London. I had stopped off there to confer with UK officials on my way to the Fifth General Conference of the IAEA. At that time the imminent election of a new IAEA Director General was a matter of strong disagreement between us and the Indians, who did not share our view that Sigvard Eklund would be the best man for the position. This question was the main subject of our discussion in London:

"Friday, September 22, 1961 - London

"I had breakfast at the Dorchester Hotel with Homi Bhabha. He deplored the Soviet resumption of nuclear

testing and the way it was done. We explored the basis of his opposition to Eklund as Director General of the IAEA. Possibly he will lessen his opposition on the basis of my suggestion that the Director General following Eklund should be from some developing country of Asia, Africa or South America, possibly from India. He will change his plans and come to Vienna before I leave and will arrange for me to see Lall (India's Ambassador in Austria) in Vienna to discuss this further."

The subject was explored further in conversations in Vienna with Bhabha and Ambassador Lall, though without any meeting of minds. The bitterness roused by this question is reflected in my brief journal mention of comments at a reception held shortly after Eklund's election as Director General:

"Tuesday, October 3, 1961 - Vienna

"I attended a reception given by the Austrian Government at the Schonbrunn Palace, where I met the Chancellor of Austria and other government officials. Vasily S. Emelyanov and Bhabha are saying that they will recommend that their countries withdraw from the IAEA. Emelyanov reiterates that he will not attend any more IAEA meetings and will not allow any other Soviet scientist to do so (this includes especially meetings of the Scientific Advisory Committee)."

Eklund's distinguished performance as head of the IAEA soon healed the divisions that had attended his election, and the threat of withdrawals was dissipated. Both Emelyanov and Bhabha were on hand to represent their countries at the IAEA's Sixth General Conference a year later.

Usually, of course, our bilateral cooperation was a principal subject of my discussions with Bhabha in 1961 and later, both abroad and during his occasional visits to the United States. India's interest in nuclear power, already mentioned, led to a significant development in our cooperation in the early sixties. Originally, Indian plans contemplated a primary emphasis on reactors utilizing natural uranium fuels. With the passage of time, however, these plans changed, and a US-type light-water plant, fueled with slightly enriched uranium, was selected for the country's first atomic station - Tarapur. Two extracts from my journal illustrate the course of discussions that led to the Tarapur project:

"May 31, 1962 - Washington

"I met with Kenneth Galbraith (Ambassador to India) at the State Department, along with Whitman, Smyth, Wells and others to discuss US support for a 300 MW GE reactor at Tarapur, India. We agreed to do it if a study shows it to be economically feasible (as it appears to be) and if within previously determined US aid to India."

"July 11, 1962 - Washington

"I hosted a luncheon at the Mayflower Hotel for M. N. Chakravarti (Administrator), M. Dayal (Staff Engineer) and Dr. M. R. Srinivasan (Staff Engineer) of the Indian Tarapur Atomic Power Project. Others present included Mr. Moorthi (Economic Minister, Indian Embassy), Dr. Aran Ghosh (First Secretary, Indian Embassy), Commissioner Wilson, Gen. Luedecke, Ed Ferguson, Algie Wells, Frank Pittman, Harold Price, Myron Kratzer, Chris Henderson, Carl Thomas (State) and Hal Bengelsdorf. The Indians have decided to buy a General Electric or Westinghouse enriched uranium plant for Tarapur. They want fuel guarantees, plutonium buy-back, and AID loan (which is apparently forthcoming), and a fuel lease (apparently not to be granted)."

The choice of Tarapur was based on various factors. One was a finding by a US team (led by Myron Kratzer), after a trip to India, that plants of this type could be installed at a few selected points there to yield power costs within range of the cost of conventional power generation at the same sites. Another factor was the submission by a US-based manufacturer (International General Electric) of a turnkey bid regarded by India as the most satisfactory of those submitted. At least equally important was the prospect of making advantageous financial arrangements for purchase of the US reactor - a prospect fulfilled in the terms of an \$80-million loan approved by the US Agency for International Development.

To permit US collaboration on this project, a US-India Agreement for Cooperation in the Civil Uses of Atomic Energy was negotiated, providing for the exchange of information "with respect to the development, design, construction, operation, and use of the Tarapur Atomic Power Station, including research and development related thereto and problems of health and safety..." and providing also that the USAEC would sell to India all the enriched uranium required to fuel the plant. The Agreement specified safeguards arrangements to give assurance that no material, equipment, or device made available for use in Tarapur would be used for other than peaceful purposes; and the parties expressed agreement in principle that "at a suitable time" the IAEA would be asked to enter into a trilateral agreement for the implementation of the safeguards provisions. The negotiation of the safeguards clauses was difficult and protracted, as indicated by several entries in my journal for the spring of 1963:

"Monday, March 4, 1963 - DC Office

"Commissioners Haworth, Ramey, and I, Wells, Luedecke and others met with Dr. Homi Bhabha (Chairman, Indian AEC), Chakravarti (Project Administrator, Tarapur Reactor), Jagannathan (Member, Indian AEC), Ghosh (First Secretary, Indian Embassy), Maheshwar Dayal (Physicist, Engineer in Charge, Tarapur), and M. R. Srinivasan (Nuclear Engineer, Tarapur) to tell them that the US will insist on IAEA safeguards for the Tarapur Reactor."

"Thursday, March 7, 1963 - Germantown

"The Commissioners hosted a luncheon for Dr. Bhabha, Jagannathan and Chakravarti in the Dining Room. The Indians are now attempting to circumvent the agreement in principle to the application of IAEA safeguards to the US-aided Tarapur Reactor. I said that the US will insist on our position."

"Friday, June 7, 1963 - DC Office

"I called Ambassador Galbraith, who said he had talked with Senator Pastore on the telephone regarding the Tarapur project and, among other things, was careful to tell him there was face-saving language in the agreement, but it did put the IAEA into the picture. He gave Pastore a short outline of the background of the situation. Pastore told him he didn't want to be troublesome on this; if we were insisting on international inspection we needed to press with the Indians as well as the Russians."

"I called John Conway and told him I had talked with Pastore and that I had also talked with Ambassador Galbraith about the Tarapur project. I mentioned that Galbraith made the point that the particular language in the agreement had some face-saving aspects, and that Bhabha has had to come a long way on this, and that the language and the intention are definitely that the IAEA will be in the picture on inspection. Dr. Bhabha called me from Seattle to try to get me to agree to have the IAEA Board of Governors postpone action at their June meeting in Vienna to adopt safeguards for reactors above 100 MW. I refused and said his insistence could jeopardize the Tarapur agreement."

"Monday, June 10, 1963 - DC Office

"Lyman Fink (GE) called about the Tarapur project. He had heard that we're having problems with Bhabha and that we may be building up to an impasse. I discussed the problem with him and told him of my conversation of a day or so ago with Bhabha. Fink said that much of Bhabha's concern has to do with implementation of some of the agreement's details; regarding inspection of hardware, for example, he is afraid that when it comes time for an inspection, say 10 years from now, the composition of the IAEA officials will have changed, and there may be a different interpretation put on the matter. I agreed that Bhabha may have a legitimate concern, but it should be handled legitimately, rather than just pursuing delaying tactics."

In my bi-weekly report to President Kennedy, dated June 11, 1963, I summarized the situation as follows:

"In my bi-weekly report of May 14, I mentioned that we were nearing the completion of negotiations between the United States and India on the establishment of appropriate safeguards for nuclear materials. This agreement is of particular importance in view of the proposed Tarapur Atomic Power Station (two 190 megawatt power reactors).

"While the Joint Committee has been kept currently informed of the negotiations between the United States and India, Senator Pastore told me recently of his increasing concern relative to the proposed safeguards arrangements and his desire to meet with you on this and other matters in the near future. I hope to meet with Senator Pastore soon - in an effort to resolve the several points he has raised - as well as with Dr. Homi Bhabha, Chairman of the Indian Atomic Energy Commission, on June 18. Although we are keeping Mr. Bundy's office currently informed, the following summary is submitted for your information:

"The proposed arrangement, accepted by the Indian Government after referral to Prime Minister Nehru, provides that the Indian Government agrees in principle that Agency safeguards will apply to the project after the Agency has developed a system of safeguards for large reactors generally consistent with the bilateral safeguard provisions specified in the proposed bilateral agreement, which would prevail initially. Senator Pastore believes that the Indians should agree unconditionally to the acceptance of Agency safeguards when these are developed.

"Subsidiary to this question, Senator Pastore is concerned over a difference of interpretation between the United States and India as to the precise role the Agency would have in implementing the safeguard arrangements. The United States had advised India that we believe the Agency should have the primary responsibility in administering the safeguards, while India believes that the Agency role may be somewhat less comprehensive than this, with the United States retaining some degree of participation even after the Agency has begun to administer the safeguards. The Committee is also concerned that the Indians may not cooperate, and in fact, may actively oppose the development of a system of safeguards by the IAEA, the adoption of which is a precondition to the Agency's being requested to take over administration of the safeguards under the bilateral agreement.

"The US position on these questions, developed and presented to the Indian Government by the Department of State with the assistance of the Commission, is briefly as follows:

"From the beginning of the negotiations, the US has sought only 'agreement in principle' to Agency safeguards from the Indians. Not only did we believe that it was unreasonable to request other governments to bind themselves to the acceptance of an Agency system which has not yet been defined, but we have been concerned that the United States should not be bound to an Agency system which may prove to be inadequate. The agreement as now drafted, while it employs the term 'agreement in principle,' in fact unconditionally requires that the Agency be invited to enter into an arrangement for the application of safeguards if the Agency system is generally consistent with the bilateral system. The difference in interpretation as to the role of the Agency when it begins to administer safeguards is a comparatively narrow one since the Indians acknowledged that the Agency should have a responsible role. While we prefer the position that the Agency should have the prime responsibility and that the US should not continue to participate in safeguards once the Agency has taken over, we did not rule out some degree of continuing US participation if the Agency has no objection.

"The United States has advised India of our concern over obstructionism on their part in the development of an Agency system that would be generally consistent with the bilateral system, and at the same time we have considered it inappropriate to request the Indians to abandon positions they have long held on safeguards in exchange for US assistance on Tarapur to the extent that these positions are not inconsistent with the implied obligation on their part not to prevent the adoption of an Agency system generally consistent with the bilateral system.

"We are inclined to believe that the Joint Committee's attitude on the Tarapur safeguards problem, while undoubtedly representative of their belief in the importance of Agency safeguards, which we share, results equally from a feeling that the Indians should accept our terms on safeguards if they are to receive our assistance on the Tarapur project.

"The approach to negotiating this agreement was one of relying heavily on the United States bargaining power, but at the same time attempting to reach an amicable

meeting of the minds on principal issues and accommodating India's concerns where possible without compromise to the basic principle that Agency safeguards are to be applied to the project at the appropriate time. While the agreement contains compromises, the Indians have accepted this basic principle and in so doing have relinquished their own strong position that the Agency should play no role in the safeguard arrangements. We believe that no better agreement could have been obtained and that the alternative to the present agreement is the elimination of the Tarapur Project. Thus, the issue is one of whether the important benefit flowing to the United States from this major example of cooperation should be relinquished because the Indians are unwilling to accept a safeguards arrangement precisely of the type we would prescribe. Not the least of the benefits to be derived from the Tarapur Project would be the acceptance by the Indians in the first important instance of effective safeguards and their accepting in principle of international safeguards. The agreement would also develop close technical and economic ties between the United States and India in the important area of atomic energy and, in particular, would make the Indians dependent on the United States for the fuel supply of a one hundred million dollar power plant supplying an important part of the power requirements in the Bombay area."

My journal continues with the unfolding events:

"Tuesday, June 18, 1963 - DC Office

"Wiesner called and said he expected to see Bhabha at the Indian Embassy dinner tonight and asked if there was anything new he should know about the Tarapur project. I told him there was a change; that we talked to Pastore yesterday, and by now the new safeguards regulations extending safeguards to higher power levels should have been passed at the IAEA Board of Governors meeting in Vienna. Pastore would like for us to see whether now, since we can confront Bhabha with this, he would agree in principle to the the bilateral safeguards and not disagree to these safeguards in a trilateral agreement. We agreed that we would approach Bhabha on this. I told Jerry if Bhabha pushes too hard and tries to get around these things, the whole thing could fall through."

"Wednesday, June 19, 1963 - Germantown

"Dr. Bhabha came in around noon and we negotiated on the Tarapur safeguards. I then hosted a luncheon for him in the Executive Dining Room. Others attending included C. Krishnamoorthi (Economic Minister, Indian Embassy), A. Ghosh (First Secretary, Indian Embassy),

Commissioners Wilson, Ramey and Palfrey, Phillips Talbot, Ragnar Rollefson, Edwin M. Kretzman (State), Algie Wells, Howard Brown and Joe Hennessey. We told Bhabha that he must agree to the safeguards statement now being adopted by the IAEA Board of Governors. He will let us know his decision."

"Monday, June 24, 1963 - DC Office

"Commissioner Ramey and I, Carl Thomas (State), Algie Wells and Kratzer met with Dr. Bhabha, Mr. Ghosh and Mr. Dayal and reached a final agreement on Tarapur safeguards. They agreed that the IAEA proposed safeguards are consistent with the US-Indian bilateral safeguards, which is the key question bothering Pastore, *et al.*"

"Thursday, August 8, 1963 - DC Office

"I participated in the signing of the Indian Tarapur Agreement with Ambassador Braj Kumar Nehru for India and Assistant Secretary of State Phillips Talbot at the Department of State. USAEC Commissioner James T. Ramey and First Secretary of the Indian Embassy Dr. A. K. Ghosh were also present."

It is interesting to note, incidentally, that on that same date India became a signatory to the Limited Test Ban Treaty concluded three days earlier in Moscow by the United States, the United Kingdom, and the Soviet Union.

Another step forward in 1963 was the coming into force of a US-India agreement (effected by an exchange of notes) to provide for a grant of equipment and materials for the Radiation Medical Centre at the Tata Memorial Hospital in Bombay.

Occasions for discussing developments on the Tarapur project and other matters of bilateral concern were afforded at the IAEA Conferences and at the 1964 Geneva Conference on Peaceful Uses, in the course of which Homi Bhabha was among my guests on the US nuclear ship *Savannah*. Our personal discussions, occasional meetings between other US and Indian officials, and correspondence at various levels soon turned to the idea of extending our cooperation to other areas of peaceful nuclear applications. An opportunity for thorough exploration of possibilities came early in 1965. Knowing that Dr. Bhabha would be visiting the United States in February to attend a meeting of the Scientific Advisory Committee of the United Nations and the IAEA in New York, we arranged to consult with him and his colleagues at that time.

On Friday, February 19, during lunch and a private discussion afterward, Bhabha and I considered various areas in which broader US-Indian



XBB 761-7022

Signing of US-India Tarapur Power Project Agreement at US Department of State, Washington, DC, Aug. 8, 1963. (Left to right) J. T. Ramey, A. K. Ghosh, Indian Ambassador Braj Kumar Nehru, Seaborg, Assistant Secretary of State Phillips Talbot.



XBB 732-1098

At US reception, Palais Auersperg, Vienna, on occasion of 7th General Conference of IAEA, Sept. 25, 1963. (Left to right) Homi Bhabha, Seaborg, Reverend Father Theodore M. Hesburgh (Holy See delegate to the Conference).

nuclear collaboration seemed feasible and desirable. Our meeting was followed by more extensive discussions with the full Commission and staff members concerned. These talks were extremely productive, resulting in tentative agreement on specific plans for cooperation in the areas of thorium-based fuel cycles and India's utilization of its uranium and thorium resources. We agreed also to consider cooperation in several additional areas including fast reactor development, maritime reactors, accelerator construction, and desalting. After appropriate review of these tentative plans within the USAEC and other US Government agencies, I wrote Bhabha on April 30, 1965, sending him our formal proposal. His letter of July 2 accepted our proposal and suggested a time for initial Indian team visits to the United States in connection therewith. He added that he himself could plan to come to the United States after the General Conference of the IAEA (to be held in Tokyo that year), and "if a visit by me to Washington in the second or third week of October would suit you, it might be possible to reach some early decisions about the details of our future programme of cooperation." In another letter, written two days later, Bhabha invited me to visit the Tarapur site and other nuclear installations in India.

Needless to say, I welcomed the prospects both of Homi's early return to the United States and of a visit myself to India. Plans were made accordingly: I was to make a two-day stop in Bombay *en route* home from the IAEA General Conference in Tokyo, and a meeting with Bhabha in Washington was provisionally scheduled for October 18.

These plans never materialized. In late August, 1965, hostilities broke out between India and Pakistan in the Kashmir region and soon involved the two nations in a spreading war. On September 22, in response to a cease-fire demand by the UN Security Council, both sides agreed to stop the fighting. Nevertheless, transportation uncertainty and other aspects of the situation made it impossible for my colleagues and me to reschedule our Indian visit, which had of course been cancelled. Under the difficult circumstances that obtained, Bhabha himself found it necessary to remain in India and was unable even to attend the IAEA meeting in Tokyo as he had intended; and his trip to the United States in October was out of the question.

On January 10, 1966, in Tashkent, USSR, Indian Prime Minister Shastri and Pakistan's President Ayub Khan signed the "Tashkent Declaration" pledging the withdrawal of armed forces in Kashmir to behind the cease-fire line that had been established in 1949. Although in India relief over this development was accompanied by mourning for Prime Minister Shastri, who succumbed to a heart attack a few hours after signing the agreement, resumption of normal operations and programs now seemed possible. With respect to US-Indian collaboration in the nuclear field, this meant further planning for our expanded cooperation. Pending another meeting with Homi Bhabha, I seized an opportunity for a discussion with Ambassador Nehru both on this subject and on the concern we felt over pressures building up in India in favor of Indian development of nuclear weapons:

"January 20, 1966 - Washington

"[At the Jouett Shouse reception, Ambassador Nehru and I] discussed the debate that is now going on in India as to whether they should undertake the development of nuclear weapons. I said that India's course of action on this was very important because it could determine the action of a number of other countries. He spoke about the prestige problem, and I pointed out that there were a number of things that the United States could do to help India, such as to cooperate in thorium utilization...have an Atomic Energy Attaché assigned to India, sponsor important international conferences in India, etc. He appreciated these suggestions and said that they might be helpful, but that they wouldn't solve the problem. I said that I was sure they wouldn't solve the problem, but they might alleviate it to some extent and he agreed that this might be the case."

I looked forward to a chance to discuss these matters further with Homi Bhabha. But four days after my conversation with Ambassador Nehru, a cable from the US Embassy in Vienna brought shocking news: 'MISSION INFORMED AIR INDIA FLIGHT WITH BHABHA ABOARD CRASHED MONT BLANC THIS MORNING. NO INFORMATION AS TO SURVIVORS.'

Confirmation of the tragedy followed quickly. Air India's 707, bound for New York from Bombay, had crashed in fog with 117 aboard. There were no survivors.

The world of science was stunned by this sudden, cruel loss. For me, as for all who knew him personally, the loss was especially keen. I sent the following message to India's Prime Minister Indira Gandhi, who had been named to succeed Shastri less than a week before:

"My colleagues and I extend to you and your countrymen our heartfelt sympathy on the tragic and sudden death of our good friend Dr. Homi J. Bhabha.

"A world leader in the development of atomic energy, Dr. Bhabha's untiring efforts to bring the benefits of atomic energy to his fellow men will be sorely missed. He will be long remembered not only in India but throughout the world by all those who were privileged to know and to work with him and to whom his efforts to develop the peaceful uses of atomic energy for the good of all mankind were an inspiration."

I had an opportunity to express my sorrow to Prime Minister Gandhi in person when she visited the United States just two months later. (I had first met her and her father, Prime Minister Nehru, during their visit to the United States in November 1961.)

Bhabha's role in India's nuclear energy program had been so all-important that there was an understandable delay in the appointment of a successor. Finally, on May 26, 1966, the Cabinet named Dr. Vikram A. Sarabhai to two of the chief positions Bhabha had held: Secretary of the Department of Atomic Energy and Chairman of the Atomic Energy Commission. A prominent physicist, Sarabhai was already serving as Chairman of the Indian National Committee for Space Research and Director of the Physical Research Laboratory at Ahmedabad. In sending him congratulations on his appointment, I spoke of our countries' past cooperation in peaceful nuclear applications and expressed confidence that this would continue under his leadership.

In his response to my message and in subsequent communications, Dr. Sarabhai left no doubt as to his interest in continuing Indian-US cooperation in the nuclear field. Soon afterward, arrangements were completed for Indian team visits to the United States in two areas contemplated in our interrupted plans: thorium fuel cycles, concerning which cooperation had been agreed on, and accelerator construction, which had been among the additional fields under consideration.

The Tenth General IAEA Conference, held in Vienna in the fall of 1966, provided my first opportunity for discussion with Sarabhai:

"Wednesday, September 21, 1966 - Vienna

"Attended Indian reception in Governors Lounge at IAEA where I met and talked to Vikram Sarabhai. We discussed his forthcoming trip to the United States - he wants to see Dr. Donald Hornig, the President's Science Adviser on Friday and wants us to set up meeting with Hornig and Dr. Jerome Wiesner of MIT, who had visited India as a US Government consultant in early 1965, and an NSF representative to discuss US support for accelerator in India during his visit to Washington."

Sarabhai's above-mentioned trip to the United States took place the following month, October 1966. Sarabhai met with me in Washington on the 17th for a general view of current and potential cooperative activities and related questions. One subject of particular interest concerned a basic problem of power generation and utilization in developing countries. Dr. Sarabhai said that when visiting Oak Ridge and the Tennessee Valley Authority he had been struck by the fact that in developing countries such as India, electric power generating facilities were usually small plants that would never be capable of producing cheap electric power. As a result, such countries found it difficult to engage in industries that required large quantities of electric power at low rates. Thus a sort of vicious circle was created. Sarabhai felt that what was needed was the construction of large nuclear power plants surrounded by user industries such as fertilizers, chlorine, and other electrochemicals, so that the developing countries could have the benefits of low-cost electric power. I remarked that I had been thinking about something similar which I referred to as "energy centers."

In our talk, Dr. Sarabhai emphasized India's views on a number of topics. He expressed concern over the "even-handed attitude" of the United States with respect to controversies between India and Pakistan, "regardless of the merits of the issue." On the idea of a non-proliferation treaty, he was not sure this was in India's interests; furthermore, he felt that the international safeguards that would be required might, on the one hand, contribute to proliferation (by providing technical information to nationals of countries that might not otherwise obtain it) and on the other hand, be used by an unfriendly country to frustrate the peaceful nuclear program of a country being inspected. In response, I indicated that we felt that both of these concerns were manageable; and I expressed our desire to proceed with the transfer of Tarapur safeguards administration to the IAEA as contemplated by our Agreement on Cooperation.

In the course of our conversation, Dr. Sarabhai invited me to visit India at some convenient time in the near future. I said that I would be visiting Australia in January but wasn't sure that I could extend my trip to include a visit to India. Sarabhai went on to tell me that the Indian Atomic Energy Establishment at Trombay was to be renamed in honor of Bhabha at a ceremony the Prime Minister would attend, and that he hoped very much I could be present. He promised to advise me as soon as the ceremony date had been decided.

The day after our personal meeting, Dr. Sarabhai and the associates who accompanied him met with the other USAEC Commissioners and staff. The discussions of these two days resulted in proposals for greatly expanded cooperation. In a letter dated October 27, 1966, I wrote Sarabhai confirming our specific proposals as developed in the Washington talks and outlining specific actions to be undertaken during the next several months. The expanded cooperative program agreed on comprised the following areas:

1. Parametric reactor studies, including potential advantages of agro-industrial complexes.
2. Thorium cycle technology for power production.
3. Plutonium recycle.
4. Food irradiation.
5. Radioactive waste disposal and storage.
6. Uses of radiation in biology and medicine not covered under Item 4.
7. Technical information in support of proposed tandem Van de Graaff and variable energy cyclotron projects.

By mid-December 1966 the plans for my January trip to Australia, which I had mentioned to Sarabhai, had become definite. As I had hoped, I found it possible to include India in my itinerary. The renaming of the Trombay research center was scheduled to take place on one of the two days I would have in Bombay. I looked forward eagerly to conferring with Indian scientists,

visiting some of their nuclear facilities, and attending the ceremony of tribute to Homi Bhabha.

After leaving Australia, my group and I flew to Bangkok for a day of meetings and visits there and then headed west. On the plane with Helen and me were USAEC Commissioner Gerald Tape and his wife Jo, my Special Assistant Arnie Fritsch, Myron Kratzer (Director, AEC Division of International Affairs - DIA), Ulysses M. Staebler (Assistant Director for Technical Exchanges - DIA), Cecil King (AEC Management Assistant), Herman Pollack (Acting Director of the State Department's Office of International Scientific and Technological Affairs), and Maurice Timbs of the Australian AEC, who was also to attend the ceremony at Trombay.

We took off for Bombay at 7:30 p.m. on Tuesday, January 10, 1967:

"We flew over the Bay of Bengal and the cities of Visakhapatnam, Karimnagar, Nizamabad, and Ahmadnagar and arrived at Bombay at 10:15 p.m. Bombay time (which is two and a half time zones different from Bangkok and nine and a half zones different from Washington). We were met by Dr. and Mrs. Homi Sethna (he is Director of the Trombay Laboratory to be dedicated to Homi Bhabha on Thursday, January 12), M. N. Chakravarti (Project Administrator, Tarapur Nuclear Power Project), Mr. and Mrs. Dan Braddock (US Consul General in Bombay), Len Weiss (US Minister-Counselor for Political Economic Affairs in New Delhi) and Don Fuller (US Science Attaché in New Delhi).

"Helen and I rode with Dr. and Mrs. Sethna and their driver to the Taj Mahal Hotel where we checked into the Rajput Suite."

"Wednesday, January 11, 1967 - Bombay, Trombay

"Helen went sight-seeing and shopping with Mrs. Sethna and Jo Tape. They saw the Silver Bazaar, the Thieves Market (where stolen goods are placed on sale), the Hanging Gardens on Malabar Hill, the Wall of Vultures (where they throw the bodies of non-Hindu dead for which the complicated exemption papers have not been obtained), the Red Light District, and many evidences of the extreme poverty of hoards of people.

"The American group had a meeting in the Taj Mahal Hotel at 9:00 a.m. (Tape, Pollack, Kratzer, Fritsch, Staebler, Braddock, Weiss, and Fuller) to discuss forthcoming meeting with Sarabhai and his people. Braddock gave us a briefing on the current political situation in India.

"We had a meeting at 9:45 a.m. with Sarabhai at the Indian AEC headquarters which is near the Taj Mahal

Hotel. Present were the American group, including Jack Miklos of the Consulate General, and Sarabhai and Sethna. We discussed (1) the visit of US reactor experts to India now set for March (which was agreeable), (2) arrangements for visit of Indian scientists to United States to investigate isochronous (88 inch) cyclotron, (3) their desire to send four people to Savannah River Plant to see Heavy Water Plant (will investigate but plant visit may not be useful), (4) IAEA documentation plan (Sarabhai believes plan too expensive but we said we are supporting only a less ambitious plan), (5) safeguards for Tarapur Reactor (they don't want those presently under discussion to be tied so closely to IAEA safeguards), (6) India's continuing policy on non-proliferation (Kratzer referred to G. Parthasarathi's statements as Indian representative to the United Nations implying Indian desire to work toward thermonuclear devices - Sarabhai denied this. He pointed out danger of spread of nuclear weapons information by IAEA inspector system - he used example of inspector from Morocco giving his country nuclear weapons information. We discussed development of nuclear explosives for peaceful purposes by countries like India - Sarabhai used argument of need for a democracy like India to have freedom of action and we refuted this by saying they use but don't themselves build jet aircraft - Sarabhai summarized by saying India is not building and does not intend to build nuclear explosives for peaceful or any other purposes), (7) my offer of loan of 30,000 curie cobalt-60 irradiation source to India for possible use for food (fish) preservation and good grain disinfection (they asked us to investigate loan of ship and irradiator for fish preservation - we will do this - they will accept the 30,000 curie irradiator - Brenwell of University of Michigan, who is spending six months at Hanford, suggests US irradiate some of grain shipped to India as an experiment), and (8) our proposal of possibility of stationing a USAEC scientific representative in India (Sarabhai would welcome this, wants him in Bombay, not New Delhi).

"Group, with Timbs added, left Gateway of India for trip on launch to the Trombay Atomic Energy Establishment. Sarabhai did not accompany us - Sethna was our host. We arrived at Cirus (Canadian-Indian-Reactor-Uranium-System) jetty at noon.

"We were driven to Apsara (one MW pool-type reactor named after water nymph), the first Indian-made reactor, where we met key staff in the Conference Room.

"Here I met Jagdish Shankar, who worked with me at the Radiation Laboratory at Berkeley some 10 or 15 years ago. Sethna gave a description and history of the Atomic Energy Establishment at Trombay. It has a total of 8500 employees. During his remarks he made the interesting point that radiation-induced mutations increase the yield of a certain kind of rice. Trombay gives a year post-graduate course to about 150 students each year in physics, radiochemistry, electronics, etc. Cost of fossil fuels in India is high and potential of hydro is not high. Total electric capacity in India is 12,000 MW.

"Sethna said that on several occasions they had had thousands of sitters-in protesting their decisions to build plants elsewhere than Trombay. He said the Berkeley sitters-in were amateurs compared to those at Trombay and elsewhere in India.

"We then toured the building. Ayyagari S. Rao (Head of Electronics Department and Director of Radiation Protection) showed us the Apsara Reactor, which started operating in 1956. Raja Ramanna showed us his work on asymmetry of fission. Shyam S. Kapoor, who worked with Stanley G. Thompson at Berkeley, showed us his work on Cf-252 spontaneous fission (Stanley and Alice Thompson are going to visit Trombay next month). Kapoor will measure difference in anisotropy of low and of high energy gamma-rays emitted in the fission reaction, first with Cf-252, then with thermal neutron-induced fission.

"Rao showed us the Electronics Department. They have 800 people. This department builds all the electronic equipment for Trombay. They have large production units with hundreds of employees, many women. The women wear the traditional Indian costumes, the men wear western clothes. We saw a gallium-arsenic laser outfit which transmitted an audio signal by laser beam. We had lunch, hosted by Sethna, in their lunch room (catered by Taj Mahal Hotel) - Tape, Pollack, Kratzer, Fritsch, Staebler, King, Timbs, Trombay scientists including Gopal-Ayengar who did mutation work on rice, and I were present.

"We were shown Cirus Reactor by S. M. Sundaram. Then we were shown the plutonium chemical extraction plant by N. Srinivasan. The plant uses the Purex Process to extract plutonium from the Cirus Reactor fuel elements. At the tail end the plutonium comes out as the nitrate after elution from Dowex 1 anion column - the oxalate is precipitated, this undergoes hydrofluorination and the trifluoride is reduced to the metal with

calcium metal plus iodine. Samples of plutonium nitrate, oxlate, trifluoride and metal (including the first sample of metal produced in India) were on display. They have processed 12-15 tons of natural uranium fuel from Cirus, have a lot of plutonium on hand, according to Sethna, so that storage is a problem and they have a year or 1½ years backlog to process. My impression was that they have the capability to gather enough plutonium to enable them to develop an atomic bomb, a concern because the Cirus reactor is not subject to safeguards even though the Indian agreement with Canada limits the reactor to use only for peaceful purposes.* The plant has 231 employees plus 65 in training for their forthcoming larger plutonium chemical extraction plant to handle material from Tarapur and other power reactors. (At one time they lost about 700 gm of plutonium into the bay when an employee made a series of errors in turning valves.)

"Next, Deshbande showed us the Isotopes Laboratory. They process about 30 different isotopes, produced in Cirus, in about 300 different compounds to furnish India's needs in agriculture and medicine. For example, they produce I-131 by distilling it from irradiated metallic tellurium.

"Just before we left we visited the National Botanical Gardens, which are owned and operated by the India AEC, on the Trombay grounds. Located on top of a hill, this gave us a marvelous view of the Trombay Laboratory, and numerous pictures and movies were taken. We left the Cirus jetty by launch at 4:00 p.m. and arrived at Gateway of India at about 4:50 p.m.

"We then went to the USIS headquarters where we were met by Herb Baumgartner (who is in charge) and John Simpson (Press Officer). We went to the auditorium where I held a press conference from 5:00 to 5:45 p.m. I was flanked by Tape and Kratzer on the stage and about 30 reporters were present. After an opening statement, in which I paid tribute to Homi Bhabha, described our visit to Trombay and our discussions regarding increasing the co-operation between India and the United States and my pleasure at being in India at Dr. Sarabhai's and Dr. Bhabha's (earlier) invitation, the questions began. Many of the questions were rather difficult, having to do with China's

*This is the source of plutonium used for the nuclear device that was exploded on May 17, 1974, in the Rajasthan desert area.

capability and intentions and the need of India to defend herself by making nuclear weapons and the value of and problems of a non-proliferation treaty. I said that I thought that India's nuclear technology was the equal of that of China with the difference that India had chosen to emphasize only the peaceful uses of nuclear energy. I led the questioning into the field of peaceful uses which enabled me to emphasize the value of nuclear power in India in the future (due to their high cost of fossil fuels and limited hydro resources), the use of radioisotopes in medicine and agriculture, especially the preservation of food, disinfection of grain and eradication of insect pests. I said that Sarabhai and I are discussing ways of increasing cooperation in the food irradiation field, mentioning fish in particular, and said I was making some definite proposals.

"Then we went to another USIS building close by, escorted by Dr. Pai of the USIS, where Dr. Sethna and I taped a 10-15 minute discussion on the peaceful uses of nuclear energy for use on All India Radio (for which I received a check for 50 rupees). In this discussion I expressed my pleasure at visiting India, mentioned the renaming of the Trombay Atomic Energy Center in Bhabha's honor and our discussion regarding increased cooperation between India and the United States in the peaceful uses field. Sethna and I discussed the growing and important role of nuclear power in India and the many uses of radioisotopes in medicine, agriculture, and industry. We mentioned especially their use for the preservation of food and in the disinfection of food grain.

"Following this we went to the Bhulabkai Desai auditorium where, after an introduction by Dr. Sarabhai, I spoke to a full auditorium (some 800 students and scientists from Trombay and Indian universities) on recent research on the transuranium elements. Here I met Dr. Barun Ch. Haldar (who had worked with us at the University of California Radiation Laboratory at Berkeley from October 1950 to June 1951), who is now at the Institute of Science in Bombay. He introduced me to a number of his students.

"Then I returned to the Taj Mahal Hotel about 8 p.m. where Helen was waiting. She and Jo Tape had been sight-seeing, in the morning, as I have already indicated, and shopping, after lunch, under the guidance of Mrs. Sethna. They had attended a luncheon at the Taj Mahal Hotel hosted by Dr. and Mrs. Sarabhai, also attended by Mrs. Sethna, Bert Goldschmidt and Francis Perrin of France,

J. Lorne Gray from Canada, and others. (Goldschmidt, Perrin and Gray were in India to attend the renaming ceremony at Trombay.) Helen, Jo and Mrs. Sethna went shopping at Heirloom House and a couple of other well known shopping centers after lunch.

"Helen and I rode with the Tapes to the dinner party hosted by Dr. and Mrs. Sarabhai at Kashmir House (which is at one of Bombay's best golf clubs). This was an outdoor buffet dinner attended by the members of the American group (Fritsch, Kratzer, Staebler, and Pollack), Len Weiss, and Dr. and Mrs. Sethna and many other Indians, and numerous delegates to tomorrow's renaming ceremony at Trombay such as Maurice C. Timbs, Gray, Goldschmidt and Perrin, as well as P. M. Fedoseev, W. M. Gulshkov, A. S. Sadikov, M. M. Shemyakur, Aleksander M. Prokhorov, S. G. Korneev and V. I. Tkachenko (of the USSR). Helen and I sat at a table with Mrs. Sarabhai and Prokhorov. Mrs. Sarabhai is a classical dancer of international reputation and lives in Ahmedabad; therefore Dr. Sarabhai spends three days a week in Bombay and four in Ahmedabad. Aleksander M. Prokhorov shared the Nobel Prize in Physics with Charlie Townes for their independent work on lasers. He is a delightful talkative fellow. He was born in Australia and has visited many countries including the United States. He invited Helen and me to come to Moscow to enjoy cross-country skiing with him near his home in Moscow."

"Thursday, January 12, 1967 - Bombay, Tarapur

"We got up early and caught the Saurashtra Express from Bombay Central to Boisar station near the Tarapur Nuclear Power Project. We had a special car on the train. Our group (Tape, Fritsch, Kratzer, Staebler, King, and Pollack), Timbs, Gordon W. Manly (of AID), Weiss, Braddock, and Fuller were aboard along with our hosts M. N. Chakravarti, who is in charge of the Tarapur Station, and Maheshwar Dayal, who is the engineer in immediate charge on duty at the Tarapur site. (I had met Chakravarti, Dayal and their colleague, M. R. Srinivasan, in the United States as early as 1963 when the Tarapur Atomic Power Project was in the initial discussion stage.) On the way Chakravarti and Dayal explained to me the background for the project. The site has water inlet capacity to accommodate 1000 MW, thus 600 MW in addition to the 380 MW under present construction. Much of the design and construction is being accomplished by Indian nationals. The cost is on schedule and the rate of construction is also on schedule (about 70% complete).

"We were met at Boisar Station by B. R. Kannad (Civil Engineer in Charge). On the way to Tarapur we saw the colony (208 living units, plus hospital, hotel, school, clubs, swimming pool, tennis courts, etc.) for the construction supervisory personnel, to be used later by the operating personnel. We saw many goats and cows roaming the broad fields on our way along the special road that had been constructed for access to the site.

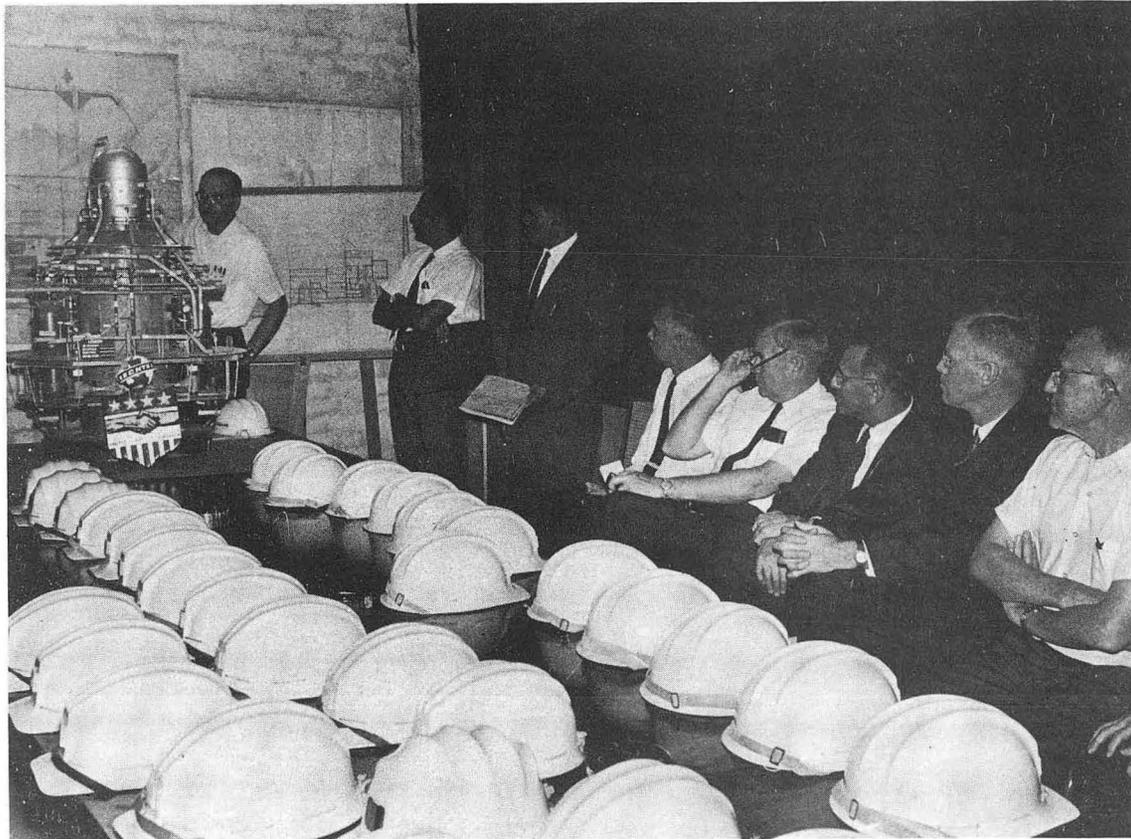
"Upon arrival at the site we were met by B. E. Woodward (a friend of USAEC Commissioner Bill Johnson) of IGE (International General Electric) and Ray L. Portlock of Bechtel (Project Manager). Woodward, who is Manager of Indian Operations of the Tarapur Nuclear Power Project, briefed us on the design and construction progress of the two Tarapur Reactors with the help of a scale model. There is a total of 5500 people working on the construction. The Tarapur Station is adjacent to the Arabian Sea.

"IGE is prime contractor, Bechtel is main subcontractor, Grumman is subcontractor for building the water inlet and the offshore (dredging) work.

"We began our tour with J. J. Gavin (Project Engineer of IGE) who took us to the room below the pressure vessel of Reactor No. 2, then to the room housing the control rod drive system of Reactor No. 2, and then to that for Reactor No. 1, then to the room below Reactor No. 1 where we saw the more completed control rods, etc. above us for Reactor No. 1, then to the level of the reactor vessel for Reactor No. 1 (vessel is 53 ft. high), then to the third level which is at the middle of the reactor vessel, then to the fourth level where there are fuel storage facilities, and finally to the top level (which is 200 ft. above sea level or 97 ft. above the base level) above the reactor vessel.

"Next, we went to the control room where we met R. H. Kopel (of IGE) - this was put together at Trombay Laboratory. Then we went to the turbine area which was shown us by A. G. Bishop (of IGE). I then met Rao who is in charge of maintenance and then Sivaram who is the pressure vessel expert (having spent seven months at the Chatanooga, Tennessee plant).

"Next we all toured the site area in cars. In the area where the water inlet is being built we saw women laborers hauling up dirt in baskets carried on their heads (working for Hochtief). P. Cartwright (of IGE) showed us around here. Then we toured the labor camp (which houses no women) where we saw the market, bank, barber



XBB 761-7020

Briefing on Tarapur Reactors, Tarapur Station, India, Jan. 12, 1967. (Left to right) B. E. Woodward, Maheshwar Dayal, M. N. Chakravarti, Seaborg, G. F. Tape, Leonard Weiss, Donald Fuller, Ray Portlock.

shop, etc. It has two movie houses where movies are shown in Moro and Hindi. Then we visited the Environmental Laboratory, which we were shown by Health Physicist Kamath (who actually works in Bombay).

"Next, we visited the hostel in the Colony area before we went back to Boisar to catch the train at 1:45 p.m. to the Dadar Railway Station which was our connecting point for Trombay. On the road to Boisar and in Boisar we saw many family carts pulled by horses or oxen used for transportation of the family.

"We arrived at the Dadar Railway Station at about 3:30 p.m. where we were met by Mrs. Chakravarti who rode with Tape, Timbs and me in the car to the Trombay Atomic Energy Establishment where we arrived at 3:50 p.m. We were given a short tour of an exhibition portraying various activities at Trombay in the company of Prime Minister Indira Gandhi, Vikram Sarabhai, and Homi Sethna.

"We met Helen and Jo Tape at the tea for Prime Minister Gandhi held in the unfinished modern administration building at Trombay. They had visited Elephanta Island in the morning, going over and back by launch, under the guidance of Mrs. M. R. Srinivasan. They saw the caves with stone carvings dating back to 800 A.D. They had lunch at the Taj Mahal Hotel after they returned with Mrs. Srinivasan. Then they rode by car to Trombay with Mrs. Sarabhai and Mrs. Sethna.

"I sat next to Prime Minister Gandhi at the tea. I told her that I thought India was making good progress in the peaceful uses of nuclear energy and that the Trombay Laboratory was a first class laboratory. I referred to the value of irradiation in the preservation of food and mentioned that the United States intended to lend a radiation source to India for use for this purpose.

"Following the tea, the ceremony, attended by about 15,000 people, for renaming the Center the 'Bhabha Atomic Research Center (BARC)' commenced at 5:45 p.m. The Governor of the State of Maharashtra (where the Center is located), P. V. Chelian, spoke first, followed by Sarabhai, then Sethna, and finally Prime Minister Indira Gandhi. They all eulogized Bhabha. At the conclusion of her talk the Prime Minister spoke extemporaneously about her father, the late Prime Minister Nehru, describing his interest in the application of science to the advancement of India. I sat on the stage at the ceremony along with M. C. Timbs, J. L. Gray, F. Perrin, the Ambassador of Thailand, J. B. Adams (England), U. L. Goswami (IAEA), Armando Duran (Spain),



XBB 761-7021

*At dedication of Bhabha Atomic Research Center, Trombay, Jan. 12, 1967.
(Left to right) Vikram Sarabhai, Homi Sethna, Prime Minister Indira
Gandhi, Seaborg.*

Homi Bhabha's brother and his mother, Mrs. Meherbai J. Bhabha, and others.

"Among those who came up to talk to us after the ceremony where Dr. Hirdaya Mathur (who worked at the University of California Radiation Laboratory at Berkeley in 1955) and Professor Jerome R. Singer of the University of California at Berkeley who was in India to attend a scientific meeting.

"Helen and I rode back to Bombay and the Taj Mahal Hotel with Jerry and Jo Tape and Dr. Sethna's assistant, P. K. Nagarajan, driven by a driver who drove at a hectic, horn-tooting, nerve-racking pace, as had Helen and Jo's driver on the way to Trombay."

"Friday, January 13, 1967 - Bombay

"Helen and I rode to the airport in a car with the Tapes and Herm Pollack. On the way we saw the numerous sections of Bombay where people live in crowded conditions in primitive huts made out of miscellaneous picked-up materials. Helen and Jo had seen many of these sections during their tour yesterday.

"Dr. Sarabhai, Dr. and Mrs. Sethna, Mr. and Mrs. Braddock, and Nagarajan were at the airport to see us off. Sarabhai mentioned the difference of opinion that has risen in regard to the Tarapur Reactor concerning whether it was necessary to provide 'inerting' facilities. It was agreed that we would receive their technical evaluation, study it and give them our reaction to it."

Thus ended a visit that was both absorbingly interesting and, my colleagues and I felt, extremely useful with respect to US-Indian collaboration in the peaceful uses of atomic energy. Our Indian friends clearly shared our view of its value. A few weeks later, in response to my letter of appreciation for the hospitality shown us, Sarabhai wrote (on March 3, 1967) expressing appreciation in his turn for our visit and "the further opportunity it has provided for strengthening the areas of cooperation between our two organizations."

As soon as I returned to Washington I prepared my usual trip report for the President, which was sent January 18, 1967, and included the following remarks on India:

"In India, I was the guest of the Indian Atomic Energy Commission and its Chairman, Dr. Vikram Sarabhai. During our visit, India's impressive atomic energy research establishment at Trombay was renamed by Prime Minister Indira Gandhi in honor of the late Dr. Homi Bhabha, former Chairman of the Indian AEC and a world renowned scientist. The heads or senior officials of a number of atomic energy

authorities around the world attended the dedication ceremony, which was arranged by Dr. Sarabhai to coincide with our visit.

"During this visit, I held extensive conversations with Chairman Sarabhai and visited the Indian atomic energy research establishment at Trombay outside Bombay and the Tarapur Atomic Power Project, 60 miles north of Bombay, which will provide 380 MW of electric power from two enriched uranium, boiling water power reactors designed and manufactured by the General Electric Company. This nuclear power plant, the largest now underway in Asia, is being financed by a US AID loan of \$80 million.

"I also discussed with Chairman Sarabhai the implementation of our arrangements for increased cooperation in peaceful uses of atomic energy, which we developed with him during his visit to the US last October, as the guest of the US Atomic Energy Commission. These arrangements have now been approved by the Indian Government and we are making plans for their prompt implementation. One of the areas covered by our new arrangements in cooperation is the application of radiation to the preservation of food and the disinfestation of grain. In this regard, I offered to Chairman Sarabhai the loan of an experimental irradiator, containing 30,000 curies of cobalt-60, which can be used by India in extending its studies of the radiation preservation of various foodstuffs, including fish and the disinfestation of food grains. In return for the loan of this irradiator without cost to India, the US will receive the full results of the experimental work performed. I later discussed this offer with Prime Minister Gandhi during my meeting with her at the dedication ceremony.

"Chairman Sarabhai was optimistic concerning the benefits that the radiation preservation of food may bring in alleviating India's critical food situation and I share this optimism. One of the products on which the Indian AEC plans to concentrate its efforts in the radiation preservation field is fish, and the experimental irradiator which I offered can be of considerable help in advancing these studies. The Indian Ocean is a rich source of food, particularly proteins in which the Indian diet is so deficient, yet little of these products penetrates more than a few miles inland, largely because of the high rate of spoilage. While much work remains to be done, radiation pasteurization is one of the techniques which holds promise for extending the shelf life of such perishable food products by the extra time necessary to enable their distribution to far larger numbers of people.

"The disinfection of grain is also an urgent problem. Current estimates indicate that 10% to 20% of India's grain crop is destroyed by insect pests before it reaches the market place. Radiation may make an important contribution to the reduction of this tragic loss, providing the equally important problem of reinfestation of the grain following radiation, because of the poor food distribution system, can be solved.

"In view of these many advantages to India of the peaceful uses of nuclear energy obtainable through cooperation with the United States, I discussed with Sarabhai the possibility of stationing a USAEC Scientific Representative in India. He was enthusiastic about this suggestion and urged that such a representative be stationed at the Consulate in Bombay rather than at the Embassy in New Delhi.

"Turning to the facilities we visited, I can report that India has a truly remarkable peaceful nuclear energy program. The research facilities near Bombay are equal in scope and sophistication to those of many of the most advanced countries outside the military nuclear powers. There is no doubt that with these facilities and with its competent nuclear scientists and engineers, India has the capability to design and develop nuclear devices on a comparatively short time schedule. However, India has no plutonium nor capability to produce plutonium other than that which is committed by international agreement to use for peaceful purposes only. To be specific, the Canadian-Indian Reactor Uranium System (Cirus Reactor), a research reactor, is confined, by international agreement between Canada and India, to use only for peaceful purposes, although there are no safeguard arrangements in effect to ensure compliance with this guarantee through on-site inspection. The much larger nuclear power projects, on which India is now receiving help from the US and Canada, are subject to both guarantees and effective safeguard arrangements.

"I believe that the Tarapur Atomic Power Project will become one of the show-cases of United States assistance in India, and, in fact, in Asia. It is now about 70% complete and on schedule. By 1968, it will be supplying its power to the largest electric power grid in India. The US suppliers, the US AID, and the Indian Atomic Energy Commission, all merit genuine congratulations for their performance on this project to date.

"One of the most useful aspects of my visit to India was the technical lecture which I presented on the transuranium elements and my press conference. The lecture, which was attended by an estimated 800 Indian scientists and engineers, and which was an entirely scientific report, helped, in my view, to underscore the strong US interest in basic research, and by implication, the support which the United States Government receives from the scientific community in the US.

"In the press conference which I held, I paid tribute to the exceptional progress which India has made in the peaceful uses of atomic energy. The achievement of nuclear detonations by China has made deep inroads on India's prestige and self-confidence, and my assessment that India was capable of achieving a nuclear weapons capability, even though it had wisely chosen to devote its efforts to peaceful uses, received, along with other aspects of my visit, broad press coverage. I also appeared, together with Dr. Homi Sethna, the Director of Bhabha Atomic Energy Center at Trombay, on All India Radio in a discussion of the peaceful uses of nuclear energy and the cooperation between India and the United States in this field.

"To summarize my impressions of India, I believe that it is clearly the leader in peaceful applications of nuclear energy in Asia, with the single exception of Japan. It has the capability of mounting a significant nuclear weapons program on relatively short notice, but I saw nothing on my visit to suggest that, at the present, it is engaged in any such activities. I believe that India can benefit in large measure from the peaceful uses of nuclear energy and that it is in our national interest to assist them in those activities under the effective safeguard arrangements we have developed to ensure against diversion to military uses of any US supplied help."

The following years saw a marked increase in our cooperative activities along the lines discussed in our meetings. Indian experts, singly and in small teams, came to the United States in furtherance of specific objectives; and while I myself had no opportunity to return to India (except for a one-hour stopover at the Delhi airport on March 31, 1970), other USAEC officials did visit there and US consultants were provided through the IAEA as part of our collaboration in certain fields. Valuable joint studies of the potential contribution of agro-industrial complexes (or "energy centers" or "nucleplexes") were conducted, with particular reference to sites in India. As I had promised, we arranged to lend BARC an irradiator for use in their food irradiation program. Also in accordance with our discussions, a USAEC office

was established at the US Consulate General in Bombay, and a USAEC Scientific Representative started his assignment there in January 1969. A high point of US-Indian collaboration occurred a year later: the dedication of the Tarapur Atomic Power Station in January 1970.

Sarabhai came to the United States many times during these years, so that quite frequent personal consultation with him was possible. Nuclear-related topics of mutual interest were also discussed as necessary with the Indian Ambassador in Washington. For example, not long after my visit to India - on April 14, 1967, to be exact - Ambassador Nehru, Dr. Sarabhai, and Mr. L. K. Jha (Secretary to the Prime Minister) met with me and Commissioners Ramey, Tape, and Nabrit to discuss India's views regarding the NPT. But neither in this meeting, nor in other conversations and correspondence on the subject, were we able to dissipate India's resistance to signing. As with the Euratom nations, the problem of IAEA's administration of safeguards under the treaty was the basic stumbling block. India clearly wanted to await the outcome of Euratom-IAEA negotiations on the question before taking any definitive action.

Even negotiations directed toward IAEA administration of safeguards on Tarapur (as contemplated in our bilateral Agreement for Cooperation) were delayed for several years. Not until January 27, 1971, was the necessary trilateral agreement finally signed. Meanwhile, involved negotiations had been initiated regarding safeguards on US-origin heavy water that was to be transferred from Canada to India for use in the Canadian designed Rajasthan Atomic Power Plant (RAPP).

Aside from Sarabhai's trips to the United States, the annual IAEA General Conferences provided us with a personal meeting ground each fall. Our bilateral cooperation was naturally a frequent subject in our discussions there. On some occasions, however, IAEA-related matters of special mutual interest were predominant. This was the case, for example, when I arrived in Vienna the evening of September 21, 1970, to attend the 14th General Conference:

"We left Frankfurt and arrived in Vienna about 7:10 p.m. Helen and I, Abe Friedman, (Deputy Director, USAEC Division of International Affairs) rode with our regular Vienna driver, Franz Burgeth, directly to the Italian Embassy to attend the Italian reception. I talked to Sarabhai about the problem that has developed concerning the IAEA Conference President and the Chairman of the Board of Governors. Sarabhai is a candidate for the Presidency and another Indian, V. C. Trivedi, is a candidate for the Chairmanship, but it does not seem desirable for both posts to be filled by one country. Ishrat H. Usmani of Pakistan is also running for chairman and the feeling is that Trivedi is better suited to this post at this particular time. I tried to persuade Sarabhai to drop out of the race for the Presidency to assure election of Trivedi to the chairmanship, but he

said that the Indian Foreign Office wouldn't stand for such an action. He said that he thought it would be all right to elect Indians to both posts, as was done with Japanese at the time of the 1965 IAEA General Conference in Tokyo. Roberto Ducci of Italy joined the discussion and tried to help me convince Sarabhai."

Sarabhai stuck to his candidacy for President of the Conference and was elected by acclamation at the opening session the next afternoon. It seems appropriate to mention here that, in the interest of harmony, when the Board of Governors elected its Chairman after the close of the General Conference, Dr. Usmani joined the other Governors in making the vote unanimous for Ambassador Trivedi.

In addition to conversing privately with Sarabhai many times during this 14th General Conference, I participated with him and Sir John Hill of the United Kingdom in recording a discussion for TV:

"Friday, September 25, 1970 - Vienna

"I then went to a taping with Sarabhai and Hill. Sir John, Sarabhai, and I were recorded on video tape in an informal group discussion. First, I mentioned the transmission of power by laser beams reflected from satellites, since this idea had attracted much attention when I proposed it at the UN conference on environmental effects of nuclear power. Sir John noted that nuclear power plants offered the best hope of getting optimum, clean supplies of electricity and asked me if 100-200 MWe plants could be economical. I replied that they would have to be competitive with other energy sources and this would depend on location. Sarabhai brought up the matter of Nuplexes as a means of expanding the economy of developing nations. I suggested that the plains of the Ganges be considered for a Nuplex site and that the power generated be used in part to pump water from underground for agricultural purposes. I pointed out that a full-size Nuplex would generate 10,000 MWe, compared to pilot projects of 1500-2000 MWe. Sir John was pessimistic about how long it would be before a Nuplex could be built."

I met again with Sarabhai in the spring of the following year:

"March 26, 1971 - DC office

"I met with Vikram A. Sarabhai, Kuldip Sahdev (First Secretary, Indian Embassy), Commissioner Ramey, Myron Kratzer, Abe Friedman, and Julie Rubin in my office, as a prelude to our luncheon for Sarabhai. Sarabhai told us about the meeting of the UN Scientific Advisory Committee in New York this week and the plans to broaden the scope

of expertise on this committee. We then went into the Commission dining room. Others present were: Commissioners Johnson and Larson, Bob Hollingsworth and Ed Bloch.

"After lunch Sarabhai raised a number of questions. He was particularly concerned with the problem of safeguards on heavy water furnished by the US and used in India in a Canadian-built reactor. The issue is the length of time that these safeguards should be in effect and this will require further discussion with the Canadians and Indians. Sarabhai made the proposal that there be US-Indian collaboration in the field of the molten salt reactor and we agreed that we would explore this. He also would like to start a small Indian group of some 10 or 20 people to become familiar with controlled thermonuclear fusion in order that India might be ready in this field when the time comes, and we said we would look into the possibility of collaborating on this. He said that he is looking into the possibility of building a number of electronic accelerators for use in hospitals in India; we indicated his best source of help here would be through private companies in the United States that sell such accelerators."

My last meetings with Sarabhai occurred in September 1971, first at the Fourth Geneva Conference on the Peaceful Uses of Atomic Energy and then at the 15th IAEA General Conference in Vienna. We saw each other frequently in the course of these events. More than once, we spoke with satisfaction of our countries' bilateral collaboration and with optimism of the benefits promised by the worldwide nuclear cooperation, particularly for the peoples of developing nations. Despite the grim omens of renewed conflict between India and Pakistan, we looked ahead to a time when genuine peace might be established as prelude to greater opportunities and steady progress for the peoples of South Asia.

But Vikram Sarabhai was never to see that peace. On December 30, 1971, he died in his sleep of a heart attack. Less than six years after Homi Bhabha's death, India had again suffered the totally unexpected, shocking loss of a brilliant leader in the field of nuclear energy. Again the loss was not India's alone but that of international science and especially the worldwide nuclear community. For Sarabhai was a genuine internationalist. Representatives of advanced and developing nations alike turned to him for advice; and he was a source of strength in the IAEA during years when the Agency's importance was steadily mounting. His keen intelligence, breadth of knowledge, and articulateness, together with his warmth, friendliness and outstanding sense of humor, earned him friends throughout the world.

It is unfortunate that India, after all, did choose to try to become a nation with nuclear weapons capability. In retrospect, my visit to the Trombay Atomic Energy Establishment in January 1967, when I was shown the

output of plutonium from the Canadian-furnished Cirus reactor was, of course, a forewarning of India's capability. I believe that, although it must have been national policy at that time to develop this capability as an option, the decision to produce a nuclear explosive device (indistinguishable from a nuclear weapon) had not been made. Our persistent and successful insistence on the application of IAEA safeguards to the Tarapur Reactor and our continuing efforts to persuade India to sign the Non-Proliferation Treaty were, in the end, unfortunately not successful in persuading this country to forego the nuclear weapons option.

CHAPTER 11

PAKISTAN

The Pakistani nuclear energy program was officially launched ten years after India's. Pakistan's later entry into the field of atomic science was an inevitable result of the situation that had obtained in British India with respect to advanced education. Most institutions of higher learning, especially those affording advanced scientific training and research opportunities, had been located in the part of the sub-continent that became the new India. At the time of partition, Pakistan found itself with only two universities and very few colleges and schools. Furthermore, most of the teachers in the schools and colleges had been Hindus and had migrated to India. At many institutions, moreover, existing buildings had been damaged and books had been destroyed during the disturbances that followed independence.

The new nation of Pakistan thus faced enormous problems in the educational sector in general. Under the circumstances, the relative speed with which attention was directed to nuclear science is impressive. As early as January 1955, the Government of Pakistan approved a resolution to establish an atomic energy institute and appointed a committee of scientists to that end. Pursuant to their preliminary work, an Atomic Energy Commission (PAEC), which originally served as the Council's secretariat but later became itself the effective government organization in nuclear matters, commenced its work the following spring.

Cooperation between the United States and Pakistan in the field of peaceful nuclear applications started early in our Atoms-for-Peace Program. In fact, a US-Pakistani Agreement for Cooperation came into effect in August 1955--over three years before the establishment of the PAEC (and eight years before the US-Indian Agreement for Cooperation negotiated for the Tarapur project). Cooperative activities initiated during the period of our agreement with Pakistan included the transfer of radioisotopes, supply of a USAEC depository library, the services of US consultants, and the education, training, and visits of Pakistanis at USAEC facilities. In addition, in 1960 a reactor grant was committed, which provided for a US contribution of \$350,000 toward the cost of a US research reactor to be installed as the central facility of the future Pakistan Institute of Nuclear Science and Technology (PINSTECH) at Nilore near Islamabad. In view of the expiration of the US-Pakistan Agreement for Cooperation in mid-1960, it was agreed that the research reactor would be exported under the US Cooperation Agreement with the International Atomic Energy Agency (IAEA) and a "Project Agreement" between Pakistan and the Agency.

Although I was able to visit Pakistan only once while serving as USAEC Chairman, there were many opportunities during those years for personal meetings with Pakistani nuclear officials elsewhere abroad and

in the United States. Soon after my appointment, for example, I was visited at Commission headquarters by Professor Abdus Salam, a member of the PAEC and one of Pakistan's principal scientists. A number of subjects pertinent to our cooperation through the following years were raised in our conversation on April 10, 1961:

"Professor Salam began by stating how pleased scientists throughout the world were to find that the Chairman of the USAEC, for the first time, is a scientist.

"He then spoke about matters in two general areas, representing the two different types of activities in which he is engaged: (1) as a Member of Pakistan AEC, and (2) as a Professor of Theoretical Physics at the Imperial College, London. He says he spends about 4 or 5 months a year in London, about an equal time in the United States, and the rest in Pakistan.

"(1) He outlined the energy situation in Pakistan. He said that, although they have a fair amount of natural gas, they would like to reserve a good proportion of it for the production of chemicals, fertilizers, etc. He said they have an energy requirement doubling time of about 6 years. Thus, if they develop about 500 megawatts from gas and 300 megawatts in the next three years from hydroelectric power (although another 1,000 megawatts from hydro is available in time), this still leaves a big place for nuclear fission power. He thinks nuclear power is economically competitive at the present time with other sources of power—because of the lower cost of nuclear fuel, in view of the difficulties of hauling oil and coal into Pakistan—and will rapidly have an advantage over these other sources. In view of our program for the production of reactors in the intermediate range, that is, in the range of a few hundred megawatts, he would like to propose that the United States help Pakistan by providing such a reactor under the terms wherein we pay the difference in the cost between the construction of a nuclear power plant and the cost of a conventional plant.

"As a second suggestion in this area, he made the point that it would be extremely advantageous if, in connection with the Institute at which their 5 megawatt swimming pool reactor will operate, the United States would furnish close direction, perhaps through one of its AEC laboratories, such as Oak Ridge. He had in mind that Oak Ridge would send people to the Pakistan Institute to furnish supervision, inspection, inspiration, and direction.

"(2) He told me about the plans for an International Institute of Theoretical Physics under the auspices of the IAEA. He said there are about 50 fellowships already available, of which one-third of the people might come from the West, one-third from the East, and one-third from underdeveloped countries. He said that Hans A. Bethe, Robert Marshak, Victor F. Weisskopf and nearly all theoretical physicists, except Homi J. Bhabha, G. Placzek and a few others, are in favor of this undertaking. Salam said that a home has been offered for it in Copenhagen, and that another possible site is Geneva. I mentioned my correspondence with Olaga, who offered a site in Dubrovnik, Yugoslavia, and we both referred to Italy's offer of a site at Trieste. I said I was interested to get this additional information on this undertaking.

"I asked him about his relations with Bhabha. He said that, personally, they were all right; however, India's claim that they could use their 1,000 capable scientists to make an atomic bomb within a year, and other attitudes, cause problems between the two countries.

"He gave me reprint of a speech he made in January at the Pakistan Science Conference.

"I referred him to DIA Director Algie Wells and asked Wells to discuss these matters with him in more detail."

Professor Salam's proposal that the United States help Pakistan acquire a power reactor reflected the PAEC's early interest in the potential contribution of atomic energy in meeting their country's growing power needs. Well before my April 1961 conversation with Salam, the Government of Pakistan had initiated efforts to obtain US assistance in the construction of nuclear plants, particularly in East Pakistan. The subject was raised by Salam in another Washington meeting with me just a few months later, on July 13, 1961:

"He showed me a telegram from the consultant firm of Gibbs & Hill, pointing out that nuclear power was economically competitive at about 100 megawatt level under certain assumptions as to financing and rates of interest in East Pakistan. I told him that the decision as to US assistance was beyond the purview of the Atomic Energy Commission and involves the State Department and the Executive. I suggested that Pakistan prepare a definite proposal that the United States might consider, but made it clear that I could not predict what the outcome would be.

"Dr. Salam went on to point out that they had held discussions with Jerome Wiesner (the President's Science Adviser) in regard to a huge desalinization project in West Pakistan where agricultural land is becoming salted to such an extent that it is not useable. A \$1 billion project of pumping water out of the ground through wells and desalting it is under study. Salam raised the question whether this project might not be a good occasion for the use of nuclear power, and I suggested that they could allude to it in the above suggested proposal for a nuclear power plant."

Pakistani efforts to enlist our help in a nuclear power program continued in the ensuing years. The US Agency for International Development (AID) gave careful consideration to the idea of including the requested assistance among the numerous AID-supported projects in Pakistan. After extensive study, however, the decision was reached that this was not possible in view of the limited AID funds available and the higher priority accorded to other Pakistani development programs receiving US assistance. With respect specifically to the proposed plant in East Pakistan, moreover, it was concluded that a nuclear station of economic size would be ill-suited to the existing and anticipated demand and distribution pattern there.

It seems appropriate to mention here that negotiations between Pakistani and Canadian representatives over a period of several years resulted eventually (in May 1965) in agreement on the construction by the Canadian General Electric Company of a nuclear power plant in West Pakistan (near Karachi), with the Canadian Government providing the bulk of the required foreign exchange in the form of several long-term loans. As for a plant in East Pakistan—proposed for construction at Rooppur—discussions were held in the course of the years with representatives of various nations. In January 1967, as will be mentioned in my account of my visit to Pakistan, there were reports that arrangements had been made with a US firm for the project, utilizing a private loan. In 1968 it appeared that a Soviet agency might undertake the project. Early in 1970 the signing of a construction contract with a Belgian firm seemed imminent. Nothing definitive ever developed; and events in the fall of 1971 seemed to preclude active consideration of the project by anyone in the foreseeable future.

Two other subjects touched on in our April 1961 talk merit comment now. First, as indicated in my journal on that conversation, Salam was a keen advocate of the establishment of an IAEA-supported International Institute of Theoretical Physics, a proposal which was being studied at the time. During the next three years his efforts, and the efforts of others, bore fruit. The International Centre for Theoretical Physics was established in 1964 at Trieste, Italy, with Salam as Director. Its operations were funded in varying amounts by the IAEA, the Government of Italy, the Ford Foundation, and the United Nations Educational, Scientific,

and Cultural Organization (UNESCO) until 1970, when the Agency and UNESCO concluded a five-year agreement providing for joint operation and equal contributions. The Centre has made an outstanding contribution to the area of pure science and has brought together in a working relationship many scientists from both developed and developing nations.

A less happy note struck in my conversation with Salam was that of Pakistani distrust of India, reflected in his reference to India's attitude on the possibility of making an atomic bomb. This distrust was manifested frequently in our meetings with Pakistani nuclear leaders. It led, indeed, to suspicion and resentment about US cooperation with India in peaceful nuclear applications, despite the safeguards assured on special nuclear material and equipment transferred to India from the United States.

I had numerous other meetings with Dr. Salam during my years with the USAEC. The Pakistani scientist I saw most frequently, however, often at the Annual General Conferences of the International Atomic Energy Agency in Vienna, was Dr. Ishrat H. Usmani, Chairman of the PAEC from 1960. Dr. Usmani made many visits to Washington, which afforded opportunities for useful exchanges on topics of bilateral concern as well as those with broader implications. In the spring of 1964, for example:

"Friday, May 8, 1964 - Washington, DC

"At 12:50 p.m. I had lunch at the Metropolitan Club with Dr. I.H. Usmani, Commissioner Ramey, and Myron Kratzer. We discussed Pakistan's plan to build 70 MWe power reactors in East Pakistan, which Usmani claims will be competitive; they will want Export-Import Bank loan...Usmani made a suggestion, which I think is close to President Johnson's Point Five: Why not have an international agreement among the countries that don't have nuclear weapons at the present that they would submit their nuclear power activities to IAEA inspection and safeguards. He said that he would look into it, and I said I would be interested if anything comes of it."

As I look back, Usmani's suggestion in our conversation at that time seems particularly interesting. It reflected a view, then developing among many leaders, that helped pave the way to the Non-Proliferation Treaty's Article Three, under which non-nuclear weapons states party to the Treaty agree to accept IAEA safeguards with respect to nuclear materials used in all their peaceful nuclear activities.

In addition to Usmani's visits to the United States, numerous special events provided occasions for us to meet. We saw each other at the annual IAEA General Conferences, of course, and also at other international gatherings such as the 1964 and 1971 International Conferences and during the visit I hosted in 1964 aboard the US nuclear ship *Savannah*.



XBB 761-7014

At fifth General Conference of IAEA, Vienna, Sept. 27, 1961, (Left to right) John Hall, Ishrat H. Usmani, Seaborg, Abdus Salam.

Thus we had frequent chances to discuss US-Pakistani nuclear cooperation, which continued to develop. Through the IAEA each year, the United States provided substantial assistance to Pakistan for cost-free experts, equipment, and the training of fellows. Work on construction of Pakistan's US research reactor proceeded; and we agreed to supply, as a gift through the Agency, \$47,000 worth of 90% enriched uranium for part of the reactor's first core. Meanwhile, even before the reactor's installation was completed, cooperation started between our Oak Ridge National Laboratory along the lines envisioned by Salam, which Usmani also favored. Initially this collaboration was conducted on a limited, *ad hoc* basis, within the Oak Ridge operating budget. The desirability of a more formal "sister laboratory" arrangement became apparent to all, and we began to explore the possibility of obtaining AID funds for this purpose.

More than once in our conversations Dr. Usmani invited me to visit his country. I was most anxious to do so and was glad when finally this seemed feasible: Pakistan, like India, was on the original itinerary of my trip after my attendance at the Ninth General Conference of the IAEA in Tokyo in 1965. Unfortunately, as I explained when writing of US cooperation with India, my travel arrangements then had to be changed because of the outbreak of hostilities between the two nations; and the first chance to reschedule my visits came when plans were being made for the round-the-world trip of January 1967.

As it happened, this was a particularly appropriate time for me to visit Pakistan. The US-aided research reactor at PINSTECH had gone critical a year earlier, and arrangements had therefore been made to pay Pakistan the \$350,000 we had pledged toward its cost. My trip afforded an opportunity for personal presentation of the check to the PAEC. Furthermore, as a result of correspondence between our two organizations and consultations in the United States and Pakistan, we now seemed able to move with assurance toward an AID-supported sister laboratory arrangement; and the State Department and other interested US Government elements considered it desirable for me to discuss this directly with Usmani. Another current topic was the possibility of our lending Pakistan an irradiator for use in its food preservation and pest control program.

We left Bombay on the morning of Friday, January 13:

"Friday, January 13, 1967 - Bombay to Peshawar, Rawalpindi, and Lahore

"The plane took off at 8:50 a.m. with Helen and me, the Gerald Tapes, Arnie Fritsch, Ulysses M. Staebler, Cecil King, Herman Pollack, and Myron Kratzer aboard. We arrived at Peshawar, West Pakistan, at 11:00 a.m.

"Since yesterday was Jo Tape's birthday we had a surprise birthday party for her during this flight with an excellent birthday cake furnished by the stewards.

"We had a view of the snow-capped Himalaya Mountains en route. We flew over the cities of Jaipur and New Delhi, India, and Lahore, Gujranwala, and Rawalpindi, Pakistan.

"We were met at Peshawar by Ambassador Eugene M. Locke, American Consul Stephen Winship, Jim Mandros (USIS), William Cargo (Deputy Chief of Mission, Embassy), Gordon Knox (Political-Military Affairs Officer, Embassy), and Pakistani officials. Our party and the Embassy group then flew to Rawalpindi on a MAAG DC-6 plane, leaving about 11:30 a.m. and arriving about noon. We read Pakistani (English language) newspapers on the way to get background on the situation in Pakistan. Stories in the papers indicated that Usmani had announced on Wednesday that arrangements had been made to buy a 150 MW reactor for Rooppur (East Pakistan) from an American firm utilizing a private loan. Also the *Pakistan Times* carried an article by Usmani on the future of nuclear power in Pakistan.

"We were met at the Rawalpindi (Chaklala) Airport by Jordan T. Rogers (US Embassy), Mrs. Cargo, Virgil Moore, and other Embassy personnel and Dr. and Mrs. Abdul Ghani. Ghani is the Director of the PINSTECH Laboratory. Many of the PINSTECH scientists, heading the various Departments, also were in the welcoming party. The eight- and six-year old daughters of two scientists from the Laboratory put garlands of flowers and tinsel (called hars) over the heads of Helen and Jo and flowers over Jerry and me.

"Helen and I rode with the Ambassador to the Lockes' official residence where we had lunch. We saw many Pakistani in picturesque native costumes on the way.

"In addition to our group, lunch guests of Ambassador and Mrs. Locke included Mr. and Mrs. Rogers, Mr. and Mrs. Cargo, and Mr. and Mrs. Knox. Ibex was served. After lunch Cargo accompanied our group to the PINSTECH Laboratory.

"Because it was the Eidul Fitr (Eid) Holiday we saw the streets full of people dressed in their colorful costumes. We saw many buffalo which are used both as beasts of burden and as sources of milk. The PINSTECH Laboratory at Nilore is in the recently built city of Islamabad (built within the last four years), which is the capital of Pakistan.

"We toured the 5 MW swimming pool reactor building. Many pictures and movies were taken. After the tour the senior scientists - Dr. Ghani, Dr. Abdur Rahman, Dr. N.M. Ahmad, Dr. Muhammad A. Mannan, Mr. Muhammad Shafique, Mr. M.N. Qazi, Dr. Noor M. Butt, Dr. F.H. Hashmi, Mr. S. Mansoor Ahmad,



XBB 761-7015

Visit to Reactor, PINSTECH Laboratory, Rawalpindi, Pakistan, January 13, 1967.
(Left to right) Seaborgs, G. F. Tape, Abdul Ghani, Jo Tape.

and Mr. S.M. Bhutta--and many of their wives (including Mrs. Ghani) assembled for a repast of cookies, cakes, tea and coffee. Here I talked to a number of reporters (including representatives of the *Pakistan Times*) in a sort of informal press conference. I referred to Dr. Usmani's article on the future of nuclear power in Pakistan, and said I agreed with it, told them in response to questions about the fraction of the US GNP put into research and development (about 0.2%) and said Pakistan should strive to achieve the same level, discussed the role of nuclear power now in the United States and in the future for Pakistan and the role radioisotopes should play in medicine, agriculture, industry, food irradiation, and grain disinfection in Pakistan. Then Dr. Ghani introduced me and I gave a short talk to the assembled crowd. I covered the same topics as in my remarks to the reporters, said PINSTECH would form the basis for the practical applications of nuclear energy in Pakistan and spoke regarding the future production and identification of superheavy elements like element 126.

"Then we went back to the Rawalpindi (Chaklala) Airport and boarded the same DC-6 for the flight to Lahore. Ambassador Locke, Cargo, Dr. Ghani, Knox, McGowan, and others accompanied us. We arrived at Lahore at 4:20 p.m.

"We were met by Mr. and Mrs. John Bowling (US Consul General at Lahore), Usmani, Mumtaz A. Shaukat (Director of the Lahore Atomic Energy Centre) and all the key members of Shaukat's staff. Helen and I and Jo and Jerry Tape each received a bouquet of flowers from a little girl (to Helen and Jo) and a boy (to Jerry and me). Then Ambassador Locke and I rode with Usmani to do some sight-seeing in Lahore followed by the others in other cars. We drove past Lahore Fort which was used by the Moguls. It was built some 400 to 500 years ago. (Muslims ruled the sub-continent including India from the 13th to the 18th century.)

"We then visited the Badshahi Mosque (Royal Mosque), a magnificent 300 year old structure with impressive minarets. We removed our shoes and walked through the huge courtyard (where a tremendous crowd had gathered yesterday to observe the Eid Holiday) and into the Mosque. We saw in the sky outside the Mosque numerous high-flying kites engaged in a battle to knock each other down out of the sky.



XBB 7510-8068

Visit to Badshahi Mosque, Lahore, Pakistan, Jan. 13, 1967. (Left to right) Seaborgs, Ishrat Usmani, Eugene M. Locke.

"The city streets were full of tongas (wooden two-wheeled carts each usually drawn by a single horse and packed full with a large family--some were highly decorated.) During the ride in the car I mentioned to Usmani our offer to enter into a sister laboratory arrangement between PINSTECH and Oak Ridge National Laboratory and our offer to loan Pakistan a 30,000 curie cobalt-60 source for their use in experimentation on food irradiation and grain disinfection. I also told him the United States would require a trilateral agreement involving the IAEA to impose safeguards in order to supply enriched uranium fuel for their proposed Rooppur power reactor (150 MW), which he said they will buy from Westinghouse in the United States with a Swiss loan arranged by Westinghouse (this was the deal mentioned in the *Pakistan Times*)."

I must interrupt this account to point out that despite the indications, at the time of our visit, that firm arrangements had been made for the Rooppur project, this proved not be the case. Further conversations with Usmani himself confirmed our earlier impression that financing for the project remained highly uncertain. A few months later (on May 20, 1967) the Pakistani Parliamentary Secretary for Scientific and Technological Research stated--in response to a question asked in the National Assembly--that the project for a nuclear plant at Rooppur had been replaced by a plan for a conventional steam plant to meet the interim power shortage in the area. (A larger nuclear plant, he said, would be planned to meet later requirements.)

After our brief sight-seeing diversion we went to the Lahore Atomic Energy Centre:

"Upon arrival at the Centre we were met by a number of scientists and then Tape and I were taken on a tour under the guidance of Shaukat. Among the people we met were M.H. Qureshi, who applies radioisotopes to analytical chemistry and who received his training with Wayne Meinke at the University of Michigan. (He said he had met me when I visited the Phoenix Project at the University in 1962.) We also met A.R. Sani who is doing tracer work on americium and curium (received from Amersham Laboratory in England) and who, after my talk, questioned me on the validity of the 5f orbital bond hybridization explanation suggested by Diamond, Street and me in 1954.

"We then went to the Lecture Hall, which was full of people including many photographers. Usmani introduced me for my lecture on 'The Chemistry of the Transuranium Elements.' After initial laudatory remarks he launched into an attack on the United States, stating that the United States was aiding India's nuclear program without the safeguards necessary to prevent diversion of the materials and aid to the production of nuclear weapons. Following my talk, I made the presentation of the \$350,000 check from the United States to the Pakistan government to apply to the cost of the 5 MW reactor at PINSTECH. I referred to Usmani's key role in putting Pakistan on the road to civilian nuclear power, said Pakistan will be one of the leaders in Asia in this field, mentioned our intention to increase our cooperation with Pakistan, and ignored Usmani's unfavorable remarks concerning US policy. Then I answered some questions from the audience covering my talk on the transuranium elements.

"Following this I went to a room full of press representatives and TV and other photographers (about 30) and, flanked by Usmani, Tape, and Kratzer, conducted a press conference. They asked some rough questions concerning US nuclear aid to India, based on the misconception that we were furnishing aid without safeguards, thus helping the Indians to build nuclear weapons, were furnishing them plutonium, etc. They also had the impression that the USAEC was diminishing its cooperation and aid to the Pakistan AEC.

"I answered the numerous slanted questions in such a way as to refute many of the misconceptions, and the newspaper articles that appeared the next day indicated that I had been fairly successful. I emphasized American, Canadian, and IAEA safeguards on Indian power reactors and said that the United States had not furnished plutonium to India. McGowan, American representative of the Associated Press, helped by initiating questions on peaceful uses of atomic energy. I told them about our plan to increase cooperation with Pakistan in the peaceful uses of nuclear energy, emphasizing the proposed sister laboratory arrangement and our offer to loan Pakistan a 30,000 curie cobalt-60 source (worth about \$75,000) for use in research on food irradiation for preservation and for food grain disinfestation. I emphasized the good base provided by the laboratories at PINSTECH, Lahore, Dacca, and elsewhere to give Pakistan the means to progress in the much needed peaceful uses of nuclear energy such as nuclear power, the many uses of radioisotopes in medicine, agriculture, industry, food irradiation, grain disinfestation, etc. I emphasized Pakistan's growing need for electricity and said that nuclear power offers the best prospects for meeting that need. I emphasized that we were furnishing the food irradiator with the understanding that the information developed would be made available to the United States.



XBB 7510-8069

View of audience for Seaborg lecture in auditorium of Atomic Energy Centre, Lahore, Jan. 13, 1967.

"Following the press conference Helen and Jo joined us (they had been visiting with Mrs. Bowling, Mrs. Ahmad, Mrs. Shaukat, and others). We went to the Centre dining room where a Pakistani dinner hosted by Usmani was served. Dr. Abdus Salam (now Science Advisor to President Ayub Khan), who had arrived near the end of my press conference, was among those present. Others were Consul General and Mrs. Bowling, Ghani, Shaukat, Ambassador Locke, and the Tapes, Kratzer, Pollack, and Cargo. Fritsch, Staebler, and King had started on the four-hour drive back to Rawalpindi before dinner because the MAAG DC-6 plane had engine trouble and was not available for the return trip to Rawalpindi, which had been planned for after dinner. Actually, the plane had landed at Lahore Airport, with all of us aboard, on only three engines because the trouble had already developed. As a result of this our plans were changed so that Helen and I and the Tapes spent the night as house guests of Consul General and Mrs. Bowling."

"Saturday, January 14, 1967 - Lahore to Rawalpindi and Peshawar

"We flew from Lahore to Rawalpindi on a commercial airline plane arriving at 8:10 a.m. Helen and I, the Tapes, Locke, Usmani, Salam, Ghani, Kratzer, Pollack, Cargo, and Knox were aboard.

"Ambassador Locke, Kratzer, Pollack, Tape, Usmani, Salam, and I met with President Ayub Khan* in his office on the government grounds from 8:35 a.m. until 9:05 a.m. (Mandros also was present). When we arrived for the appointment we were met by General Rafi Kahn, the President's military secretary, who escorted us to Ayub's office. After his greeting I began the conversation by saying that we had visited the PINSTECH and Lahore atomic energy laboratories and found them excellent. I said that this would give Pakistan the basis they will need to benefit from the many peaceful uses of nuclear energy so necessary in our age. I said I thought Pakistan will require nuclear power soon to meet its growing requirements for electric power and I described the recent upturn in nuclear power in the United States and our need to develop breeder reactors. I emphasized the value of radioisotopes to Pakistan in medicine, agriculture and industry and irradiation to preserve food and disinfect food grain. I mentioned our plan for a sister laboratory arrangement and our offer to loan Pakistan a 30,000 curie cobalt-60 source for use in food preservation and grain disinfestation research with the results to be available to the United States. Ayub mentioned that he had visited

*I had met President Ayub Khan during his visit to the United States in the summer of 1961.



XBB 7510-8070

Abdus Salam and Seaborg at dinner, Atomic Energy Centre, Lahore, Jan. 13, 1967.

Calder Hall in England and had seen the complex plutonium extraction plant. This gave me the opportunity to describe the production of plutonium as a by-product of nuclear production of electricity, which could be used either as nuclear fuel or for nuclear weapons. I said that the United States requires safeguards for all power reactors and other aid we furnish foreign countries, including India, and these are being transferred to IAEA safeguards, and that only the small research reactor Cirus at Trombay was not subject to safeguards.

"Ayub and Usmani seemed to agree that these facts weren't generally known in Pakistan and that a program of public education was needed. I told him that the United States was striving hard to achieve a non-proliferation treaty to be followed by arms limitation among the nuclear powers. Ayub said that as a historian he felt the role of the smaller countries was important (he had in mind the starting of World War I) and expressed the hope that many of them would work among themselves to help achieve a non-proliferation treaty. Usmani mentioned Plowshare and I described its value in excavation and in underground applications to recover low grade gas and oil. I described the Gasbuggy experiments to be conducted in the United States next summer (with which Ayub was familiar because he had read about the project in the *New York Times*) and I suggested that Pakistan might want to keep in touch with the project's results. He asked about progress on controlled fusion and Tape and I described the long-range nature of this program and its potential (fuel equivalent to 500 Pacific Oceans full of high grade fuel oil). Salam mentioned the 200 BeV accelerator and I said a site had been chosen (Chicago) and that it would be available to scientists like Salam, who had recently made a significant contribution to theory in the elementary particle field. At his request I described for Ayub the 200 BeV accelerator and its purpose. He brought the conference to a close by thanking us for the interesting discussion. Photographs were taken before and after the meeting.

"During the time of the meeting with Ayub, Helen and Jo went shopping escorted by Bob Kent (of the Embassy) and bought typical Pakistani dolls and camels at a small shop. Then they went to a handicraft shop and bought numerous items. The driver purchased hookahs for them at another shop.

"Then we all met at Ambassador Locke's residence and began the 80 mile drive to Peshawar (necessary because the MAAG plane was still inoperable) with the Lockes. On the way we saw hundreds of tongas with their loads of Pakistani families. We passed the

famous Indus River on the way and at that point saw Attock Fort and the town of Attock (historic points). It was a very hectic ride at high speed with many near collisions.

"We arrived at the Peshawar Airport soon after 12:00 and waited there until Consul General Winship came with our passports and some other material required by Ambassador Locke. After Winship arrived we took off together with Ambassador and Mrs. Locke (Mrs. Locke went as far as Madrid). On the way I worked on a packet of USAEC papers, which we had received by mail in Bombay."

Despite its brevity, our trip was extremely useful in giving us first-hand information about the status of Pakistan's growing nuclear program and in enabling us to meet with the scientists of this developing nation on their home ground. Perhaps most important was the opportunity to alleviate the concern that even informed Pakistanis felt regarding US aid to the Indian nuclear program. As I have indicated, my emphasis (both in my press conference and in the meeting with President Ayub Khan) on the affirmative steps we were taking to cooperate with Pakistan in the peaceful uses of nuclear energy and on our insistence upon safeguards over any nuclear assistance we provided to any country including India seemed to have a positive effect.

My report to the President, referred to in the previous chapter, which was sent in a letter dated January 18, 1967, went on to make the following remarks about Pakistan:

"My visit to Pakistan was hosted by Dr. I.H. Usmani, Chairman of the Pakistan Atomic Energy Commission. I visited Pakistan's new Institute for Nuclear Science and Technology (PINSTECH) at Islamabad (where I gave a talk on the peaceful uses of nuclear energy), and its Atomic Energy Centre at Lahore, and presented a check for \$350,000 to the Government of Pakistan in fulfillment of a US commitment to share in the cost of Pakistan's first research reactor, under the Atoms-for-Peace program. Most importantly, along with Ambassador Locke and Commissioner Tape, I visited President Ayub Khan and had what I believe was a constructive conversation with him on a broad range of nuclear energy problems.

"Pakistan is far behind India in its nuclear energy achievements. Pakistan's first reactor -- a small research unit -- is just now achieving routine operation. Pakistan has begun a nuclear power program through a cooperative arrangement with Canada to construct a 140 MWe power plant of the natural uranium, heavy-water moderated type. It has a good, but early start, on the uses of radioisotopes for medical, agricultural, industrial, and food irradiation purposes.

"I believe that Pakistan will unquestionably need and make extensive use of nuclear power for the generation of electricity, although I believe it will lag well behind India due to the supplies of natural gas in Pakistan, its limited but significant hydroelectric potential, and the smaller unit size which the Pakistani power grid can now accommodate.

"I found in Pakistan a deep concern regarding the nuclear intentions of India. In introducing me in connection with my lecture to an audience at the Lahore Atomic Energy Centre and my presentation of the \$350,000 reactor grant to Pakistan, Chairman Usmani publicly expressed his mistrust of India's nuclear objectives and stated that, if India were to explode a nuclear device, the US and other nations would share the blame by having provided India with assistance without international controls. A number of questions during the press conference I held after my lecture and check presentation were in a similar vein.

"As in India, the press conference which I held was well attended, and was the subject of widespread reporting. I emphasized the affirmative steps the US has taken to cooperate with Pakistan in the peaceful uses of nuclear energy and the fact that we insist on safeguards over any nuclear assistance which we provide. I am hopeful that this assurance, which, for example, was headlined in the *Pakistan Times*: 'US Not to Help India Make A-Bomb,' may contribute significantly to alleviating the suspicion and concern which even informed Pakistanis now hold in relation to Indian nuclear intentions.

"During the visit which I paid on President Ayub Khan, I had a further chance to counter Pakistan's contention that the US is aiding India in achieving a nuclear weapons capability. I gave President Ayub Khan categorical assurance that US nuclear assistance to all nations, including India, was provided under safeguard arrangements which ensure against diversion of nuclear materials to military purposes. President Ayub Khan appeared to be receptive to these assurances and stated that the undertaking of a military nuclear program by India would be - and I quote - 'ruinous not only to India but to Pakistan as well.' Ambassador Locke and I made clear our strong agreement with this statement. I also stressed the strenuous efforts which the US is making to bring about the conclusion of a non-proliferation treaty.

"I extended to President Ayub Khan an offer, identical to that which I made to India, to lend Pakistan a 30,000 curie radiation source for research and development in irradiation preservation of foods. I also offered to enter into a 'sister-laboratory' arrangement between a USAEC National Laboratory and Pakistan's new Institute of Nuclear Science and Technology. These offers, which I had already discussed with Chairman Usmani, were well received, and should contribute significantly to strengthening our good relationship with Pakistan on peaceful uses of atomic energy.

"I was impressed with President Ayub Khan's suggestion that the developing nations and other smaller powers might group together and take the initiative to help bring about a non-proliferation treaty. We in the Atomic Energy Commission have consistently tried to encourage other nations--both individually and as a group--to place their nuclear programs under effective international safeguards.

"To summarize, I believe that Pakistan, along with India can share in the benefits of the peaceful uses of nuclear energy, although Pakistan's needs and capabilities will dictate a somewhat longer time schedule there than in India. I believe that Pakistan is far removed from either the intent or the capability to develop nuclear weapons, but that it is deeply disturbed by India's status in both regards. I believe that continuing US measures, such as my visit to Pakistan and increased assistance to legitimate Pakistan objectives in the peaceful uses of nuclear energy can help alleviate this problem."

As contemplated in our discussion with Usmani, steps were taken in the succeeding months to establish an AID-financed sister-laboratory relationship between Oak Ridge National Laboratory and PINSTECH. This relationship was to provide for exchange of visits and assignments, information and consultant services, and the supply of minor equipment items not available in Pakistan. The necessary formalities between all elements concerned--the PAEC, USAEC, and AID offices in Washington and Pakistan--required some time to complete, but before the end of 1967 arrangements had been agreed on and the first visits by Oak Ridge scientists to PINSTECH under the new plan had taken place.

The matter of the irradiator loan involved a considerably longer delay. Upon further consideration, the PAEC concluded that their needs would be best met not by the portable 30,000 curie cobalt-60 type we initially offered but instead by a pool-type Mark IV irradiator. Since none of this type was available, we had to arrange to have one built, and the necessary facility to house the irradiator had to be constructed in Pakistan. Further delay resulted from a PAEC change of mind regarding the desired location of the equipment. Originally it was intended for the Pakistani Irradiation and Pest Control Research Institute (IPCORI) to be established at Tonge in East Pakistan. However, in view of the lack of any progress in facility construction at that site, the decision was made to utilize the USAEC irradiator at the research center at Lyallpur in West Pakistan instead. The irradiator tank was finally shipped from our Brookhaven National Laboratory in the fall of 1970; and arrangements were made to ship the isotopic source as soon as the site construction had been completed and the tank installed.

I continued to meet with Dr. Usmani periodically during his visits to the United States and at the IAEA General Conferences, for discussions of various aspects of our cooperation and other topics of common interest. For example, on Friday, September 27, 1968, in Vienna:

"...I met in my suite with Usmani, together with Ramey, Kratzer, and Brown. The conversation was very general, covering such topics as desalting..."

and again, on June 22, 1970, in Washington:

"At 2:25 p.m. I met with Dr. Ishrat H. Usmani, Chairman of the Pakistan Atomic Energy Commission, along with Abe Friedman and Julie Rubin. It was primarily a courtesy call, but we did discuss the matter of safeguards, and he again expressed his concern about India's intentions in the field of nuclear weapons."

Our sister-laboratory cooperation developed satisfactorily and when the time came to look beyond the arrangement already in effect the decision was made to broaden the program. Pursuant to discussion between AID, PAEC, and USAEC officials, I was able to write Usmani on July 30, 1971, formally outlining the plan to extend our assistance to include—in addition to PINSTECH—other PAEC establishments such as those at Dacca, Lyallpur, and Lahore. I informed the PAEC Chairman that AID would make available up to \$50,000 for this program during the next 18 months, and—subject to fund availability—another \$50,000 for the subsequent 18-month period; it had been agreed that the PAEC would contribute a corresponding amount in rupees. The seven priority research fields in which the laboratories planned to cooperate included two in which Usmani and other PAEC scientists had always taken particular interest—nuclear power reactor technology and desalination—and all were areas regarded as likely to have the greatest potential impact on Pakistan's economic development.

Meanwhile the need had arisen for a different type of assistance. I mentioned earlier that the Canadian General Electric Company had contracted to build a nuclear power plant near Karachi. This Karachi Nuclear Power Plant (KANUPP) involved a Canadian-type reactor, using natural uranium as fuel and heavy water as moderator. As construction approached the final stages, it became apparent that because of serious difficulties encountered in establishing its heavy water production facilities, Canada would be able to fill its commitment to supply 150 tons for the plant only if we authorized the transfer of this amount of US-origin heavy water from Canada to Pakistan. After obtaining assurances that the material would be covered by the safeguard provisions of the existing Canada-Pakistan-IAEA trilateral agreement, we did authorize transfer. Subsequently we sold Pakistan an additional 7½ tons of heavy water required for the project; this sale was financed by a USAID loan.

The fall of 1971 brought numerous occasions for talks with Usmani, both at the Fourth Geneva Conference on Peaceful Uses and at the IAEA General Conferences in Vienna. At Geneva, I attended with interest the session on desalting and agro-industrial complexes, which Usmani chaired with great skill, in the course of which he advanced the idea of establishing an 'Atoms for Water' program to build large desalting plants in different arid zones of the world.

During one of our conversations in Vienna, Usmani suggested a return visit to Pakistan:

"Thursday, September 23, 1971 - Vienna

"Helen and I had breakfast with Usmani in the dining room of the Imperial Hotel. He invited us to attend the dedication or startup ceremony of the nuclear power station in Pakistan to be held next February or March. His term as Chairman of the Pakistan AEC expires next April and he is somewhat uncertain as to whether he wants to continue for another 3-year term..."

The power plant to which Usmani referred was, of course, the Canadian-designed KANUPP, which had achieved criticality in August. I hoped that I might be able to accept the invitation to attend its official inauguration*--though this seemed unlikely even then (and proved to be impossible).

Later that same day in Vienna, I heard Usmani's address to the General Conference:

"I returned to the Festsaal and heard Usmani of Pakistan. He called for a comprehensive Test Ban Treaty and for more non-nuclear weapon states to adhere to the NPT. He indicted the nuclear weapon states and the IAEA for 'showing callous indifference to the efforts on the part of some non-nuclear weapons states to produce nuclear explosives for so-called peaceful purposes.' (He was, of course, referring to his concern over the efforts of India.) He called for a war on poverty throughout the world. He paid me a tribute as a great internationalist, said I was going to the academic world to discover the new element 'seaborgium,' which would have as great an effect on the world for peace as plutonium has had for nuclear energy."

I deeply appreciated the generous comments made about me on this occasion by Dr. Usmani, himself a dedicated "internationalist" and a profound believer in the value of meetings like those in which he and I have participated through the years. His views and hopes in connection with such contacts between scientists were clearly reflected in a statement he made some years ago, when welcoming delegates to the International Seminar on Low Energy Physics in Dacca on January 16, 1967 (just two days after my visit to Pakistan). Although I was not present and in fact had no chance to read Usmani's address until some time later, I think a very brief quotation is appropriate here. Speaking of the significance and effect of this century's

* The official inauguration was actually not held until November 1972. By then Usmani was no longer head of the PAEC, having been replaced as Chairman by Munir Ahmad Khan in January 1972. At the same time, Usmani was named Secretary of the newly created Ministry for Science and Technology.

scientific and technological revolution, the PAEC Chairman declared:

Space and time have assumed new dimensions, and humanity is consciously or unconsciously moving toward the ideal of oneness. The community which is most prominent in weaving the pattern of one world is the community of scientists who through the media of books, journals, conferences, and seminars bring men of understanding and knowledge together for the meeting of minds in the search for truth.

But scientists alone cannot weave the pattern of peace, as has been shown once again by the tragic events of 1971. Four years after Usmani made the statement quoted above, the ideals of oneness and understanding seemed remote indeed from a part of the world where they were most needed.

CHAPTER 12

CANADA

There is probably no closer alliance between two countries in the field of nuclear energy than that between the United States and Canada. Even during the period when our cooperation was severely restricted by the provisions of the Atomic Energy Act of 1946, the USAEC maintained the liaison office in Canada which had been established during the war in connection with US-UK-Canadian cooperation on the Manhattan project. Originally located in Montreal, the office had been transferred to Chalk River, Ontario, when facilities were constructed there for Canada's first nuclear research establishment. After the creation of the USAEC in 1946, the liaison office became that of the first USAEC Scientific Representative, appointed over ten years before one was stationed in any other foreign country. In addition to the limited technical exchange program possible at that time, our representative's responsibilities included arrangements related to our continuing uranium purchases (which had started with a shipment for the Manhattan Project in August 1942), our interest in using the "Nuclear Reactor Experimental" (NRX) being built at Chalk River, and our desire to buy the plutonium that would be produced in Canadian reactors.

The limited US-Canadian cooperation allowed during the ten years following the end of the war was expanded as soon as possible after the passage of the Atomic Energy Act of 1954. A bilateral Agreement for Cooperation on the Peaceful Uses of Atomic Energy came into force on July 21, 1955 - the same day our first bilateral with the United Kingdom came into effect. Making particular reference to Canada's interest in the use of nuclear energy for power generation, this Agreement provided for the exchange of technical information, services, equipment, and materials (including special nuclear materials) and for the mutual utilization of testing facilities. All these mechanisms have been used at one time or another throughout our long collaboration. The basic agreement has been supplemented by "Memoranda of Understanding" in specific areas of mutual interest, the most important of which has been the development of heavy-water moderated power reactors (Memorandum of June 7, 1960). As with the United Kingdom, we also entered into agreements with Canada covering the exchange of atomic energy information, material, and equipment for mutual defense purposes.

While conducting a wide range of pure and applied nuclear research in many areas, Canada began even during the war to devote special attention to the promise of nuclear power and to the independent development of its own nuclear power concept (known as CANDU, for "Canadian Deuterium-Uranium") based on natural uranium-fueled, heavy-water moderated and cooled reactors. This system has proved highly successful from some aspects and appears to offer certain advantages over other systems. As is natural with any new system, however, its development has been attended by problems. Unforeseen design and operating difficulties slowed the reactor construction program

at first; initial attempts to market the system abroad failed, aside from exports for power stations in India and Pakistan; and serious problems were encountered in establishing the capability to produce the all-important heavy water.

In view of Canada's emphasis on heavy water reactors and the fact that for many years the USAEC also conducted research and development projects in such systems, our past cooperation has naturally been most extensive in this general field and has involved frequent contacts and correspondence between our two organizations and, for a long time, a close relationship between the USAEC's Savannah River production and research facilities and Canada's research facilities. For the United States, our collaboration in this field was most useful during its early years, when the Chalk River NRX reactor, for many years the most powerful research reactor in the world, was the only possible facility for certain tests required in connection with various USAEC projects. Long before entering into our bilateral Agreement for Cooperation, in fact, the United States was able to start utilizing the NRX for some testing, including testing of fuels for production reactors. This was possible thanks to the 1946 Act's amendment of 1951, which permitted us to transmit to Canada certain Restricted Data necessary for this purpose. In the years following passage of the Atomic Energy Act of 1954, the USAEC made arrangements to utilize additional Canadian facilities, notably Chalk River's National Research Universal (NRU) reactor, which achieved criticality in 1957.

My personal associations with Canada's nuclear activities date from the wartime period. As early as August 1941, I visited Gilbert LaBine, Dr. W. R. Horne, and Carl French, of Eldorado Gold Mines, Ltd., in Toronto, as well as Pochan, their chemist, at their Port Hope refinery, to arrange for the shipment to Berkeley of ore and refinery samples in which I proposed to make a search for the then-new element plutonium in nature. In the succeeding years, the relationship of research underway in Montreal to the research I was pursuing at the Metallurgical Laboratory in Chicago compelled me to keep in close touch with the scientists there. On one occasion (September 1944), as I indicated when writing of US-French cooperation, this necessitated my travel to Montreal for discussions and detailed review of work in progress. Later, in December 1945, I visited the Ottawa laboratories of the Canadian National Research Council and the Chalk River site. There I saw the Zero Energy Experimental Pile (ZEEP) - the first nuclear reactor to operate outside the United States - which had recently gone critical, and the NRX, then under construction.

During my postwar years as Professor and Chancellor of the University of California, I was able to keep in touch with Canadian nuclear developments to a certain extent, partly thanks to occasional trips to Chalk River to use the NRX in my transuranium research. I also saw Canadian friends at international gatherings such as the 1955 and 1958 Geneva Conferences on the Peaceful Uses of Atomic Energy. When I came to Washington to serve as Chairman of the USAEC, however, I was not yet acquainted with the Canadian official with whom I was to confer most often during the next decade. This was James Lorne Gray, President of

Atomic Energy of Canada Limited (AECL), the Canadian Crown company responsible for all governmental atomic energy activities except those pertaining to raw materials (the province of another Crown company, Eldorado Mining and Refining Limited).

An opportunity to meet President Gray came on March 15, 1961, soon after I assumed my duties:

"This was primarily a call to get acquainted. General Alvin R. Luedecke (USAEC General Manager) was present.

"Mr. Gray did mention the problem of the renewal of our cooperative arrangement with Canada regarding the NRU, a 200 megawatt reactor. This agreement, whereby we furnish the enriched fuel and receive it back after irradiation in order to extract the plutonium, is up for immediate decision as to renewal, and this will offer some problems.

"He also mentioned the success of their high burn-up natural-uranium heavy-water power reactor."

This was the first of many meetings in which I participated over the years, here and in Canada, with Gray and with other Canadian nuclear officials, such as Dr. Wilfrid Bennett Lewis, AECL Senior Vice President of Science, and Dr. George C. Laurence, long-time President of Canada's Atomic Energy Control Board. For example, Commissioner Haworth and I met with Lewis on March 12, 1962:

"We discussed the proposed 1964 Conference on Peaceful Uses of Atomic Energy, and we told Lewis we felt this should be sponsored by the IAEA through an *ad hoc* committee. Lewis said he would explore this approach with the United Nations' Scientific Advisory Committee who favored UN sponsorship of the Conference."

In ensuing relations with the Canadians, the smooth conduct of our cooperative effort was greatly enhanced by these talks and many others in which I did not take part. Perhaps more than with representatives of any other single country, Americans met with Canadians in various types of meetings regarding particular aspects of our cooperation - meetings between the top officials of our two organizations, between AECL and USAEC staff, between scientists of our respective research facilities, between representatives of contractors responsible for different projects. Physical proximity as well as the nature of our long-established cooperation encouraged frequent contacts at all levels.

The IAEA General Conferences, of course, afforded numerous opportunities for conversations with Canadian delegates about our bilateral programs as well as matters of broader interest. Canada was among the allies with whom we worked especially closely at these conferences in

support of common objectives. At the time we were working for the election of Sigvard Eklund as IAEA Secretary-General, for example, my journal notes:

"Monday, September 25, 1961 - Vienna

"...At 4:00 p.m. I met with Bert Goldschmidt and the French delegation, Sir Roger Makins and the British delegation, and Max Hirsch Wershof and the Canadian delegation, plus John Hall, William Cargo, Henry Smyth, Isidor I. Rabi, and Leland Haworth, to plan the strategy for Eklund's election..."

And three days later:

"Thursday, September 28, 1961 - Vienna

"I met with representatives of the British, French, and Canadian delegations to discuss strategy. We agreed to try to have a vote on Eklund next Tuesday..."

At these Conferences, also, the United States and Canada, with other nations of our hemisphere, annually co-hosted the "Western Hemisphere" reception.

On May 25, 1962, in Washington, I participated in signing the Agreement between the US and Canada on Cooperation for Civil Uses of Atomic Energy, amending the original Agreement of June 15, 1955. Foy D. Kohler also signed for the US, and C.S.A. Ritchie signed for Canada.

The frequent meetings arranged between representatives of our two agencies, to discuss and settle specific questions as the need arose, helped insure continued harmony and prevented the development of any serious stumbling blocks in our cooperative activities. Both sides came to feel, however, that the *ad hoc* contacts should be supplemented by periodic joint meetings of the US Commission and the Board of Directors of the AECL. These meetings, it was thought, should be limited to the US Commissioners and AECL Board members and very senior staff of both organizations and should be quite informal - with no official minutes kept - in order to assure a relaxed and useful exchange of views on all matters of common interest.

Following up on earlier discussions of this idea, Lorne Gray wrote me on March 5, 1965, to suggest that the first of the joint meetings be held in Canada in June. We accepted gladly. In consultation with our staff, the Canadians prepared an extremely interesting schedule for us that included not only reviews and discussions of each country's nuclear power program and our joint projects but also visits to important Canadian research and development facilities. Both sides were interested in discussing future cooperative activities. Possibilities included, among others, stability boiling experiments in certain of the USAEC test reactors; utilization of our Savannah River C-reactor to investigate certain structural materials; reactor safety; and a joint ecology study.

With my colleagues I flew to Canada the afternoon of June 23:

"Wednesday, June 23, 1965 - Washington, to Deep River, Canada

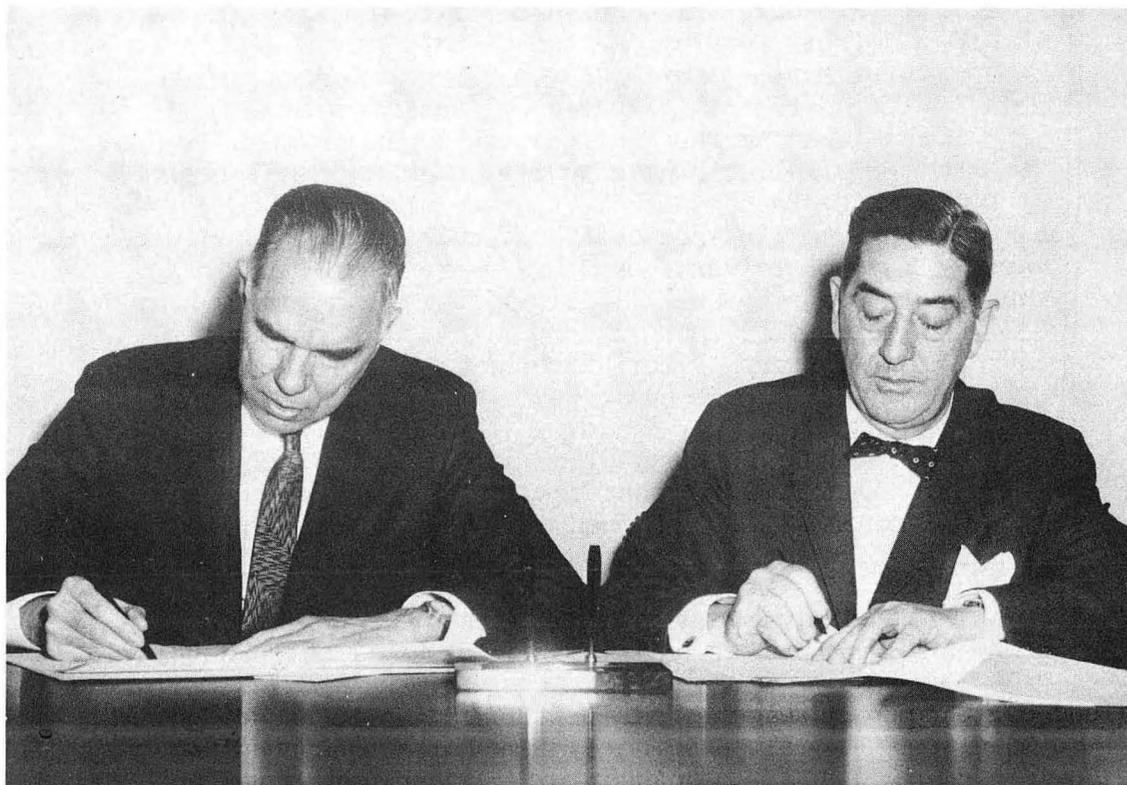
"Entire Commission, plus Wilfrid B. Lewis, Arnie Fritsch, Bob Hollingsworth, Allen Vander Weyden, and Myron Kratzer flew to Bonnechere Airport in Ontario, Canada. We were met by Miller Hudson (USAEC Scientific Representative in Canada) and driven to Deep River where we had dinner at Chalet with Lorne Gray, and Directors C. A. Grinyer, Richard L. Hearn, Donald M. Stephens, and others."

The joint USAEC-AECL meeting started the next morning at the Chalk River Nuclear Laboratories, with an overall presentation by Lorne Gray on the AECL's organization and budget, Canada's philosophy of nuclear power development, and its present nuclear power program. Following this, we were shown around the various research facilities:

"We visited the Chalk River Labs, where we were briefed by Lorne Gray, W. B. Lewis, and others. We visited the NRX and NRU Reactors. Roy F. Errington, Vice President, Commercial Products; R. F. Wright, General Manager, Works; G. H. Sprague, Treasurer; Leslie R. Haywood, Vice President, Engineering; Angus H. M. Laidlaw, Secretary and General Counsel, were also at the joint meeting of USAEC and Atomic Energy of Canada Limited."

At the reactors, our attention naturally focused primarily on the loops of interest to the USAEC. As I have already mentioned, we had long before started using parts of first the NRX and then the NRS in connection with some of our projects. More recent arrangements, formalized in a Memorandum of Understanding which Lorne Gray and I signed in Washington on February 24, 1965, provided for the performance of tests for our Heavy-Water Organic-Cooled Reactor (HWOCR) program in both the NRU and one of the reactors at the AECL's Whiteshell Nuclear Research Establishment.

As I was scheduled to accompany President Lyndon Johnson on a flight to Kansas City, Missouri, that night, I had to leave for Washington soon after noon on the 24th. Therefore I could not be on hand for the remaining visits and discussions, during which anticipated topics and others were explored, with special attention to Canada's need for heavy water. While no firm decisions on additional cooperative activities were made, participants agreed that the joint meeting had served a useful purpose in developing closer communications and that similar meetings in the future would definitely be worthwhile. In fact, planning started immediately for holding another in the United States the following year.



XBB 761-7016

Seaborg and AECL President J. Lorne Gray signing Agreement for Cooperation on the development of the Heavy Water, Organic Cooled Reactor (HWOCR) concept, USAEC Chairman's H St. office, Washington, DC, February 24, 1965.

Before our second joint meeting, I visited Canada again, this time a very different sort of occasion:

"Wednesday, March 23, 1966 - Andrews AFB and Plattsburgh (NY) to Montreal

"Eric (my son), Julie Rubin and I flew to Montreal in a MATS Jetstar leaving Andrews at 8:30 a.m. and arriving over Montreal at 9:45 a.m. However the signal light indicated that the right wheel was not lowered for landing (despite the fact that it appeared to be) so after circling awhile we flew back to Plattsburgh Air Force (SAC) Base in New York State. We prepared for a possible crash landing, but the actual landing was normal. A military car then drove us to Montreal, leaving Plattsburgh about 11:15 a.m. and we arrived at McGill University about 1:45 p.m. We finished lunch with the group, after which Leo Yaffe spoke briefly (Royal Victoria College). We went to the new Otto Maass Chemistry Building (dedicated in the morning along with two other buildings), where I gave a talk on 'The Present Status of the Transuranium Elements' to a full auditorium. Following this we went to the Sir Arthur Currie Memorial Gymnasium-Armoury where I received an honorary D.Sc., along with Lloyd Grenfell Stevenson (Doctor of Letters), Ralph Waldo Gerard, Luther Leonidas Terry, George Wald, Leo Edmond Marion, Henry George Thode, Frank Ambrose Beach, Howard Borden Newcombe, and John Zachary Young. Then we went to a reception."

In the course of the sixties, the USAEC's interest in heavy water reactors declined. As early as 1963 we had reduced our investment in this field somewhat. The February 1965 agreement enabling us to utilize certain Canadian facilities for tests had allowed us to continue research in this concept within our available funds. By mid-1966, however, in the light of budget restrictions which permitted significant financing only of high priority programs, it was apparent that sharp curtailment of our HWOCR program would be necessary. Among other steps taken at that time was a decision to reduce support for the US-Canadian cooperative program from one million dollars annually to a half-million for Fiscal Year 1967. This was naturally disappointing to the Canadians and was one of the principal subjects they raised at our second joint meeting, held at our Argonne National Laboratory (ANL) on May 2-3, 1966. I participated in the principal sessions and activities, held the first day:

"Monday, May 2, 1966 - to Chicago

"Julius Rubin, John Palfrey and I flew to Chicago. We were met by Kenneth Dunbar (Manager, Chicago USAEC Operations Office) who provided us with transportation to Argonne, and Miller Hudson.

"At 9:15 a.m. Rubin, Palfrey, George Kavanagh, Milton Shaw, Spofford English, Ulysses Staebler, Robert Hollingsworth, Gerald Tape and I met with the Board of Directors and principal staff of Atomic Energy of Canada Limited, J. Lorne Gray, R. L. Hearn, D. A. Golden, D. M. Stephens, Andrew R. Gordon (members of Executive Committee, Board of Directors), W. B. Lewis (Senior Vice President of Science), L. R. Haywood (Vice President of Engineering), Ara J. Mooradian (Managing Director, Whiteshell Nuclear Research Establishment), J. Ward Greenwood (Head, International Affairs, Ottawa) to discuss US and Canadian programs.

"I had lunch at the Old Guest House in Argonne with members of the Commission and with the Board of Directors and principal staff of Atomic Energy of Canada Limited. Argonne National Laboratory was host at the luncheon.

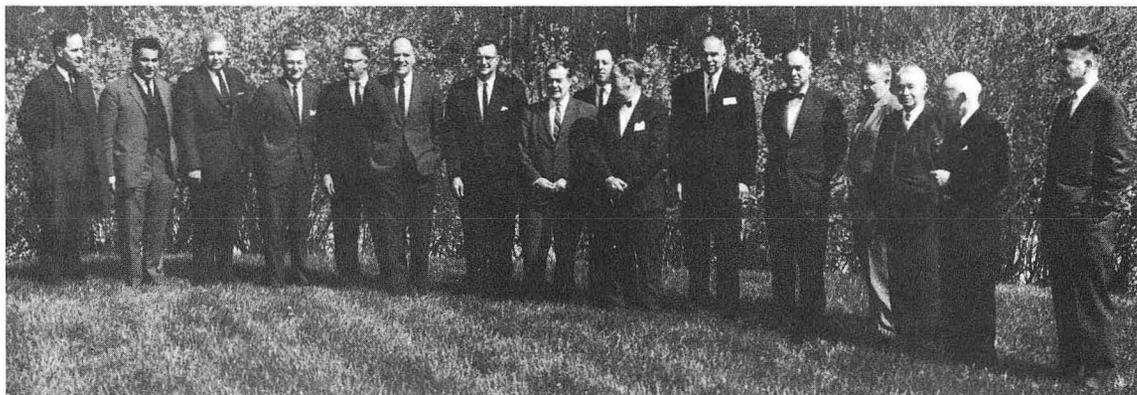
"At 5:30 p.m. we attended a cocktail party hosted by the USAEC. Those present from Argonne National Laboratory were Stephen Lawroski, Winston Manning, Max Matheson, David Okrent, etc.

"At 6:30 p.m. we attended a dinner party hosted by the USAEC. I gave a few remarks."

In the course of our discussions, the Canadians emphasized their desire to continue cooperation with us pursuant to our Memorandum of Understanding concerning heavy water reactors. We assured them of our own interest in continuing close cooperation within our fund limitations, and it was agreed that our respective programs would be reviewed to identify the parts best suited for ongoing activity.

Aside from the cooperative, heavy water reactor program, attention at the 1966 meeting focused especially on other reactor program developments. In addition, Dr. Lewis gave a special presentation on AECL's project for construction of an Intense Neutron Generator (ING) as the principal tool for a major basic research effort contemplated at Chalk River. I discussed briefly the status of the USAEC 200 Bev accelerator being planned for construction at a site then still to be chosen. A tour of ANL facilities was arranged, based on interests the Canadians had expressed.

In the succeeding months the decision was reached to close out completely our HWOCR program. On March 24, 1967, I wrote Lorne Gray advising him of our decision, which meant that we must terminate (as of one year from the date of my letter) the 1965 arrangement to make use of test facilities at the Chalk River and Whiteshell establishments. I was glad to be able to advise Gray at the same time, however, that funds for Fiscal Year 1967 had been made available to raise the total 1967 amount for our cooperative program to \$1 million, as in the preceding years.



XBB 761-7017

Second joint meeting of representatives of USAEC and AECL, Argonne National Laboratory, Chicago, Illinois, May 2, 1966. (Left to right) U. M. Staebler, A. J. Mooradian, G. F. Tape, L. R. Haywood, K. A. Dunbar, D. A. Golden, R. E. Hollingsworth, W. B. Lewis, J. H. Rubin, J. L. Gray, Seaborg, S. G. English, G. M. Kavanagh, R. L. Hearn, D. M. Stephens, M. N. Hudson. (Photo: Argonne National Laboratory)

For our third joint meeting the AECL suggested Montreal, June 1-2, 1967. No better place or time could have been chosen. The Canadian Nuclear Association (CNA) was to hold its annual meeting and conference there May 28-31. Canada's splendid international exposition, "Expo '67," was in full swing. The expected presence of senior UK nuclear officials, among many coming from countries abroad to attend the CNA conference, offered a ready-made opportunity for what would be the first tripartite meeting of top US, UK, and Canadian nuclear officials since 1945.

"Monday, May 29, 1967 - Montreal

"I flew with the James T. Rameys, Gerald F. Tapes, Robert E. Hollingsworths, Milt Shaw, John S. Kelly, and Ernie Tremmel from Baltimore to Montreal leaving at 7:30 p.m. and arriving at 8:55 p.m. We were met by Miller Hudson, and driven in by his French assistant. We checked into the Sheraton Mount Royal Hotel. Lynne (my daughter) arrived from Boston at about 11:15 p.m., and Helen, after flight via New York, arrived with the Wilfrid E. Johnsons around midnight."

"Tuesday, May 30, 1967 - Montreal

"This morning Helen and Lynne went to Expo '67 with the wives, led by Mrs. Perry (Lorne Gray's Administrative Assistant), Mrs. Hudson and others.

"Arnie Fritsch and I took the Metro (subway) to Expo '67, rode the Expo Express to look the grounds over, then we visited La Ronde (entertainment area), Scandinavian Pavilion, Man the Producer (Theme Exhibit), and the Cuban and Euratom Pavilions. We took the Minirail through the Canadian Exhibits and visited the French Pavilion (nuclear energy part).

"At 1:00 p.m. I attended a buffet luncheon at the UK Pavilion hosted by Sir William Oliver. Sir William Penney, Chairman, United Kingdom Atomic Energy Authority, Lorne Gray, and W. B. Lewis, were also present, along with other AEA, AECL, and USAEC members.

"Then we all toured the UK Pavilion under the guidance of Helen Todd, after which we went to the Du Pont Canada Auditorium where, joined by Helen and Lynne, we saw the premiere of the IAEA film 'Nuclear Challenge' introduced by Sigvard Eklund, Director General, IAEA. We had pictures taken

with the Eklunds. Then Helen, Lynne, Arnie and I toured the Soviet Pavilion. Vadim N. Artamkin (guide) showed us around the nuclear exhibits. We toured the American Exhibit, and I received a medallion from Fredman.

"At 5:30 p.m. Stanley R. Tupper, American Commissioner General for Expo '67 and I hosted a reception in the US Pavilion. UK, AECL, and USAEC people were present. Also present were US Consul General Hawkins, and Charles M. Drury, Canadian Minister for Defense Production.

"At 7:00 p.m. I attended a Tripartite Dinner (US, UK, Canadian AEC's) given by AECL at Pavilion d'Honneur Helene de Champlain. Drury spoke on 'The Quiet Revolution' (the French in Canada) and Penney and I spoke briefly.

"At 8:30 p.m. there were informal tripartite discussions at the restaurant.

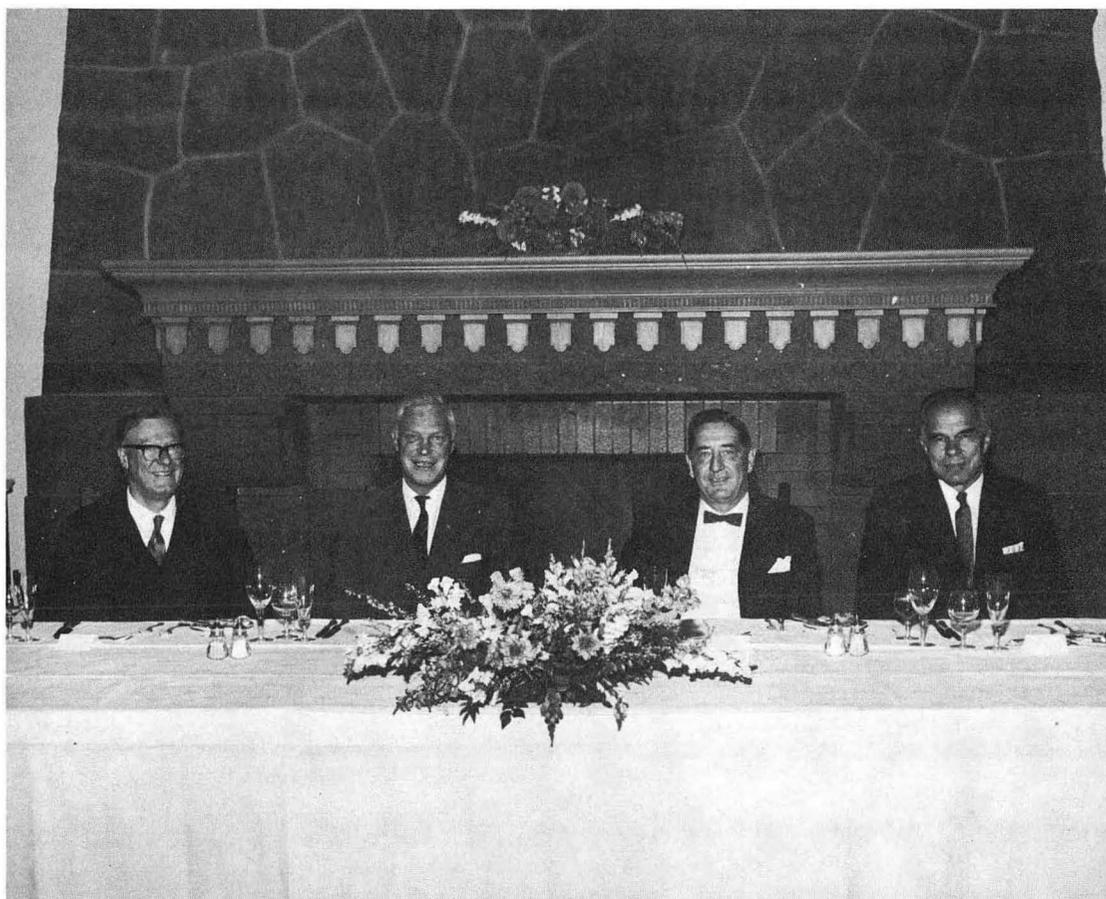
"I returned to the hotel about 10:15 p.m. and Helen and Lynne returned about 10:45 p.m. after attending a reception in the AECL apartment and then dinner with wives."

"Wednesday, May 31, 1967 - Montreal

"Lynne went to Expo '67. Helen went to a coffee hour with wives then joined Lynne at Expo where they stayed until closing at 10:00 p.m.

"I had a discussion with George Laurence, President, Atomic Energy Control Board of Canada at 9:30 a.m. We discussed safeguards and NPT. Present were Kratzer, Tape, Fritsch and Johnson.

"At 10:45 a.m. I met with Sir William Penney, Chairman, UKAEA. Sir William requested this meeting with me to discuss the prospects for UK reprocessing of US reactor fuels. He then raised the question of the raw materials outlook. He indicated his personal concern about the creation of an artificial market for uranium ore by countries such as Japan and Germany based on their projected operational requirements. I indicated that the United States of course had a concern about the shortage of raw materials and was attempting to solve this through three distinct approaches, the first being the obvious exploration for new supplies of uranium ore; the second the development of fast breeder reactors; and the third the utilization of thorium.



XBB 761-7018

US, UK, Canadian Tripartite Dinner, Pavilion d'Honneur Helene de Champlain, Montreal, Canada, May 30, 1967. (Left to right) Sir William Penney, Charles M. Drury, J. Lorne Gray, Seaborg.

"At 1:00 p.m. I attended a reception and luncheon of the Canadian Nuclear Association (CNA) at the Sheraton Mount Royal Hotel, where I spoke on 'Fast Breeder Power Reactors - A World Outlook.' I was introduced by Dr. Shrum (Chancellor of Simon Frazer University). Among the Canadian governmental, industrial and business leaders I met at the reception before the CNA luncheon were Sidney M. Blair, Vice Chairman of Canadian Bechtel, Ltd., the Honorable Robert Winters, Canadian Minister for Trade and Commerce, Jean-Claude Lessard, President, Hydro-Quebec, and Louis Hebert, President, Canadian National Bank."

In my talk, after stressing the growing power needs and the potential future contribution of nuclear power stations based on fast breeder concepts, I outlined work being done around the world in this area. I then called attention to advantages that Canada might gain from entering the breeder research and development field, from which it had thus far been absent:

I would suggest that you consider the merit of embarking on an effort to assess in depth the role Canada could play in development and sale of fast breeder reactor systems or components. Should the market for CANDU reactors never fully materialize, Canada would be largely an exporter of uranium ore and not an exporter of reactors, their components and their technology. However, with an established competence in breeder reactor technology, well within your reach because of your proficiency in thermal reactors, your international posture would continue to be strong.

I took this occasion also to emphasize our belief in the importance of IAEA administration of safeguards. I pointed out that in requiring Agency safeguards on nuclear materials exported "the policy of the United States and Canada has been identical;" I expressed satisfaction that in this area, as in others, "our common purpose has led us to a joint effort so vital to our own and world security." I went on to emphasize, however, that for the many countries with indigenous uranium resources, "the application of safeguards through external efforts can be effective only to the extent that the country needs to rely on outside sources of technology or manufacture of components." For this reason, I concluded, the world's hopes of avoiding nuclear holocaust depended heavily on the success of efforts to make an effective non-proliferation treaty a reality.

After the CNA luncheon, it was time for our meeting with the AECL:

"At 2:15 p.m. I attended the AEC-AECL Meeting at the Sheraton Mount Royal Hotel where we discussed Raw Materials (Rafford L. Faulkner and Wm. M. Gilchrist), US Civilian



XBB 761-7019

Reception, Canadian Nuclear Association, 1967 International Conference, Mount Royal Hotel, Montreal, Canada, May 31, 1967. (Left to right) S. M. Blair, Honorable Robert Winters, Seaborg, J.-C. Lessard, Louis Hebert.

Nuclear Power Program (Shaw), Canadian Nuclear Power Program (John Foster and Les Haywood), Future of AEC-AECL Collaboration (Shaw), Accelerators (ING by Lewis - \$7,500,000 design money), Plowshare (John S. Kelly) and Safeguards (Myron B. Kratzer). At 4:00 p.m. I stepped out to have a press conference.

"I visited the AECL apartment, where we may stay in August, with J. L. Gray."

The discussions in Montreal with our AECL and UKAEA colleagues, as well as with nuclear leaders from other countries whom we saw at the CNA gathering, were extremely useful. And I found Expo '67 so interesting that I returned to Canada that summer for several days' sightseeing with not only my whole family but also Commissioner Gerald Tape and his family and some other friends and their families. We made quite an entourage! Accepting Lorne Gray's hospitable offer, my family and I stayed in the comfortable and convenient AECL apartment during our enjoyable days in Montreal.

For the 1968 USAEC-AECL meeting our Canadian friends came to Washington. The mid-November date had been picked to coincide with the holding of the annual joint meeting of the Atomic Industrial Forum and the American Nuclear Society, which in 1968 was an International Conference on the Constructive Uses of Nuclear Energy.

Since our previous meeting, there had been significant developments in the Canadian program. In September 1968, apparently as part of the austerity drive then in progress, the Canadian Government had announced cancellation of what had represented the Chalk River Laboratories' major effort in basic research: the ING Project. Although there had been considerable criticism of this project, particularly in view of its estimated cost (\$155 million), hopes had remained high that it would be approved. Therefore the sudden announcement that planning for ING was to be terminated came as a great disappointment to the AECL and particularly to the scientists and engineers of Chalk River who had been engaged for over three years in studies and preliminary work for the project. They had now to consider whether at least part of the research for which the ING would have been used could be carried out in other ways. One possibility seemed to be modification of the NRX reactor to a fast neutron test facility. In addition, there was thought of trying to interest the USAEC in a joint undertaking to build an ING.

Another September 1968 development, directly related to existing US-Canadian cooperation, was the signing of a Letter of Agreement on Exchange of Heavy Water Production Technology. I have already alluded briefly to Canada's difficulties in this area. The CANDU reactor construction program had been proceeding more or less as planned despite some design and other troubles. The first project completed, the Nuclear Power Demonstration (NPD) reactor - the world's first heavy water power reactor - had achieved

criticality in 1962. In 1966 the 200 MWe Douglas Point Generating Station had started operation, becoming Canada's first full-scale electric power plant. Construction was under way on the four-reactor (each 500 MWe) Pickering Station and the 250 MWe Gentilly plant (a modification of the CANDU concept, boiling light-water cooled but heavy water moderated). In India and Pakistan, also, CANDU plants were being built. With a view to meeting the heavy-water requirements of these and future CANDU-type stations, as long before as 1963 the Canadian Government had announced that a large production facility at Glace Bay, Nova Scotia, would be constructed by Deuterium of Canada, Ltd. (a subsidiary of an American firm, the Deuterium Corporation). Start-up and first production were originally scheduled for July 1967. But the project was plagued with problems of all sorts - technical, labor, management - and in the fall of 1968 there was still no reliable forecast of start-up time. Meanwhile, Canadian General Electric had started building another heavy-water production plant at Port Hawkesbury, also in Nova Scotia. Construction there was proceeding well, but the earliest time first production could be hoped for was late 1969.

Insofar as possible the USAEC had helped Canada meet its growing heavy-water needs by making available as much of this material as we could spare. In 1967-68 alone we had sold AECL 500 tons and leased another 200. These supplies, supplemented by others in the following years, permitted only a hand-to-mouth existence, as it were. For long-term needs Canada had to assure its own production capability. With this in mind, AECL had asked the USAEC to provide assistance in the technology area. A preliminary letter agreement in the spring of 1967 had outlined the cooperation contemplated, and initial steps had been taken toward arrangements by which our Savannah River Plant would have various training, experts, and testing services made available by its operating contractor (DuPont) to Canadian General Electric in connection with construction of the Port Hawkesbury plant. Now, with the approval and signing of the September 1968 letter, it was possible to move ahead with this and other desired assistance, in return for which the USAEC was to receive all design and operating data on Canadian heavy-water production plants.

A third important development in 1968 was AECL's first clear expression of interest in a cooperative arrangement with us in the area of fast breeder reactor technology, as part of our continuing cooperation in reactor development. As had been foreshadowed by the termination of our HWOCR program and by a tentative 50% reduction (later restored, as I mentioned) of USAEC funds for our cooperative heavy-water reactor program in Fiscal Year 1967, our financial support for that program was coming to an end. A million dollars had been authorized again for Fiscal Year 1968, we expected the same amount to be made available for 1969, but we could hope for nothing after that except minimum amounts to cover the expenses involved in terminating our activity. (For such expenses, a \$250,000 sum was, in fact, granted for FY 1970 and a final amount of \$75,000 for 1971.) There was growing concern on the part of the Canadians, therefore, that the exchange established by our Memorandum of 1960 would become unbalanced in favor of the United States, because despite the phasing out

of our own program we would continue to receive significant data on the Canadian Heavy-Water Reactor (HWR) program. Since there were a number of areas in the Canadian program that were relevant to the USAEC Fast Breeder Reactor (FBR) program and vice-versa, the Canadians advanced the idea of extending our HWR cooperation to the FBR area.

All these topics and others received attention during our meeting in November, at which the most significant step was the decision in favor of our proposal, based on USAEC-AECL staff discussions, on modifying our arrangements under the 1960 Memorandum in order to include the area of fast breeders. Among other things, this would provide for the exchange of reports on fast breeder technology and the assignment of Canadians to USAEC facilities engaged in breeder projects. The general agreement reached in our joint meeting was subsequently formalized in an exchange of letters in February 1969.

My journal for November 14, 1968, records the following details of that meeting:

"Thursday, November 14, 1968 - DC Office

"At 9:00 a.m. Commissioners (except Ramey), Bob Hollingsworth, Abe Friedman, Myron Kratzer, and others met with officials of Atomic Energy of Canada Limited (AECL) - J. L. Gray, W. B. Lewis, L. R. Haywood, A. Mooradian, D. A. Golden, C. A. Grinyer, H. G. Thode (Member, Board of Directors), and W. D. Carrothers (Chief, International Affairs). Angelo Giambusso gave a briefing on US reactor program (light water) and Tardiff on LMFBR program. Gray, Haywood, Lewis, and Mooradian spoke on Canadian reactor and research program. AECL has entered the field of marketing heavy-water power reactors. Haywood spoke on Canadian aspects of AEC/AECL Cooperative Program, and Abe Friedman spoke on US aspect. We offered to give them information on our fast breeder program. Gray spoke on Canadian heavy-water supply and demand. Paul McDaniel reviewed status of 200 BeV and Meson Facility. We discussed the changing environment of science in North America.

"I hosted a lunch at 12:30 p.m. in the Pitcairn Room of the Mayflower Hotel for the Canadian group. Present were Gray, Golden, Grinyer, Thode, Lewis, Haywood, Mooradian, Carrothers, Commissioners Ramey, Johnson, and Costagliola, Julie Rubin, Bob Hollingsworth, Ed Bloch, Howard Brown, George Quinn, Myron Kratzer, Spoff English, Abe Friedman, Milt Shaw, Angelo Giambusso, John Burke, and Robert Ramsey (USAEC Representative to Chalk River)."

As always, the 1968 joint meeting with the AECL was stimulating and helpful in ways that cannot be documented by customary forms of evidence such as papers signed or pronouncements issued. I think the value of these meetings and the quality of the cooperation between the United States and Canada in the nuclear area were well expressed in a letter to me dated February 11, 1969, from Dr. Ara J. Mooradian, AECL Vice-President and Managing Director of the Whiteshell Nuclear Research Establishment. Expressing appreciation for a souvenir photograph I had sent of a joint Department of State-USAEC reception held at the time of our November meeting (for attendees at the AIF-ANS International Conference), Dr. Mooradian went on to say: "Actually, I need very little to remind me of the occasions when I have been privileged to sit at the joint AEC-AECL meetings. The relations between our two agencies must surely be the result of a uniquely successful experiment in international cooperation... the cooperative relations which have developed over the years have a significance that goes beyond the mere exchange of technical information. It is the most successful experiment in international cooperation of which I am aware."

I believe that Dr. Mooradian's view would be endorsed by all who have taken part in our common labors.

However valuable our meetings, we felt that they should not be held merely *pro forma*, but only when there was a real need for group discussion of problems and exchange of views. This happened not to be the case in 1969, though there was consultation as necessary between staff at various levels on matters such as Canada's continued critical shortage of heavy water and various safeguards arrangements. One matter involving both these basic questions concerned heavy water we had sold to Canada, which the latter wished to export to India and Pakistan to fill the requirements of the CANDU reactors being constructed there. We agreed to authorize this provided IAEA safeguards would apply to the heavy water while it was in those reactors.

Also during 1969, we were visited by representatives of the Canadian Science Council:

"April 22, 1969 - Washington

"At 12:00 noon I attended a luncheon hosted by Dr. Lee DuBridge in honor of Dr. Omond M. Solandt, Chairman of the Canadian Science Council in the Martin Van Buren Room No. 3 of the State Department. Also present were: Dr. McTaggart-Cowan (Staff Director, Canadian Science Council), J. Ward Greenwood (Scientific Counselor Canadian Embassy), James M. Beggs (Transportation), Harold Finger (HUD), Dr. John Foster (DOD), Dr. Leland J. Haworth (NSF), Dr. Thomas O. Paine (NASA), Herman Pollack (State), Dr. Myron Tribus (Commerce), and David Z. Beckler and Davis S. Freeman (OST).

"After the lunch DuBridge called on Solandt to describe the new mechanism for policy determinations in the field of science in Canada. Solandt described briefly the functions of the Canadian Science Council which is composed of representatives, about equal in number, from universities, the government and industry appointed by the Prime Minister for three-year terms. Solandt said that one of the problems facing the Council was the development of more activity by industry in scientific research. He indicated that there is a shortage of social science professors in Canada while there is a substantial increasing interest in this field by Canadian students. He expressed the view that the social sciences should be handled by a separate council in Canada."

Meanwhile, AECL's difficulties in establishing its needed heavy-water production capability persisted. I received a letter regarding this at the end of July:

"Monday, July 28, 1969 - Germantown

"I received a letter from Lorne Gray informing me that a two-year delay is now projected to the Glace Bay plant of Deuterium of Canada, Ltd., on the basis of the result of the USAEC-sponsored study by DuPont. This is a terrible blow to the Canadian nuclear power program based on heavy water, and Gray inquires whether the USAEC can furnish them still more heavy water; unfortunately, our supply is exhausted so we won't be able to help them."

We continued to provide assistance to the extent possible. Under our arrangement for cooperation in heavy-water production technology, we acceded to a Canadian General Electric request, endorsed by AECL, that our contractor DuPont assign one or two of its experienced Savannah River personnel to the Port Hawkesbury plant during commissioning and start-up.

While USAEC-AECL cooperation remained active under the arrangements of 1969 (as expanded to cover fast breeder development) and 1968, in the spring of 1970 we came reluctantly to the decision to close our Chalk River office. In the light of increased budgetary restrictions and the termination of our need to utilize Canadian testing facilities, we felt that in the future the necessary liaison work should be handled directly from our US headquarters. In reply to my letter formally advising him of this decision, Lorne Gray responded with understanding and with high tribute to those who had served as our representatives in Canada. In his letter of March 20, 1970, Gray wrote that "the contribution the USAEC Chalk River liaison office has made over the years to AECL and its programme has been of incalculable value." Its success, he went on, had been "due in no small measure to the Scientific Representatives assigned...men of special ability and personality."

The fifth joint USAEC-AECL business meeting, the last I attended, was held in Toronto on May 25, 1970. The date coincided with the annual session of the Canadian Nuclear Association (CNA) and a joint meeting of the Canadian Institute of Chemistry (CIC) with the American Chemical Society (ACS). I had been invited to address both the CNA and the CIC-ACS gatherings, and this made for a very full schedule.

Commissioner Theos J. Thompson, George F. Quinn (USAEC Assistant General Manager for Development and Production) and I flew to Toronto the morning of May 24:

"Sunday, May 24, 1970 - Toronto

"We were met by Robert W. Ramsey, Jr. (AEC Scientific Representative in Canada), US Consul General Allen B. Moreland, Mr. Peterson, Julie Rubin and Edward J. Bloch (USAEC Deputy General Manager). We rode with Moreland to the Royal York Hotel.

"I attended a luncheon in the Saskatchewan Room hosted by George E. Gathercole (President of Ontario Hydro). Others present were: Harold A. Smith and Ian F. McRae (Chief Engineer and Commissioner, respectively, of Ontario Hydro), D. J. Gordon, Moreland, L. McConnell, R. J. Royer, Dr. J. M. Hambley, Ramsey; USAEC Commissioners Thompson and Clarence E. Larson; Bloch, Rubin, Abe Friedman, Irving Hoffman, George Quinn of USAEC staff; and Lorne Gray, W. B. Lewis, John S. Foster, L. R. Haywood and George A. Pon of the AECL.

"After lunch we rode to the Pickering Nuclear Power Station on Lake Ontario (20 miles east of the Royal York Hotel). We first went to the auditorium of the Station's Public Information Center where we heard a briefing by Larry W. Woodhead on the Pickering Station. When completed, there will be four identical 500 MW heavy water nuclear reactors. These are now in various stages of completion with No. 1 scheduled for completion next spring. We then toured the Station in two groups, and then returned to the Royal York Hotel.

"From 4:30 to 5:00 p.m. I attended a press conference in the Library Room of the Hotel. Reporters attending were: F. L. Troyer (Canadian News Features, Toronto), D. Dilschnunder (Toronto Star), Gary Ralph (Telegram), Dave Cooper (Telegram), Leonan Bertum (WOFT Radio), Mart Bonell (Globe and Mail), Joan Keaver (Financial Times), Ted Fairhurst (CKEY Radio News), Leo R. Allund (Oil and Gas Journal), and T. M. Leamon (Toronto Daily Star). The questions asked concerned the status of

the gas centrifuge development; the possibility of small countries developing this process for enriching uranium in the near future; my views on the natural uranium heavy water system; the long-range export market for nuclear power reactors; the existence of a nuclear race between the nuclear powers and would I be out of a job (if the problem were solved); the manageability of radioactivity associated with nuclear power plants; the continuation of underground testing, the status of controlled thermonuclear research; and the safety of gas produced from Project Rulison.

"Rubin and I then rode with Mr. and Mrs. B. A. R. Clark (Director, Harrison & Crossfields) to attend the reception and dinner hosted by the Chemical Institute of Canada at Mississauga Golf Club. I sat at a table with Dr. and Mrs. L. W. Shemilt (McMaster University, President-Elect, CIC), Mr. and Mrs. J. S. Dewar (Union Carbide Canada Ltd., Conference Chairman), Dr. Sidney Udenfriend (Director, Roche Institute of Molecular Biology, N.J.), John Hall (public relations firm) and Miss Finch (Hall's fiancée). After dinner Dr. Norman S. Grace (Dunlop Research Centre, Sheridan Park, President, CIC) and Dr. Byron Riegel (President, ACS) spoke briefly."

"Monday, May 25, 1970 - Toronto

"I had breakfast with the morning speakers and meeting officers of the joint CIC-ACS meeting. They were T. H. Glynn Michael (General Manager, CIC), Dewar, Dr. Grace, Riegel, B. R. Stanerson (retiring Executive Secretary, ACS), Frederick T. Wall (Executive Director, ACS), Udenfriend, and Dr. O. M. Solandt (Chairman, Science Council of Canada). We then walked over to the O'Keefe Centre, Rubin and Friedman joining us in the walk.

"We assembled in an anteroom and then the breakfast group went on the stage. Grace opened the meeting and asked Riegel to introduce me. Riegel referred to my four careers (teacher, researcher, university official, and public affairs statesman). I spoke on 'Energy and the Future.' "

In this talk, stressing the primary importance of a rational long-range approach to future energy needs, I asserted that we "must begin to determine what resources could serve us best for what purposes and the effects of their various uses on both our natural and man-made environment... must begin to think, plan, and act as we never have before in making energy work for us without its inadvertently working against us."

The time had come, I suggested, when men, nations, and the entire international community must begin more serious energy policy planning. We must take all factors including environmental considerations into account. We must narrow "the energy gap" between advanced and less developed nations, by helping the latter acquire economic energy and use it constructively. I touched on the US "Atoms-for-Peace" Program and the work of the IAEA, citing the NPT and other safeguards mechanisms as protection against what some would see as a danger (through the spread of nuclear power generation) of nuclear weapons proliferation. In conclusion, I declared:

Contrary to the notion that our use of energy must necessarily deplete our planet's resources or despoil nature, I believe that our wise use of energy...can restore nature and rejuvenate man....In short, the future of energy is the future of man. Without it we become nothing. With it we become whatever we wish and strive to be.

After my talk, Rubin, Friedman and I walked back to the Royal York Hotel:

"From there we drove in a special car to the Skyline Hotel where I held a press conference in the Paris Room from 11:30 a.m. to 12:00 noon. The reporters were: P. Calamine (Southam News Service), K. Kelly (*Canadian Press*), J. Frazer (*Financial Times*, News Service), J. A. Miller (*Northern Miner*), H. Champ (TV-Television). Also present were a large number of interested people from the CNA Conference.

"I then joined the head table group for the Canadian Nuclear Association luncheon and we went to International Room C where the luncheon was held. Lorne Gray presided and introduced me, including reference to the fact that this was the 600th or 700th time this had been done since I became Chairman of the USAEC. I spoke on 'Nuclear Reactors and Public Reaction.' In this talk I expressed the same basic themes as in the morning but focused rather on ways to counteract public apprehension and promote public understanding regarding nuclear power plants.

"Following the luncheon I rode with Lorne Gray and D. A. Golden to the Constellation Hotel. Here, in the Norman Casey Room, we held a joint USAEC/AECL meeting,* beginning at 2:30 p.m.

*Present at the meeting were USAEC Commissioners Ramey, Johnson, Thompson and Larson, Howard C. Brown, Jr. (Assistant General Manager), Rubin, Bloch, Quinn, Friedman, Ramsey, and Hoffman of the USAEC; and Gray, Directors Golden, C. A. Grinyer, Jean-Claude Lessard and Frederick C. Wallace, Lewis, Foster, Haywood, Donald Watson (Vice President, Administration), Mooradian, Angus H.M. Laidlaw (Secretary and General Counsel), and W. D. Carrothers (Head, Office of International Affairs) of the AECL.

"Lorne Gray opened the meeting by noting the intention of having informal discussions rather than briefing sessions as in the past. He suggested the first general area of discussion be on public understanding and stated my speech at the Canadian Nuclear Association luncheon earlier today had fairly well covered the subject.

"Dr. Lewis identified one problem in Canada...the absence of adequate publications in libraries seemed to eliminate the opportunity for well-informed rational people to counter some of the sensational news about nuclear activities that was receiving attention. Lewis also stated that closer attention should be paid to ridiculous positions such as recently tabled at IAEA meetings in which use of rockets for high level waste disposal and ion bombardment to eliminate high level waste was supported. I expressed surprise that either of these concepts were given any serious consideration but agreed to look into the possibility of discouraging the surfacing of such ideas by US representatives in international meetings.

"Lorne Gray identified a problem encountered by AECL in Australia where, he said, US industrial contractors were down-grading the Canadian heavy-water reactor system. Gray stated any attempt by AECL to fight back would end in hurting nuclear power in general. He recognized the USAEC did not have any control over companies, but implied some word from the Commission might be in order to reduce or eliminate the problem.

"The possible problem of reactor siting along the US Canadian border was surfaced. Both sides agreed to raise the issue with their respective regulatory organizations. The AECL representatives seemed a little concerned that the more restrictive US standards not be imposed on Canadian reactor siting.

"A general question was raised by AECL as to how they might obtain improved support within the government for nuclear as well as other scientific programs. Ramey explained how the JCAE had been established as a watchdog committee but by close association and increasing knowledge of USAEC activities had in the long run provided a source of support within the Congress for nuclear and scientific matters. The difference between the Parliamentary and Congressional systems may not lend the same potential for similar benefits in Canada. With regard to specific cutbacks in the Federal budget for Canada, the relative percentage of personnel reductions seemed to be the same on both sides of the border. One strong note of optimism was voiced by Dr. Mooradian but was admitted to be largely intuitive.

"Lorne Gray reviewed the present status of heavy-water production in Canada. The Glace Bay plant in Nova Scotia is still two years away from any production but the two other plants in Canada were essentially on schedule with the first plant ready to charge hydrogen sulfide gas. There was brief discussion on the possibility of AECL's purchasing the unused heavy-water plant towers at the US Savannah River Plant (SRP) and this matter is being reviewed by staff. The possibility of AECL obtaining the 300 tons of heavy water purchased by the Germans for their Argentine reactor was raised and also the 185 tons from Sweden for which AECL and the Japanese were competing for purchase. Lorne Gray raised a question about the Swedish heavy water as to whether the USAEC would restrict resale of the material to a price no higher than its original purchase by the Swedes from the United States. He noted similar restrictions were placed on AECL for resale of heavy water to Pakistan and India. No clear answer to the question was provided.

"A concluding statement about the heavy-water picture was that AECL would continue to see a shortage of material through 1973 after which their total production would satisfy all reasonable requirements.

"A suggestion was offered that a new topic covering organic reactors be added for discussion at the Fourth Geneva Conference. There appears to be renewed enthusiasm in Canada for the heavy-water moderated organic-cooled system. Specific reference was made to an Edison Electric Institute (EEI) report in which the heavy-water cost was quoted as \$25 - \$30 per installed kilowatt and it was explained this was the reason the High Temperature Gas-cooled Reactor (HTGR) looked better than the heavy-water organic-cooled reactor. The Canadians believe a heavy-water cost of \$7 per kilowatt is achievable and also stated an overall plant efficiency of 39 percent appeared possible.

"Lorne Gray raised the question as to whether Canada should consider building a uranium enrichment plant using low cost hydro power in Canada. He made it clear this interest would only be reasonable if they could count on US cooperation for available technology and if there were no embargo on sending the product into the United States. I stated the Administration was presently reviewing the possibility of making the technology available abroad but admitted

we had been mainly thinking of this assistance for countries purchasing enriched uranium reactors. I agreed to factor the Canadian interest into our future consideration of this matter.

"Dr. Mooradian inquired about the availability of some specific information on activity transport and boiler crud transport that was reportedly available in the Navy reactor program. I agreed to look into the matter if the specific information desired could be further identified.

"The meeting closed with a general comment by both sides that the informal discussions had been very beneficial."

In connection with Gray's concern, reported in the above extracts from my journal, as to whether there would be an embargo on sending the product of a Canadian enrichment plant into the United States, it seems appropriate to include here a brief note regarding the existing embargo. Our policy has been to permit the import of foreign uranium into the United States for enrichment for power reactor fuel only if it is to be re-exported from the United States for use elsewhere. Having large quantities of uranium which it would like to be able to market to US power reactor operators, Canada has naturally pressed us to change this policy. This matter, like that of the desirability of sharing our enrichment technology, was under consideration at the time of our joint 1970 meeting, but there was no way of knowing then (or even much later) when a policy change might be expected.

Two more events were on our schedule before return home:

"At 7:00 p.m. I attended a reception and dinner in the Nova Scotia Room, hosted by Lorne Gray. The same group that attended the meeting this afternoon was present. I sat at a table with Gray, Golden, Foster, Watson, Bloch, Larson, and Friedman. After dinner Gray and I made a few remarks concerning the excellent AEC-AECL relationship."

"Tuesday, May 26, 1970 - Toronto

"Rubin, Brown and I rode in a special car to the Benson Building at the University of Toronto. Here, in the Sports Gym, I gave the opening paper of the joint AEC/CIC meeting symposium, 'Twenty-Five Eventful Years.' I was introduced by Jack Bulloff and spoke on 'Twenty-Five Eventful Years - Entering the Nuclear Age.' Following my talk I was asked one question - by Leo Yaffe concerning the Soviet work on element 104.

"I had a brief visit with Joe Katz and then Rubin, Brown and I rode to the Toronto Airport."

In my talk at the CIC-ACS symposium that morning I gave a historical sketch of the development of US and Canadian national nuclear research and research facilities during the quarter century that had passed since the end of the war. I spoke first of US-Canadian cooperation during the war and then summarized the basic problems encountered and overcome in the postwar period, both within the United States and Canada and also with respect to collaboration between our countries. I mentioned some of my early transuranium research and (performed under vastly different conditions) some of the most recent research, involving the identification of elements 104 and 105 by Ghiorso's group at the Lawrence Radiation Laboratory in Berkeley. In conclusion, I expressed my belief that whatever errors or omissions we might think we saw in the past, nevertheless the "scientists, engineers, and administrators on both sides of the international border can take pardonable pride in the accomplishments of the first quarter century of the nuclear age...."

During the balance of 1970 and the first part of 1971 familiar matters characterized nuclear cooperation between the United States and Canada. The problem of assuring IAEA safeguards on US-origin heavy water exported for the CANDU reactor in Pakistan was ironed out; difficulties persisted with respect to heavy water for the CANDU plant in India. Assistance from the United States toward establishment of Canada's heavy-water production capability increased. Miscellaneous technical information exchanges continued. Some of the considerations are illustrated in my journal account of a meeting with Lorne Gray on March 12, 1971:

"Friday, March 12, 1971 - Germantown

"Commissioner Larson and I met with Lorne Gray in the Commission meeting room. Bob Hollingsworth, Ed Bloch, Myron Kratzer, Frank Baranowski, George Quinn, John Flaherty, Julius Rubin and others were also present.

"The primary topic for discussion was Canada's need for heavy water. Without additional heavy water they will be in a position of having reactors ready for operation within a few years, but kept immobilized because of insufficient heavy water. Gray suggested that we might loan him some of the heavy water at Savannah River which we are holding in reserve in the event we need to start up another reactor - this would be done with the understanding that it could be returned to us upon one month's notice. He indicated that this will probably be proposed at the highest level of the Canadian Government to the US Government. We all recognized that it might be difficult to remove heavy water from a

Canadian reactor, with electric capacity in such short supply, for the purpose of returning it to the United States for weapons production purposes.

"Gray also wanted to explore with us our policy with respect to toll enriching for Canada. Some of our staff people have given him the impression that it would be against US policy to do this. At the present time they need only small amounts for control rod purposes, etc. I assured him that our policy is to supply toll enrichment to Canada. Our agreement for cooperation may be vague on this point, but Kratzer will discuss this further with Gray to see whether we can accommodate him. Gray then raised the question whether the United States would be willing to cooperate with Canada in building a uranium enrichment diffusion plant at a site in Canada where electric power costs are low. Canada might also cooperate with Japan - Prime Minister Trudeau is going to talk to Japan's Prime Minister Sato about this possibility during a visit to Japan on June 8. We indicated that this matter of foreign cooperation has not yet been settled and, thus, we would not want to inaugurate discussions now, but we will talk to them as soon as we are ready.

"Gray also brought up the matter of safeguards for heavy water in India, in which the United States and Canada are both involved. This is a continuing problem and it will involve further discussion with Sarabhai when he visits Canada and the United States next week."

The Canadians displayed growing interest in participating in a multinational enrichment facility; and they also, from time to time, re-emphasized their hope that we would relax our embargo on enriching Canadian uranium for use in power plants in this country. Regarding these matters, Mr. Jack Austin, Canadian Deputy Minister for Mines, Energy, and Resources, came to see Commissioner Johnson and me on May 17, 1971. Mr. Austin was accompanied by other officials of his Ministry and of the Canadian Embassy in Washington. With me, in addition to Commissioner Johnson, were several senior USAEC staff and a representative of the US Department of State:

"Monday, May 17, 1971 - Germantown

"Commissioner Johnson and I met with Jack Austin, who was accompanied by G. M. McNabb and O. J. C. Runnalls of the Ministry for Mines and Energy; P. M. Towe, Minister, Embassy of Canada; and H. C. Armstrong, Counselor, Embassy of Canada. Also present were John Trevithick (State Department), Myron Kratzer, Abe Friedman, George Quinn, John Flaherty, Julie Rubin, and H. D. Bengelsdorf. Austin said that the reason he wanted to meet with us was to

discuss certain policy questions in the uranium enrichment area, particularly concerning the gaseous diffusion enrichment process. He wanted to know: (1) whether US utilities would buy enrichment services from a future Canadian or Canadian-Japanese gaseous diffusion plant situated in Canada; (2) whether the United States would, sometime in the future, share its barrier technology as part of an international US-Canada or US-Canada-Japan gaseous diffusion venture in Canada, and (3) when the embargo would be lifted in the United States on the importation of uranium for use in US power reactors. I said that we are in the process of discussions within the Government concerning the last two of his inquiries and are not yet in a position to give him an answer - perhaps we will be after a few months. With respect to his first question I indicated that we had no particular US policy that would forbid the sale of such Canadian enriching services in the United States and certainly, as time goes on, there will be international competition in this area in the United States. He asked whether we thought that it was for the over-all good of the nuclear power industry to have uranium enriching plants beyond those in the United States, and we indicated that we thought this was inevitable and a natural course of development.

"We indicated that so far as any cooperative effort with Canada, or with Canada and Japan, is concerned, a multi-national agreement for cooperation, i.e., a multi-national treaty, would be required and this can only be accomplished through approval by the US Congress. We asked him about the role that the private firm 'Brinco' plays in Canada since they had informally approached some people in the United States about a joint US-Canadian venture utilizing their hydroelectric source on the Lower Churchill. Austin indicated that they have the confidence of the Canadian Government, but any such arrangement would have to involve the Canadian Government.

"We asked him about the details of the conversations with the Japanese. He indicated that Minister Green of Canada had discussed cooperative Canadian-Japanese operations in the uranium enriching with the Japanese AEC during his visit to Tokyo in December. Also, very recently A. Matsui of the Japanese AEC has been in Vancouver exploring such possibilities; similar talks have involved the officials of Tokyo Electric. Their discussions with the Japanese have been only exploratory in nature so far. We indicated that the Japanese had not approached us very directly although Y. Nakasone, the Director General of the Defense Agency, had been in the United States some months ago and spoken with some government officials in the United States, but not including the AEC."

At the time I left the USAEC, there had still been no relaxation of our embargo on enriching foreign uranium for domestic use. But less than two months after our talk with Deputy Minister Austin, we were able to inform Canada and other interested nations that we were ready to discuss on a multinational basis the possibility of cooperation in the area of uranium enrichment based on our gaseous diffusion technology. Thus the path seemed to be opening toward a new phase in the associations between the nuclear programs of the United States and Canada - the associations which, as I recalled in a cable congratulating the people of Deep River on their town's 25th anniversary in July, 1970, "had some of their earliest beginnings at the Chalk River Nuclear Laboratory... and have continued to this date with an outstanding spirit of friendship and cooperation."

CHAPTER 13

PUERTO RICO

Strictly speaking, of course, cooperation with Puerto Rico must be regarded as domestic rather than international - and therefore not properly within the scope of this account. Nevertheless, the Puerto Rico Nuclear Center (PRNC) plays so important a role with respect to our international nuclear cooperation that I consider it appropriate to include these journeys, along with a little background information.

When the Atoms-for-Peace program was launched in the fall of 1954, attention turned promptly to the potential contribution of peaceful nuclear applications to the developing nations of the Americas. The initiation of bilateral cooperation with many of these nations was accompanied by increasing awareness of the need from some kind of regional nuclear center to serve Latin America. Planning gained impetus following the Panama Conference of Western Hemisphere Heads of State held in July 1956, at which President Dwight D. Eisenhower specifically urged action to "hasten the beneficial uses of nuclear forces throughout the hemisphere."

During the succeeding months, the idea of a regional center gained widening support. The Commonwealth of Puerto Rico, meeting ground of the cultures of the Americas, seemed an ideal location. Officials of the University of Puerto Rico, the Commonwealth's largest institution of higher education, endorsed the idea enthusiastically; the US Congress appropriated funds; and on October 2, 1957, the University signed a contract with the USAEC for operation of the Puerto Rico Nuclear Center.

The Center's basic general aim was to aid the Latin American nations in developing the skills essential to nuclear energy activity, by providing graduate level educational and research opportunities. More specifically, the objectives were to demonstrate the constructive uses of nuclear energy in those countries and help solve problems which could be attacked most effectively by virtue of the Center's island and tropical location.

In the pursuit of these objectives, the Center has been an outstanding success. With facilities at each of the University's three campuses - at Rio Piedras near San Juan, at the coastal city of Mayaguez on the western shore, and in old San Juan itself - the PRNC functions as a major focal point for nuclear activity in the Americas. Steadily increasing numbers of students and scientists come to take advantage of the advanced formal training (in courses conducted primarily in Spanish) as well as laboratory and research experience provided at each of these sites.

My first visit to the PRNC occurred in February 1966. The immediate reason for the trip was a meeting of the USAEC General Advisory Committee (GAC), at which I was to present a report on USAEC activities.

The GAC was established by the Atomic Energy Act of 1946 (and continued by the 1954 Act) to advise the Commission on scientific and technical matters related to materials, production, and research and development. Its nine members were appointed by the President from civil life. I had the honor to

serve (1946-1950) as an initial member of the GAC under appointment by President Harry S. Truman. The GAC met at least four times a year, at various locations. I was glad of its decision to meet this time in Puerto Rico, because it would afford me a chance to look at some of the PRNC's facilities.

As it happened, Washington weather at the time made the flight south especially welcome:

"Tuesday, February 1, 1966 – Washington, Baltimore, San Juan to Mayaguez:

"I was driven to the office with difficulty due to the traffic tie-up caused by the snow. After spending a half-hour at the office I was driven to Baltimore to catch the plane to San Juan, Puerto Rico. Commissioners Gerald Tape and James Ramey, Arnie Fritsch, and other AEC people were on the same plane. We were met by Dr. John Bugher (PRNC Director and member of the General Advisory Committee), Floyd P. Trent, (Area Manager, AEC Puerto Rico Area Office), and PRNC Deputy Director Henry Gomberg. Tape, Fritsch, and I toured the Puerto Rico Nuclear Center facilities (mostly medical) at Rio Piedras near San Juan. I met Dr. Robert A. Luse (head of Agricultural Bio-Sciences), who was a graduate student at Berkeley obtaining his Ph.D. with Professor A. Douglas McLaren while I was Chancellor.

"We flew to Mayaguez and checked into the Mayaguez-Hilton Hotel. We then attended a reception and buffet by the swimming pool, given by the Executive Director of the Puerto Rico Water Resources Authority (PRWRA) Rafael V. Urrutia, and principal officers of the Authority. I sat at a table with Mr. and Mrs. Urrutia, Dr. and Mrs. Bugher, Dr. and Mrs. Manson Benedict (he is on the GAC), and Tape."

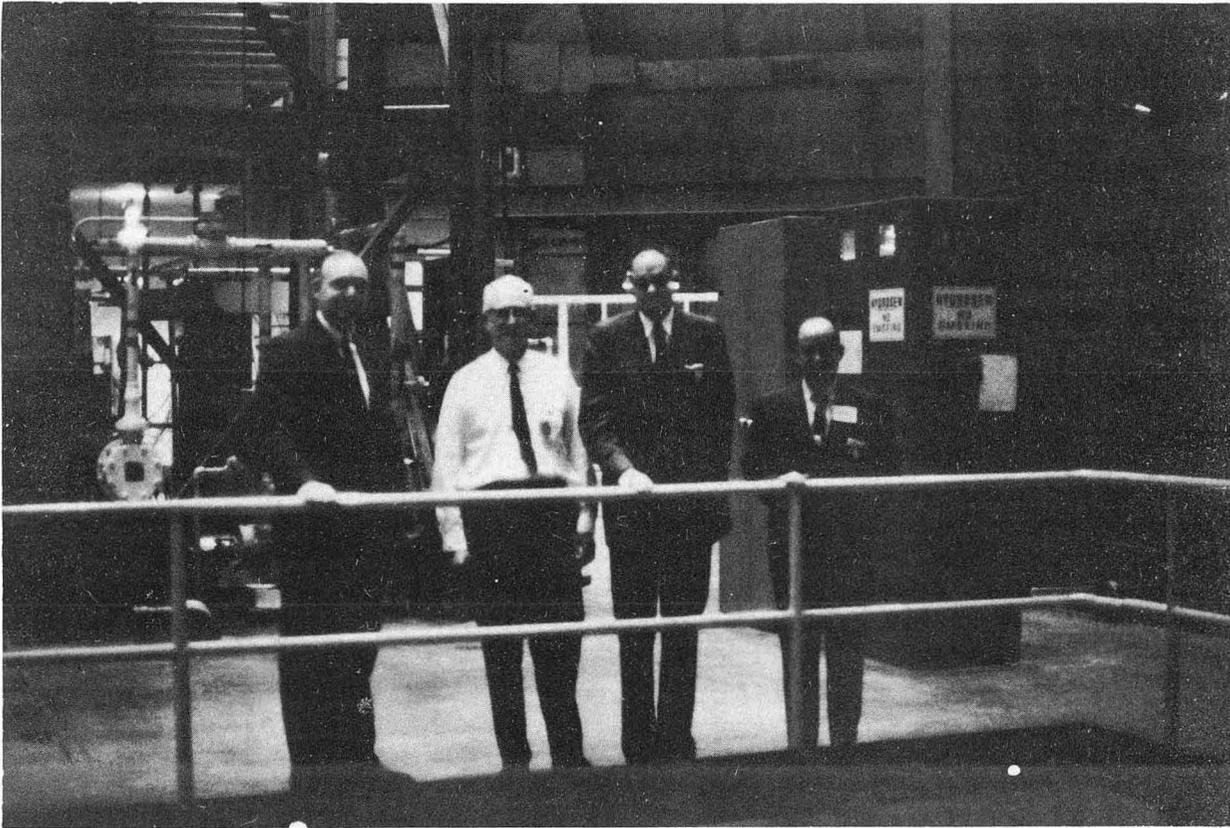
"Wednesday, February 2, 1966 – Mayaguez, San Juan, and home

"With Tape and Fritsch, I toured the Puerto Rico Nuclear Center at Mayaguez, conducted by Henry Gomberg. Most of the nuclear work is here; they have a 1 MW reactor which operates 16 hours a day.

"The Commissioners, staff, and I met with the General Advisory Committee. I gave an extensive 1-1/2 hour report with help from Tape, Ramey, and Bob Hollingsworth (USAEC General Manager); this was perhaps the best meeting we have had with the GAC. All the Committee members were present. (Members: L. R. Hafstad, Chairman, Manson Benedict, John C. Bugher, Edwin L. Goldwasser, Jane H. Hall, Stephen Lawroski, Norman F. Ramsey, Howard G. Vesper, William Webster; Committee Scientific Officer Duane C. Sewall and Committee Secretary Anthony A. Tomei.) We had a buffet lunch with them.

"Fritsch and I visited the 16.5 MWe Boiling Water Nuclear Superheat (BONUS) Reactor,* located about 15 miles from Mayaguez. We were escorted by Urrutia and Walter H. Zinn.

*Built under the USAEC's Power Demonstration Program, this reactor was a joint project of the USAEC and the Puerto Rico Water Resources Authority.



XBB 761-7023

*Visit to Puerto Rico Nuclear Center at Mayaguez, February 2, 1966.
(Left to right) Arnold Fritsch, Walter Zinn, Seaborg,
Raphael V. Urrutia.*

and his Combustion Engineering people. The reactor is operating very well.

"Arnie and I returned to San Juan on a Water Resources Authority plane, flying over Arecibo Ionospheric Observatory (operated by Cornell University) on the way. This is the site of the world's largest radar-radio telescope.

"After our return to the capital Arnie and I toured old San Juan, particularly the Castillo de San Felipe del Morro started in the 16th century.

"We flew out of San Juan at 5:30 p.m. and arrived in Baltimore at 8:00 p.m. I felt rather ill on the way due to the onset of a cold or the flu and its accompanying severe headache."

The last of my several trips abroad during 1967 was to the Puerto Rico Nuclear Center to take part in the celebration of the Center's tenth anniversary. The principal event of the celebration was a Symposium on "Nuclear Energy and Latin American Development" held in San Juan October 30 and 31, 1967. Well over a hundred participants attended from the United States, Puerto Rico itself, and fifteen nations of Latin America. The participants included Ernesto E. Galloni (National Atomic Energy Commission, Buenos Aires, Argentina), Federico Paz Lora (Executive Director, National Commission of Nuclear Energy, La Paz, Bolivia), Robert H. Wilcox (USAEC Scientific Representative, American Embassy, Rio de Janeiro, Brazil), Efrain Friedmann (Executive Director, National Nuclear Energy Commission, Santiago, Chile), Benjamin Viel (President, National Nuclear Energy Commission, Santiago, Chile), Tulio Marulanda (Director, Institute of Nuclear Affairs, Bogotá, Colombia), Jose Enrique Sallent (President, National Commission for Nuclear Affairs, Dominican Republic), Jose Ruben Orellana (President, Atomic Energy Commission, Quito, Ecuador), Ricardo Diaz Duque (Director, National Institute of Nuclear Energy, Guatemala City, Guatemala), Carlos Graef Fernandez (Commissioner, National Nuclear Energy Commission, Mexico City, Mexico), Bernardo Lombardo (Director, Center for Nuclear Studies and Chancellor, University of Panama, Panama City, Panama), Jose Danilo Pecci (President, National Commission of Atomic Energy, Asunción, Paraguay), Javier Correa Miller (President, Board of Control of Atomic Energy, Lima, Peru), Amador Cobas (Deputy Director, Puerto Rican Nuclear Center, San Juan, Puerto Rico), Guillermo Irizarry (Secretary of State, Commonwealth of Puerto Rico), Hon. Roberto Sanchez Vilella (Governor of Puerto Rico) and Mrs. Sanchez, Edward J. Brunenkant, Jr. (Director, Division of Technical Information, USAEC, Washington, DC), John T. Conway (Executive Secretary, Joint Committee on Atomic Energy, Washington, DC), Octave J. DuTemple (Executive Secretary, American Nuclear Society), E. E. Fowler (Director, Division of Isotopes Development, USAEC, Washington, DC), Robert H. Gifford (Executive Director, Southern Interstate Nuclear Board, Atlanta, Georgia), Robert H. Goeckermann (USAEC Scientific Representative, American Embassy, Buenos Aires, Argentina), Paul McDaniel (Director, Division of Research, USAEC, Washington, DC), J. R. Maxfield, Jr. (Maxfield Clinic Hospital, Dallas, Texas), Russell S. Poor (Director, Division of Nuclear Education and Training, USAEC, Washington, DC), Herman Roth (Director, Laboratory and University Division, Oak Ridge Operations Office, USAEC, Oak Ridge,

Tennessee), S. R. Sapirie (Manager, Oak Ridge Operations Office, USAEC, Oak Ridge, Tennessee), Shields Warren (Cancer Research Institute, New England Deaconess Hospital, Boston, Massachusetts), Donovan Q. Zook (Director, Atomic Energy Affairs, Department of State, Washington, DC), Alfonso S. Frangella (President, National Commission on Atomic Energy, Montevideo, Uruguay), and Carlos Caputo (Secretary General, Venezuelan Association for the Advancement of Science, Caracas, Venezuela). In addition, Sigvard Eklund came from Vienna bringing greetings and congratulations from the IAEA.

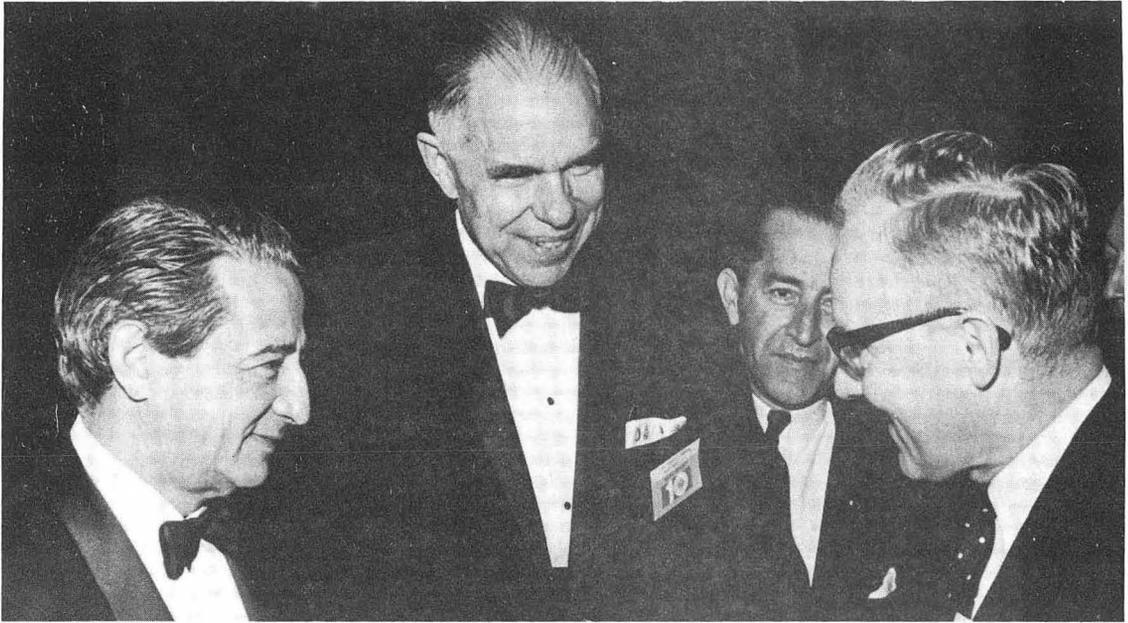
I had been invited to deliver the keynote address of the Symposium at the anniversary dinner given at the conclusion of the first day's sessions, and I had accepted with pleasure. Commitments at home allowed me to be in Puerto Rico only during the afternoon of that day and the evening; and my time there and back in Washington on the succeeding days was too full to permit more than a very sketchy personal record of the occasion:

"Monday, October 30, 1967 - Baltimore to San Juan

"Stan Schneider (my Staff Assistant), Allan Dalton of the USAEC's Division of International Affairs, and I flew from Baltimore to San Juan, arriving shortly before 2 p.m. We were met by J. Perry Morgan (Manager of the USAEC Puerto Rico Area Office) and Manuel Lopez (of Eastern Airlines). We checked into the San Jeronimo Hotel. We took a walk along the beach with Ed Westcott (AEC photographer, who took some pictures) and Morgan. I was interviewed by Jim McDonough of the San Juan *Star* on progress in nuclear energy and on my personal background. I then returned to the hotel to attend the Puerto Rico Nuclear Center Tenth Anniversary Symposium, which had begun that morning. This was the afternoon session (on Latin American problems) presided over by Jaime Benitez, President of the University of Puerto Rico. Speakers were Victor Marcial (Associate Director for Medical Programs, PRNC), Antonio Bacigalupo (Agrarian University, Lima, Peru), Henry J. Gomberg, Ben S. Stephansky (Deputy U.S. Representative to the Organization of American States - OAS), and Jesse Perkinson (Executive Secretary of the Inter-American Nuclear Energy Commission - IANEC, and Chief of the OAS Division of Science Development).

"I attended the reception and dinner at which I was the speaker on 'Nuclear Energy in Latin America.' I was introduced by Benitez. I sat between Puerto Rico Governor Roberto Sanchez Vilella and Sol M. Linowitz, US Ambassador to the OAS. I had a good chance to talk to Linowitz, who spoke enthusiastically of my trip to South America in July."

At the start of my address that evening, I suggested that "cooperation" be the keynote of the PRNC's Tenth Anniversary Symposium. That was the recurrent theme in the general survey I then gave of the development and current status of nuclear activity in Latin America. In the course of my talk, I mentioned the principal bilateral and multilateral cooperative nuclear programs already underway, as well as possibilities for expanded collaboration to assure the manifold benefits of nuclear science to the peoples of the hemisphere. I described my July trip to six South American nations and visits



XBB 761-7024

At reception preceding dinner at celebration of Puerto Rico Nuclear Center's tenth anniversary, San Juan, Puerto Rico, October 30, 1967. (Left to right) Jaime Benitez, Seaborg, Tulio Marulanda, Sigvard Eklund.



XBB 731-262

Dinner at celebration of Puerto Rico Nuclear Center's tenth anniversary, San Juan Puerto Rico. October 30, 1967. (Left to right) Governor Roberto Sanchez Vilella, Seaborg, Jaime Benitez, Ambassador Sol Linowitz, Henry Gomberg.

to their nuclear research and training institutions, some of which (along with the PRNC) I singled out as prospects for designation as centers of excellence to serve as regional centers for the multinational cooperative programs contemplated by the OAS. I emphasized the strong desire for regional cooperation that had been evidenced by the South American scientists and others whom my colleagues and I had met. After finally touching briefly on the PRNC's impressive growth, during its first ten years, as a training and study center for students and scientists from all of Latin America, I expressed my confidence about the future:

I think we can look forward to the next ten years of the life of PRNC as an era of great progress in nuclear energy in Latin America -- one in which this fine facility will continue to make a noteworthy contribution.....

As we continue to advance in knowledge and application of the peaceful power of the atom, it is my earnest hope that we shall do so in large part by means of the cooperative efforts that have marked so much of our progress in the past.

Certainly we have in the Puerto Rico Nuclear Center and in the other key nuclear installations scattered throughout the hemisphere the tools to do so.

All that is needed is the desire to work together, as our American Presidents have suggested, in regional developments that will help to ensure a better life for all. I believe we have this desire and willingness in abundance, as is evidenced by the participation of representatives from so many nations in this anniversary symposium.

My last visit to Puerto Rico as USAEC Chairman took place in February 1969. A major reason for this trip was the USAEC's interest in the possible installation of a commercial nuclear power plant in the Commonwealth. Such a project had been under consideration by the Puerto Rico Water Resources Authority for some time, and we felt strongly that an early and positive decision was desirable. Aside from the fact that a nuclear power station could be a significant factor in meeting future Puerto Rican power needs, we believed that the introduction of nuclear power into Puerto Rico would pave the way for the later application of nuclear energy in industrial complexes of a type included in a cooperative USAEC-Puerto Rico energy study that was in progress. Furthermore, the early installation of a nuclear power plant in the Commonwealth would take advantage of the experience the Water Resources Authority had gained through the operation of the BONUS plant and, particularly, would take advantage of the highly competent operating personnel trained during the BONUS operation, whose dispersion to non-nuclear activities would represent an unfortunate loss of experience. And finally, we felt that the work we were supporting at the PRNC would be strongly complemented by a decision by the Authority to undertake construction of the proposed nuclear power station. In a letter delivered to Governor Luis Ferre personally by Commissioner Ramey shortly before my visit, I had explained USAEC views on this matter at some length; and Ramey had provided the Governor with further information on the subject. I had received no answer to my letter, however;

and I felt that a personal discussion with Governor Ferre would be useful. Arrangements were made accordingly.

In addition to conferring with Governor Ferre, I was scheduled to attend a meeting of the Board of Directors of National Educational Television (NET) in San Juan; and of course I looked forward to revisiting the Puerto Rico Nuclear Center.

This trip was somewhat more relaxed than my previous ones. There was time for a little sightseeing, and I was glad that my wife could be on hand to share it with me:

Friday, February 7, 1969 - Baltimore to San Juan

"After spending an hour at the Germantown office, I went to the Baltimore Airport and flew to San Juan, arriving a little after 3. Helen had arrived at 3, having taken another flight. We were met by Dr. J. P. Morgan.

"At the airport I was approached by Harold J. Lidin of the Associated Press, who asked me the reason for my visit. I mentioned my planned attendance at the meeting of the Board of Directors of National Educational Television, visit to the AEC's Puerto Rico Nuclear Center at Rio Piedras, and meeting with Governor Ferre regarding a joint US Federal Government-Commonwealth of Puerto Rico study of a nuclear energy complex that might be built in Puerto Rico in the late 1970's.

"Morgan drove us to the office of the Governor of Puerto Rico in La Fortaleza in old San Juan. Frank Irizarry, Technical Aide to the Governor and faculty member of the University of Puerto Rico, and Professor Chandler H. Stevens of MIT's Alfred P. Sloan School of Management, who is on leave from MIT to be Chairman of the Governor's Steering Committee for the Development of Government Programs, met us in the waiting room where we conversed briefly.

"About 4:45 p.m. Helen and I, Dr. Morgan, Mr. Irizarry and Professor Stevens were escorted into Governor Ferre's office. In a brief discussion of Professor Stevens' role, the Governor explained that as a member of the corporation of MIT, he had heard for some time about the studies being conducted by the Sloan School of Management on the development of government programs. When he was elected governor, he said, the first thing he did was contact the president of MIT and request his assistance in putting the studies into practice. The Steering Committee's work will be divided between four task forces: (1) economic strategy, (2) public management, (3) human resources, and (4) environmental development. The Nuclear Energy Center work will fall within the realm of the Environmental Development task force.

"The Governor told me that he had received my letter but had not had a chance to answer it. He spoke of how interested he was in the Energy Center Study. I stated that the AEC was also interested in Puerto Rico's installing a nuclear power plant and would be glad to provide assistance to insure that the project goes smoothly. The Governor replied that this was something that also interested him very much. Puerto Rico, however, is isolated and they had to be concerned about the possibility of losing the services of a large generating plant. He mentioned that he had suggested in his meeting with Commissioner Ramey on January 31 that perhaps if they built the 560 MW nuclear plant they should also build a 200 MW fossil plant to provide back-up. It was brought out that a 560 MW nuclear plant built in 1975 would follow three 460 MW fossil units already planned for 1972, 1973 and 1974, so would not represent a large step-up in size. The Governor said he recognized this. I suggested that with the three preceding large fossil units the Authority would already have the back-up they desire for the nuclear unit.

"I also mentioned that I understood that the PRWRA study showed that building nuclear plants beginning in 1975 was the most economical route to follow. The Governor replied that he was aware that this was the case. He then stated that he would like to see a nuclear plant built, for he wanted Puerto Rico to be a leader in the application of new technology. The decision, however, would be left to the Water Resources Authority. It appeared from this that he would not interfere with them and would abide by whatever decision the Authority and its Governing Board made. I emphasized the reliability of such a nuclear power plant, pointed out that a hundred or more nuclear power plants would be in operation in the United States by that time, and said the US Atomic Energy Commission would stand ready to cooperate in every way.

"I was favorably impressed with Governor Ferre. He has a technical background and is a graduate of MIT.

"After our conference in the Governor's office, which he had sandwiched in between appointments, Governor Ferre guided us on a personal tour of La Fortaleza (Santa Catalina Palace). He showed us the rooms dating from the earliest period of its construction, which began in 1533 and was concluded in 1540. Many of the original rooms are still standing and are in good condition. We saw the two towers which are the distinctive characteristic of La Fortaleza, the bed in which Senator John F. Kennedy slept during his visit in the 1950's, the State Dining Room, the Governor's living quarters, the hall of mirrors, and the clock showing the time of 4:30 - the hour when the last Spanish Governor left La Fortaleza. We then said our goodbyes to the Governor, whom we were to see again that evening at the N.E.T. dinner.

"Professor Stevens showed us the beautiful garden, which apparently also dated back to the earliest days, and then showed us the headquarters to be occupied by the Steering Committee. He advised us that the Committee will include Santiago Vasquez, Secretary of Public Works, the only government official of that level on the Committee; Frank Irizarry; Antonio Ferre, the Governor's son and a former Chairman of the Puerto Rico Council of Higher Education under which the University of Puerto Rico operates; and additional government officials, making a total of 8 or 9 people. It was emphasized that this Committee will not conflict with the planning activities of the various Commonwealth Departments and Authorities. Professor Stevens said that Professor Charles Miller of MIT, who was President Nixon's advisor on urban transportation, will be in charge of the Environmental Development task force.

"On our way out we were introduced to Antonio Luis Ferre. The Governor's son is a very impressive young man. In addition to being Chairman of the Council of Higher Education, he has been head of Ferre Enterprises, which include among others the Puerto Rico Cement Company and the Puerto Rico Iron Works.

"Following our visit to La Fortaleza, which ended about 5:45 p.m., Dr. Morgan drove us to the Puerto Rico Nuclear Center (PRNC), where we were met by Dr. Henry Gomberg; Dr. Amador Cobas, the Deputy Director; and Mr. Fred Rushford, Technical Assistant to the Director. In the short time available, Dr. Gomberg reviewed the program and relationship of the Nuclear Center with the University and the Medical School. We had an overview of the PRNC addition being constructed, and we were shown the building plans, which were described to us in some detail.

"Following this, Dr. Morgan drove Helen and me to the Flamboyant Hotel where we checked in and prepared for the N.E.T. reception and dinner.

"At the reception I met and was interviewed by Ralph Ober of *El Mundo* on the Puerto Rico nuclear energy study and on my conversations with Governor Ferre regarding the possible construction in Puerto Rico of a 560 MW nuclear power station, to be operational by 1975.

"At the dinner we sat at a table with President and Mrs. Kingman Brewster of Yale University and Roger Baldwin (former and long-time head of the American Civil Liberties Union). Jack Delano (head of the Educational TV station WIPR, Channel 6, in San Juan) presided at the dinner. There were short remarks by Governor Ferre, by a gentleman who heads the Puerto Rico Department of Education, and by Everett Case (Chairman of N.E.T. Board of Directors)."

"Saturday, February 8, 1969 - San Juan

"I joined some of the others to go to Station WIPR-ETV, Hostas Avenue, Hato Rey, for the meeting of the N.E.T. Board of Directors.

"During the day Helen participated in the Ladies' Program. They did some sightseeing in the morning, had lunch at El Convento, and visited old San Juan in the afternoon.

"After the meeting of the Board we went by bus to the home of Jack Delano, where we met the ladies. There was a very informal reception, followed by a buffet supper, with the guests sitting at small tables in the garden. Jaime Benitez and Dr. and Mrs. Case sat at a table with Helen and me. I thanked Benitez for the financial help he had arranged for the students from South America who spend some time at the Puerto Rico Nuclear Center.

"We returned to the Flamboyant Hotel by bus. Helen and I took a walk through the resort hotel area before retiring."

"Sunday, February 9, 1969 - San Juan to home

"Helen and I accompanied many other members of the N.E.T. group on a bus tour, which included a visit to El Yunque Rain Forest and Luquillo Beach. We then went to El Conquistador Hotel at Fajardo for lunch. Dr. and Mrs. Gomberg, who had been sailing, came to help arrange our transportation back to the airport.

"Helen and I rode to the airport with one of the PRNC drivers. We flew home on separate flights. All flights were somewhat late due to the heavy snowstorm that had hit the Eastern section of the United States Saturday night and Sunday. We were greatly relieved, however that our planes were not hijacked to Cuba. (An Eastern flight, from San Juan to Miami, was hijacked the following morning.)"

To conclude these pages on Puerto Rico, it seems appropriate to mention that the Water Resources Authority did decide in favor of constructing a nuclear power station: a 583 MWe plant based on a Westinghouse Pressurized Water Reactor.* The Puerto Rico Nuclear Center has continued to make its considerable contribution to Latin American nuclear activities and advances, both in its original capacity and, later, as one of the "centers of excellence" designated for the purposes of the OAS regional nuclear programs.

* In 1975 the Puerto Rican Water Resources Authority announced that due to the decreased demand for electric power and increasing costs, they were discontinuing the installation of the 600 MWe power station; they plan to install nuclear power in the future as needed.

*
INDEX OF NAMES

- Abragam, Anatole, 85
 Abragam, Mme. Anatole, 85
 Adams, John Bertram, 185,329
 Adenauer, Konrad, 20
 Adolfsson, Bengt, 222,223,228,*229*,
 233,239,240
 Adolfsson, Britta (Mrs. Bengt),
 222,223,228,*229*,233,239,240
 Adolfsson, Eva, 223,228,*229*,233,
 234,239,240
 Adolfsson, Gösta, 223,228,233,234,
 239,240
 Adolfsson, Irene (Mrs. Gösta), 223,
 228,233,234,239,240
 Adolfsson, Jenny (Mrs. Karl), 228,
 229,230,233,234,239,240
 Adolfsson, Karl, 222,223,228,*229*,
 233,234,239,240
 Adolfsson, Lena, 223,228,*229*,233,
 234,239,240
 Adoula, Cyrille, 176
 Agnelli, G., 144
 Agnew, Spiro T., 162
 Ahmad, Mrs., 353
 Ahmad, N. M., 346
 Ahmad, S. Mansoor, 346
 Ahmad Khan, Munir, 360 footnote
 Aichi, Kiichi, 262,263,290,291,
 294,297,298
 Aigrain, Pierre, 74
 Aigrain, Mme. Pierre, 74
 Aiken, George D., 194
 Aiken, Henry David, 240,249
 Albonetti, Achille, 130,132,*133*,
 134,136,139
 Aldrin, Edwin E. ("Buzz"), 254
 Aldrin, Lars, 254
 Aler, Bo Aron Albert, 221,233,
 238,246,247,256
 Allemand, R., 77
 Allund, Leo R., 381
 Alphand, Hervé, 50
 Alvin, Lennart, *236*
 Amaldi, Edoardo, 130,*131*,140
 Amman, Fernando, 130,*131*
 Ammons, James E., 51, 196
 Amory, Michel, 31
 Anderson, Clinton P., 231
 Anderson, Herbert L., 125,*126*,140
 Anderson, John B., 226,*227*
 Andersson, L.-H., 233
 Andreasson, Rolf, 255
 Andreasson, Mrs. Rolf, 255
 Andreotti, Giulio, 140,144
 Andrews, John S.V., 194,195,196
 Andrews, Mrs. John S.V., 194
 Angelini, Arnaldo M., *131*,132,140,
 141
 Annenberg, Leonore C. (Mrs. Walter),
 197,211
 Annenberg, Walter, 197,210,212,213
 Aoki, Kinichi, (now known as
 Kumagai, Hiroo), 259,266,280,
 281,*282*
 Arada, Yoshihisa, 281
 Arisawa, Hiromi, 272,285,287,288,
 289,292
 Armand, Louis, 12
 Armstrong, H. C., 388
 Armstrong, Rodney, 272
 Armstrong, Willis C., 186
 Artamkin, Vadim N., 372
 Asakai, Koichiro, 261,262
 Asao, Shinichiro, 302,304
 Ashihara, Yoshishige, 273,278
 Asty, Jacques, 53
 Aten, Adriaan H.W., 153,156,*157*,
 158
 Auden, W. H., 240,245,251
 Austin, Jack, 388,389,390
 Avery, Donald, 174,177
 Ayengar, A.R. Gopal, 323
 Ayub Khan, Mohammad, 317,353 and
 footnote, 355,356,357,358
 Bacigalupo, Antonio, 395
 Bäcklin, Eric, 222,223,234,239
 Bäcklin, Karl-Erik, 222
 Bäcklin, Tora (Mrs. Eric), 222,
 223,228,*229*,234,239,253,254
 Badelay, Edwin, 193
 Bagge, Carl, 255
 Bagge, Mrs. Carl, 255
 Bagnall, Kenneth W., 178
 Baldwin, Roger, 400
 Balke, Siegfried, 90,*91*,226,*227*
 Ball, George, 40
 Baranowski, Frank P., 195, 387

*Page numbers in italics indicate photographs.

- Barclay, Frederick J., 199
 Barendregt, T. J., 24,25
 Barger, Herman H., 290
 Barnett, Denis, 197
 Barnett, Lady Denis, 197
 Barnick, Max, 115
 Baumgartner, Franz, 118,120
 Baumgartner, Herbert, 324
 Bauser, Ed, 194
 Baxter, Charles F., 113,116,117
 Beach, Frank Ambrose, 368
 Beach, William A., 272,284,285,
 290,293
 Beadle, George, 125,126
 Becker, Erwin Willy, 18,19,120
 Beckler, David Z., 194,379
 Bedford, Ronald, 211
 Beggs, James M., 379
 Benedict, Manson, 392
 Benedict, Mrs. Manson, 392
 Bengelsdorf, Harold D., 310,388
 Benitez, Jaime, 395,396,401
 Benn, Anthony Wedgwood, 185,186,193,
 194,195,196
 Bennett, Gerald, 106
 Berghaus, Mr., 106
 Berglund, Britt, 222,228,229,234
 Berglund, Gösta, 222,223,228,
 229,239
 Berglund, Ingrid (Mrs. Gösta), 222,
 223,228,229,239,253
 Berglund, Siv - see Lindkvist,
 Siv Berglund
 Bergman, Torsten, 250
 Bernardini, Carlo, 132
 Bertum, Leonan, 381
 Bethe, Hans A., 341
 Betts, Gen., 174
 Bevans, Charles I., 256,268,269
 Bhabha, Homi Jehangir, 226,227,308,
 309,310,311,312,314,315,316,317,
 318,319,320,321,324,325,329,331,
 337,341
 Bhabha, Mrs. Meherbai J., 331
 Bhutta, S. M., 348
 Bianchi, Giuseppe, 142
 Bienlein, Dr., 106
 Bieth, C., 72
 Biles, Martin B., 24,25,59,95
 Bishop, A. G., 327
 Blackwell, David, 252
 Blair, Sidney Martin, 374,375
 Blair, Tom, 117
 Bleha, Charles Thomas, 118
 Blin, Dr., 77
 Bloch, Edward J., 195,270,337,378,
 381,383 footnote,386,387
 Bloom, Anders, 234,239
 Bloom, Anita, see Gustafsson,
 Anita Bloom
 Bloom, Berit, 223,228,229,234,239
 Bloom, Eivor (Bäcklin) (Mrs. Olof)
 222,223,228,229,232,234,239,253
 Bloom, Justin, xviii, 42,70,74,
 78,83,113,115,116,117,118,165,
 166,196,198,200,204,206,210,211,
 212
 Bloom, Olof, 222,223,228,232,234,
 239,240,253
 Bloom, Per, 223,228,229,232,234,
 239
 Bloom, Robbie (Mrs. Justin), 74,78,
 85,118,119,120,196,198,203,
 209,212
 Blum, Dr., 118
 Blumfield, Clifford W., 198,199,
 200,201,203
 Bock, R., 115
 Böckhoff, Karl-Heinz, 24,26
 Bodde, William, 256
 Boegner, Jean-Marc, 150
 Boettcher, Alfred R., 94,95,96,
 103,104,105
 Bohlen, Charles E., 59,60,175
 Böhm, H., 119,120
 Bohr, Niels, 152
 Boltz, C. L., 185
 Bonell, Mart, 381
 Born, Ambassador, 158
 Borschette, Albert, 150
 Bost, Lawrence, 16
 Bouckaert, J. J., 159
 Bouissières, Georges, 71,73,83
 Bowen, Gordon, 187
 Bowles, Chester, 11
 Bowling, John W., 348,353
 Bowling, Mary Ellen (Mrs. John W.),
 348,353
 Braddock, Daniel M., 321,326,331
 Braddock, Mrs. Daniel M., 321,331
 Bradley, R. Glenn, 118,166,168,
 169,266
 Brand, Robert A., 63
 Brandt, Reinhard, 117

- Brandt, Willy, 90
 Bray, J. Alan, 200
 Bree, Rudolf, 165,166,167,168,169,
 170
 Brenwell, Dr., 322
 Bretscher, Egon, 100,178
 Bretscher, Mrs. Egon, 100
 Brewster, Kingman, Jr., 400
 Brewster, Mrs. Kingman, Jr., 400
 Brezhnev, Leonid, 1
 Britton, Tony, 197
 Brix, Peter, 115
 Broadly, Jack S., 200
 Brohult, Sven, 253
 Brook, Norman, 175
 Brown, Gordon, 186
 Brown, Harold, 175
 Brown, Harrison, 240,243,252
 Brown, Howard C., Jr., xviii,14,15,
 30,31,158,173,174,191,192,315,
 359,378,383 footnote,386,387
 Bruce, David K., 178,186
 Brüchner, Hans Joachim, 111
 Brunelli, Bruno, 132
 Brunenkant, Edward J., Jr., 394
 Bruner, Blanche (Mrs. Jerome S.),
 240
 Bruner, Jerome S., 240,245,252
 Brunner, Mr., 119
 Bruns, William H., 262
 Brynielsson, Harry A.B., 221,222,223,
 224,225,226,227,246
 Buckley, George Eric, 203,207
 Buckley, Mrs. George Eric, 203
 Bugher, John, 392
 Bugher, Mrs. John, 392
 Bullio, Pietro, 140
 Bulloff, Jack, 386
 Bunche, Ralph, 250
 Bundy, Göran, 230 footnote
 Bundy, McGeorge, 174,175,312
 Burdett, William C., 220
 Burgeth, Franz, 335
 Burke, John, 378
 Burnham, Donald C., 272
 Butt, Noor M., 346
 Butterworth, W. Walton, 12,13
 Butz, Earl L., 1
 Caccia, Harold, 175 footnote,178,
 181
 Caccia, Lady Harold, 175 footnote
 Caetano, Marcello, 106
 Caglioti, Vincenzo, 143
 Calamine, P., 383
 Calder, Nigel, 250
 Calderale, Giovanni, 130,131
 Calhoun, John A., 3
 Campbell, Ronald H., 178
 Cancellario d'Alena, Franco, 24,
 31,40
 Cangiano, Roberto, 132,133
 Caputo, Carlos, 395
 Cargo, Margaret (Mrs. William I.),
 346
 Cargo, William I., 346,348,353,365
 Carl Gustaf, Crown Prince of
 Sweden, 255
 Carlson, Edgar, 231
 Carlsson, Allej, 223
 Carlsson, Ingvar, 246,247
 Carrelli, Antonio, 24,27
 Carrothers, W. D., 378,383 footnote
 Carruthers, Robert, 185
 Cartwright, P., 327
 Case, Everett, 400,401
 Case, Mrs. Everett, 401
 Casey, Lee, 284
 Casilli d'Aragona, Massimo, 145
 Casimir, Hendrik, 61
 Casper, Walther, 102
 Castberg, Frede, 240,244,247
 Castelli, Franco, 129
 Cater, Doug, 194
 Cecil, Mildred, xviii
 Cerchia, Renato, 131,132
 Chadwick, James, 173
 Chagas, Carlos, 240,243,248,250
 Chakravarti, M. N., 310,311,321,
 326,328
 Chakravarti, Mrs. M. N., 329
 Champ, H., 383
 Chapman, Robert, 211
 Chatenet, Pierre, 16,17,20,24,27
 Cherian, P. V., 329
 Chernoff, Howard, 280
 Choppin, Gregory R., 149

- Christianson, Alan, 207,208,209
 Churchill, Winston S., 213,214, 215,217
 Churchill, Winston S. (grandson), 214,215,216,217
 Cintra do Prado, Luiz, 226,227
 Cisler, Walker L., 230
 Cisler, Mrs. Walker L., 230
 Clark, B.A.R., 382
 Clark, Mrs. B.A.R., 382
 Clark, Blake, 255
 Clark, Deanna (Mrs. Blake), 255
 Cleveland, Stanley M., 59,60,197,210
 Clifton, Chester V., 175
 Cobas, Amador, 394,400
 Cobb, Lynne Seaborg (Mrs. William) 255, see also Seaborg, Lynne
 Cobb, William, 255
 Cockcroft, John, 172,173,174
 Coehoorn, J., 155
 Cohen, Mr., 106
 Colabianchi, G., 143
 Cole, Sterling, 219
 Collins, John A., 233
 Collins, Mrs. John A., 233
 Colonna, Guido, 30,31
 Compton, Arthur A., 159
 Compton, Arthur H., 159,160
 Compton, Betty (Mrs. Arthur A.), 125,126,159
 Conner, John T., 230
 Conner, Mrs. John T., 230
 Consolo, Federico, 12,16
 Convert, P., 78
 Conway, John T., 100,136,311,394
 Cook, William, 181,192
 Cooper, Dave, 381
 Cordell, Dr., 77,78
 Correa Miller, Javier, 394
 Costagliola, Francesco, 67,106, 192,271,378
 Cottrell, Alan Howard, 178,181
 Couture, Jean, 69,74
 Couture, Pierre, 53
 Cowen, Robert, 250
 Crabbe, George, 284
 Criton, Dr., 116
 Croall, Stephen, 250
 Croome, Angel, 211
 Crossman, Richard, 186
 Crowson, Delmar L., 195,302,303
 Crozier, Mr., 250
 Culley, Perry H., 74
 Culley, Mrs. Perry H., 74
 Cullison, A. E., 289
 Cultrera, Pino, 143
 Cunningham, Burris B., 72,263
 Cunningham, Charles C., 197
 Cunningham, Lady Charles, 197
 Cunningham, William J., 285
 Curie, Marie Sklodowska, 47
 Dachateau, Pierre, 37,38
 Dahlman, Amb., 230
 Dahlman, Mrs., 230
 Daley, Richard J., 125,126
 Dalton, Allan, 4,395
 Dalyell, Tam, 187
 Danos, Michael, 117
 Dard, Jean, 60,66,68,69
 Darling, George B., 294
 David, François, 72,83,84
 Davidson, Mr., 205
 Davie, Michael, 250
 Davies, W. John M., 202,203
 Davis, John, 196
 Davis, Richard H., 179
 Davy, John, 185
 Dawson, Peter D., 198,200,201, 203,204,206,207
 Day, Edward, 256
 Day, Mrs. Edward, 256
 Dayal, Maheshwar, 310,315,326,328
 Dean, Patrick, 184
 de Arriaga, Kaulza, 106
 de Besche, Hubert W.A., 220,221, 230,231,255,256
 de Besche, Mrs. Hubert W.A., 230,255
 De Biase, Massimo, 140
 Debièvre, Paul, 24,26
 de Bloch, L., 193
 de Boer, J. H., 226,227
 De Courcy, John Spencer, 113
 de Creeft, Tristan, 27
 Dee, Robert W.R., 153,154
 De Gaulle, Charles, 17,24,34,36, 46,48,59,60,62
 de Groote, Paul H., 20,25,150
 de Haas, William A., 150
 De Heem, Louis, 149

- de Jong, Petrus J.S., 161,162
 Dejonghe, Paul André Jozef, 24
 de Kinder, Roger, 159
 de Laage, François, 50,52,53
 Delano, Jack, 400,401
 Deniau, Jean François, 37
 Denschlag, Herr, 114
 de Rose, François, 51
 Deshbande, Mr., 324
 des Muelen, Mr., 150
 De Stordeur, Arnold, 40
 Dewar, J. S., 382
 Dewar, Mrs. J. S., 382
 de Winter, Auguste, 159
 Diamond, Richard M., 350
 Diaz Duque, Ricardo, 394
 Dilschmunder, D., 381
 Di Nunno, Joseph J., 63,65
 Doan, Richard L., 226,227
 Dobrynin, Anatoli, 255
 Donovan, Francis T., 284,293
 Donvez, Dr., 77
 Doxiadis, Constantinos A., 240,
 251,253
 Droulers, Dr., 76
 Drury, Charles M., 372,373
 Du Bridge, Lee A., 113,194,379,380
 Du Bridge, Mrs. Lee A., 194
 Ducci, Roberto, 144,145,336
 Duffield, Robert B., 125,126
 Dunbar, Kenneth A., 125,126,368,
 370
 Dunn, William, 185,211
 Dunworth, John Vernon, 186
 Duran Miranda, Armando, 329
 Du Temple, Octave J., 394
 du Vivier, Paul, 115
 du Vivier, Mrs. Paul, 115
- Eckerberg, Lennart, 231
 Eisenhower, Dwight D., 5,391
 Ekbon, L., 233
 Eklund, Arne Sigvard, 45,62,85,220,
 223,226,228,230,256,265,308,309,
 365,371,372,395,396
 Eklund, Mrs. Arne Sigvard, 372
 Elbrecht, Steve, 280
 Emeleus, Harry J., 98,181
 Emeleus, Mrs. Harry J., 98
 Emelyanov, Vasily Semenovich,
 184,309
 Emmerson, John K., 261,262
- Emori, N., 275
 Engelhardt, Vladimir A., 239,240
 Engels, Eugene, 106
 England, Bill, 194
 English, Spofford G., 369,370,378
 Engström, Arne, 240
 Engstrom, Elmer, 231
 Erickson, Selma (Mrs. Herman
 Seaborg), 218
 Ericson, Eric, 256
 Ericsson, Harald, 246
 Eriksson, Adolph, 254
 Eriksson, Albert, 223,228,229,239
 Eriksson, Dan, 228
 Eriksson, Göran, 239
 Eriksson, Gustav, 223,228,244
 Eriksson, Inga-Britt, 223
 Eriksson, Karl-Erik, 240
 Eriksson, Lena, 228,229,239
 Eriksson, Maria (Mrs. Albert),
 223,228,229,239
 Erixon, Stig, 239,240
 Erlander, Tage, 222,228,230,
 230 footnote, 237,246,247,
 250,254
 Erlander, Mrs. Tage, 230
 Erlewine, John A., 13,18,149
 Errington, Roy F., 366
 Eschauzier, Henri F., 262
 Evans, Alfred D., 200,201,202
- Fairhurst, Ted, 381
 Falquet, Pierre, 53,58
 Farley, Phil, 59
 Farrell, Charlotte Wilhelmina, 219
 Fassbender, Josef A., 95
 Faulkner, Rafford L., 374
 Fedoseev, P. M., 326
 Fehre, Martin, 233,234
 Fenoaltea, Sergio, 136
 Ferguson, Don E., 118
 Ferguson, Ed, 310
 Fermi, Enrico, iii,v,7,125,128,
 140,152
 Fermi, Laura (Mrs. Enrico), 125,
 126,127
 Fern, Arthur L., 111
 Ferne, Georges, 61
 Ferre, Antonio Luis, 400
 Ferre, Luis, 397,398,399,400
 Fessenden, Russell, 20,24,28

- Fessenden, Catherine A.
 (Mrs. Russell), 21
 Fina, Thomas W., 29
 Finch, Miss, 382
 Finger, Harold, 379
 Fink, Bernd, 117
 Fink, Lyman, 311
 Finke, Wolfgang A., 92
 Fisher, Adrian, 39
 Fishlock, David, 211
 Fjellander, Jan, 244,245,250
 Flaemig, Gerhard, 121
 Flaherty, John J., 387,388
 Fleetwood, Baron, 222
 Fleetwood, Baroness, 222,246,247
 Flerov, G. N., 75, 239
 Florin, Al, 149
 Florin, Kay, 149
 Foch, René, 27,28,31,37,38
 Foch, Mrs. René, 31
 Fock, Henrich, 107
 Ford, Edsel, 65
 Ford, Henry, 65
 Forsling, Wilhelm, 257,257
 Forssling, Birgitta, 239
 Forssling, Bo, 233
 Forssling, Carina, 239
 Forrsling, Mona Möller (Mrs. Bo),
 233,239
 Foster, John Stanton, 376,379,381,
 383 footnote, 386
 Fowler, E. E., 394
 Franco, Gianfranco, 140,141
 Frangella, Alfonso C., 395
 Franklin, Ben, 215
 Franklin, Norman Laurence, 203,204,
 206,207
 Frazer, J., 383
 Fredman, Mr., 372
 Freeman, David S., 379
 Freeman, Fulton, 193
 Frejacques, Claude, 85
 Frejacques, Mme. Claude, 85
 French, Mr., 244
 French, Carl, 244,363
 Fricke, Burkhard, 116,117
 Friedman, Abraham S., xviii,29,42,
 53,55,63,66,67,70,71,73,74,82,
 83,84,85,111,118,164,165,166,
 168,187,188,197,198,200,204,206,
 210,211,212,303,305,335,336,359,
 378,381,382,383 and footnote,
 386,388
 Friedmann, Efrain, 394
 Friendly, Alfred, 250
 Frisch, Otto, 98,99,100
 Frisch, Mrs. Otto, 98
 Fritsch, Arnold R., xviii,2,18,20,
 21,24,26,27,29,40,59,62,63,92,
 94,95,96,97,98,103,105,106,109,
 130,134,150,151,179,181,185,186,
 187,188,189,226,227,232,233,234,
 259,261,263,321,323,326,345,353,
 366,371,372,392,393,394
 Frost, Yvonne, 215,216
 Fucks, Wilhelm, 95
 Fujii, John, 284
 Fujii, Tetsuhiro, 272,278
 Fujimoto, Takao, 303
 Fujinami, Tsuneo, 268,269
 Fulbright, J. William, 162
 Fulcher, Lewis P., 117
 Fuller, Don, 321,326, 328
 Furukata, Mr., 273
 Galanto, Fred J., 166
 Galbraith, John Kenneth, 309,311
 Galley, Robert, 61
 Galloni, Ernesto E., 394
 Gandhi, Indira, 318,320,329,330,332
 Gascoigne, Joyce A. (Mrs. Julian
 A.), 175
 Gascoigne, Julian A., 175
 Gathercole, George E., 381
 Gavin, J. J., 327
 Gavin, James, 51
 Gavin, Mrs. James, 51
 Genuardi, Gabriele, 31
 Gerard, Ralph Waldo, 368
 Ghani, Abdul, 346,347,348,353
 Ghani, Mrs. Abdul, 346,348
 Ghiorso, Albert, 72,74,75,116,387
 Ghosh, Aran K., 310,314,315,316
 Giambusso, Angelo, 378
 Gibson, Andrew E., 288,301
 Gibson, G. E., 281
 Gibson, Joe, 272
 Gierow, Karl R., 240,247
 Giese, Kurt, 114
 Gifford, Robert H., 394
 Gilchrist, William M., 374
 Giller, Edward B., 194
 Gimstedt, Olle G., 231,236
 Giraud, André, 70,72,78,80,81,
 82,83,85,86,123

- Giraud, Claudine (Mrs. André), 85
 Goeckermann, Robert H., 394
 Goedkoop, Jacob A., 153,154,155,158
 Goens, Julien Raymond Jean, 24,
 25,26,149
 Gofman, John, 286
 Golden, D. A., 369,370,378,383 and
 footnote, 386
 Goldschmidt, Bertrand, 22,46,47,48,
 49,51,53,55,56,60,61,62,63,65,66,
 67,68,70,72,74,79,80,84,85,123,
 181,226,227,325,326,365
 Goldschmidt, Mrs. Bertrand, 47,72,
 74,85
 Goldstein, Silvia (Mrs. Gerald),
 113,114
 Goldstein, Susan, 114
 Goldwasser, Edwin L., 392
 Gomberg, Henry, 392,395,396,400,401
 Gomberg, Mrs. Henry, 401
 Gombrich, Ernst H., 240,245,253
 Goodby, James E., 30,31,40,158
 Gordon, Andrew R., 369
 Gordon, D. J., 381
 Gore, Mr., 215
 Gore, Albert, 184
 Goswami, Upendra Lal, 329
 Gould, Donald, 185
 Gould, Kingdon, 166,168,170
 Gould, Mary (Mrs. Kingdon), 166
 Grace, Norman S., 382
 Graef Fernandez, Carlos, 394
 Graham, John S., 15,51
 Grahame, David C., 280,281
 Grant, Roderick N., 113
 Graves, Gene, 159
 Gray, J. Lorne, 326,329,363,364,
 365,366,367,369,370,371,373,376,
 378,380,381,383 and footnote,
 384,385,386,387,388
 Green, Mr., 389
 Greenberg, Allen S., 137
 Greenberg, Daniel, 250
 Greene, Joseph N., Jr., 210
 Greenwood, J. Ward, 369,379
 Gregory, John M., 285
 Greifeld, Helmut Rudolf, 18,19,
 119,120
 Greiner, Walter, 114,115,116,117
 Grenoble, Marjorie B. (Mrs. William
 L.), 115
 Grenoble, William L., 115
 Grewe, Ambassador, 90
 Griffin, Stewart, 284
 Griffiths, Trevor, 197
 Griffiths, Mrs. Trevor, 197
 Grill, Fanny, 234
 Grill, Gun (Bäcklin) (Mrs. Hans-
 Lennart), 222,223,228,229,234,
 239
 Grill, Hans-Lennart, 228,229,
 234,239
 Grill, Helen, 234,239
 Grill, Jimmy, 234,239
 Grinyer, C. A., 366,378,383 footnote
 Gronow, W. S., 197
 Grosse, Hans, 95
 Groves, Leslie R., 125,126
 Gruber, Karl, 98,99,256
 Grumann, Jens, 116
 Guazzugli-Marini, Giulio, 24,31,120
 Guéron, Jules, 12,14,15,16,24,25,
 26,30,31,47,153,154
 Guéron, Mrs. Jules, 31
 Guggenbuhl, Mr., 167
 Guillaumat, Pierre, 51
 Guillaumont, Robert, 83
 Gulshkov, W. M., 326
 Gustafson, Torsten, 226,227
 Gustafsson, Anita Bloom, 223,228,
 229,234,239
 Gustafsson, Jan-Erik, 234,239
 Guth, Wilfried, 241
 Haefele, Wolf, 18,19
 Haferkamp, Wilhelm, 40,41,42,167
 Hafstad, L. R., 392
 Haginoya, Tohru, 258,261,262,302
 Hahn, Otto, iii,v,94,97,98,99,107
 109,115,152
 Hailsham, Lord, 178,181
 Halban, Hans, 86
 Halban, Peter, 86,87
 Haldar, Barum Ch., 325
 Hall, Jane, 392
 Hall, John Allen, 134,135,182,
 183,261,263,344,365,382
 Hamaguchi, Shunichi, 273,275,277
 Hambley, J. M., 381
 Hamlin, Miss, 214
 Hammerling, Friederich, 111

- Hammond, Mr., 211
 Hampe, Mr., 120
 Handler, Philip, 254
 Hannant, Mr., 85
 Hansen, Peter T., 30
 Hantke, H. J., 104,105
 Harada, Tsuneo, 290
 Harkness, Richard, 256
 Harkness, Mrs. Richard, 256
 Harkort, Dr., 193
 Harlech, Lord (W. D. Ormsby Gore),
 181
 Harris, John A., 140
 Harrison, Selig, 284
 Hartmann, Peter, 104,105
 Hartogh, A.F.K., 161
 Hashimoto, Seinosuke, 261,292
 Hashmi, F. H., 346
 Hataye, John M., 289
 Haugg, Werner, 95,96,103,105
 Haunschild, Hans-H., 27,123
 Hawkins, Mr., 372
 Hawthorne, Prof., 98
 Hawthorne, Mrs., 98
 Haxel, Otto P.L., 42,118,119
 Haxel, Mrs. Otto, 120
 Hayashi, Y., 241,248,251
 Haywood, Leslie R., 366,369,370,
 376,378,381,383 footnote
 Haworth, Leland J., 51,132,133,
 174,310,364,365,379
 Hearn, Richard L., 366,369,370
 Heath, Edward R.G., 17
 Hebert, Louis, 374,375
 Hedén, Carl-Göran, 239,241,249,250,
 252
 Hehns, Julie, 256
 Heidenreich, Curt, 29,31,37,38
 Hellwig, Fritz, 30,31,32,33,34,37,
 38,39,40,41,144
 Henderson, Christopher L., 16,53,149,
 178,221,222,310
 Hennessey, Joseph F., 236,315
 Henning, Klaus Dieter, 107
 Herbst, Axel, 40
 Hermansson, Rune, 221
 Herr, Wilfred, 95
 Herrinck, Paul, 153,154
 Herrmann, Günther, 114,115,117
 Herrmann, Mrs. Günther, 115
 Hesburgh, Theodore, 316
 Heyne, Gernot, 101
 Hiatt, Robert W., 290
 Hibino, Kyoko, 284
 Hildebrand, Staffan, 244
 Hill, Andrew, 198
 Hill, John M., 188,196,197,198,200,
 201,202,203,204,206,207,208,209,
 210,211,212,336
 Hill, Lady John M., 197,198
 Hill, Victoria, 198
 Hill, William, 304,305
 Hillenbrand, Martin J., 95,96,256
 Hindbeck, O., 233
 Hindersson, Mickael, 234,239,240
 Hirsch, Etienne, 12,13,14,15,16
 Hirsch, Robert, 59,60,63,64,65,
 66,67,68,70,72,78
 Hitchman, Alan, 173,174
 Hochlein, Dr., 118
 Hocker, W.H. Alexander, 95,103,105
 Hoffman, Irving, 381,383 footnote
 Hoffmann, Jean, 166,168
 Hogen, Shinsaku, 267
 Höglund, Anne (Mrs. Rune E.A.), 251
 Höglund, Rune E.A., 251
 Hoki, Shiro, 302
 Holifield, Chet, 67,68,191,194,
 268,269,286
 Hollander, Jack M., 143
 Hollingsworth, Robert E., 4,192,
 194,236,263,302,337,369,370,
 371,378,387,392
 Hollingsworth, Mrs. Robert E., 371
 Holm, Harmut, 116
 Holm, Lennart W., 232,233,234,257,
 257
 Holte, Per Gunnar, 221
 Holum, Kenneth, 261
 Home, Earl, 175
 Hori, Sumio, 301
 Horne, W.R., 363
 Hornig, Donald F., 98,99,319
 Horowitz, Jules, 63
 Hosmer, Craig, 67,68,194
 Hosokawa, Setsuko, 284
 Howells, Mrs., 207
 Howells, Gordon Rushworth, 203,204,
 206,207
 Howells, Mrs. Gordon Rushworth,
 203,209
 Hoyle, Dixon B., 20,30,31,153,154,
 158,230,304
 Hoyle, Mrs. Dixon, 31

- Hudson, Miller N., 366,368,370,371
 Hudson, Mrs. Miller N., 371
 Huet, Pierre, 74
 Huet, Mme. Pierre, 74
 Hughes, Thomas Garfield, 203,205,
 206,207
 Hughes, Mrs. Thomas Garfield, 203
 Hultman, Folke, 221
 Humphrey, Hubert, 230,231
 Humphrey, Muriel (Mrs. Hubert), 230
 Humphries, John, 200
 Husimi, Kodi, 280,281,282
 Huss, Alphonse, 150
- Ihle, Hans, 95,96
 Iida, Masami, 277
 Iida, Masayoshi, 266
 Iltis, Theodore J., 24,25,27,31,41,
 59,95,96,103,105,106,158
 Iltis, Mrs. Theodore J., 31
 Imai, R., 258,274,275,293
 Inaba, Hidezo, 290,292
 Ingram, George M., 256
 Inoue, Hironori, 303
 Inouye, Goro, 268,269,271,286,287,
 292,293,294
 Ippolito, Felice, 132,133
 Ipponmatsu, Tamaki, 258,274,275,
 294,298
 Ireland, George D., 207
 Irizarry, Frank, 398,400
 Irizarry, Guillermo, 394
 Irvin, Fred, 110
 Ishida, Mr., 273
 Ishikawa, Takashi, 268,270
 Ishikawa, Tsugio, 303
 Ito, Toshio, 273,275,276,277,278
 Itoh, Hironori, 268,269
 Itoh, Michiko (Michi), 279,280,284
- Jacobe, J., 78
 Jacquemin, Dr., 76
 Jacrot, B., 75,76,77,79
 Jagannathan, Sarukkai, 310,311
 Janinek, Marie, xviii
 Jaroschek, K., 100
 Jarret, Mr., 178
 Jarring, Gunnar, 220,221 footnote,
 225
 Jean, Maurice, 83,84
 Jensen, J.H.D., 112,119
- Jha, Lakshimi Kant, 335
 Johnson, Amandus, 231
 Johnson, Charles, 100,136
 Johnson, Lyndon B., 98,101,110,125,
 140,159,234,265,275 footnote,
 331,343,356,366
 Johnson, Richard G., 27
 Johnson, Wilfrid Estill, 37,38,
 61,67,80,122,163,192,268,269,
 327,337,371,372,378,383 footnote,
 388
 Johnson, Mrs. Wilfrid E., 371
 Johnstone, James R., 115
 Joliot-Curie, Frédéric, 86,152
 Jones, Lewis, 174,181
 Jonsson, Bo, 255,256
 Jonsson, Mrs. Bo, 256
 Joos, Mr., 106
 Josephson, Horace, 255
 Josephson, Mrs. Horace, 255
- Kahn, Rafi, 353
 Kajikawa, Mitsugu, 289
 Kandell, Jonathan, 284
 Kankeleit, Egbert, 115
 Kannad, B. R., 327
 Kapoor, Shyam S., 323
 Kato, Hiromi, 273,274,276,277,278
 Katz, Joseph J., 84,387
 Kavanagh, George M., 369,370
 Kawabata, Seiri, 263,264
 Kawashima, Yoshio, 272,284
 Kayaba, Michinosuke, 289
 Keaver, Joan, 381
 Kelly, John S., 370,376
 Kelly, K., 383
 Kennedy, John F., 18,92,128 foot-
 note,173,174,175,176,179,312,
 399
 Kent, Robert W., Jr., 355
 Kerr, Clark, 113
 Keynes, Richard, 100
 Kido, Takayuki, 289
 Kikawada, Kazutaka, 278
 Kikuchi, Seishi, 280,281,282,
 287,293
 Kimoto, Mr., 273
 Kinchin, George Henry, 198,200,
 201,203
 Kinchin, Mrs. George Henry, 203
 King, Alexander, 241,251

- King, Cecil St.C., xviii,15,16,18,
53,149,173,178,179,221,222,321,
323,326,345,353
- Kingston, Jane, xviii
- Kino, Haruo, 303
- Kirk, John, 199
- Kiruchi, Tohru, 266
- Kishida, Junnosuke, 292
- Kishida, Koichi, 284
- Kitagawa, Kazue, 292
- Kitagawa, Yoshikazu, 303
- Kitamura, Taizo, 279
- Kits, Gabor, 120
- Kiyonari, Susumu, 289
- Kjellgren, Ruth, 223,228,229,233,
234
- Klaus, Josef, 97,98,99
- Klein, H., 116
- Klein, Raymond, 61
- Klemm, Alfred, 115
- Klineberg, Otto, 241,250
- Knight, George, 158
- Knight, Ridgway B., 152,158,159,161
- Knighton, William, 187
- Knox, Gordon, 346,348
- Knox, Mrs. Gordon, 346
- Knox, William E., 144
- Koch, Günter, 118
- Koestler, Arthur, 240,241,245,250
- Kohler, Foy D., 365
- Kolditz, J., 95,96
- Koloshen, Andrei, 281
- Komagata, Sakuji, 226,227,259,260,
261
- Kooi, Jacob, 153,154,156,157
- Kopel, R. H., 327
- Korneev, S. G., 326
- Kowarski, Lew, 86,87
- Kramer, Ernst L., 153,154,156
- Kramer, H., 103,104,105
- Kratzer, Myron B., xviii,4,20,30,
31,40,41,67,101,103,105,112,122,
132,133,136,150,153,154,158,163,
182,183,191,192,195,196,236,262,
263,266,267,270,272,276,277,278,
279,280,283,284,285,289,290,293,
294,301,302,304,310,315,321,322,
323,324,326,336,343,345,351,353,
359,366,372,376,378,387,388
- Kretzman, Edwin M., 315
- Krieps, Mrs. Roger, 166
- Krishnamoorthi, C., 314
- Kronberger, Hans, 179,204,211
- Kruys, Pierre, 40,41
- Kumagai, Hiroo, (see also former name
Aoki, Kinichi), 280,281,footnote 282
- Kumlin, Bo, 237
- Kumpfert, Hermann, 106,107
- Kurihara, Hiroyoshi, 272
- Kuroda, Mizuo, 304
- La Bine, Gilbert, 244,363
- Labowitz, Allan, 101, 302
- Lacoste, Mme Bernard, 74
- Lafleur, Joan (Mrs. Joseph D.),
74,75,85
- Lafleur, Joseph D., 70,73,74,
83,85
- Laidlaw, Angus H.M., 366,383 foot-
note
- Lall, Arthur S., 309
- Lambert, Mrs., 78
- Lambo, T. Adeoye, 241,245,248,253
- Lande, Sharon L. (Mrs. Stephen),
165,166
- Lande, Stephen L., 165,166,168
- Lang, Daniel, 250
- Lange, Gunnar, 226,228
- Langevin, Hélène, 72,73,86,87
- Langren, Mrs., 253
- Lanzano, Gaetano, 132,133,136,144
- Lanzano, Mrs. Gaetano, 144
- La Rocca, Umberto, 144
- Larson, Clarence E., 80,272,276,
277,279,280,284,285,289,291,
293,294,302,303,304,337,381,
383 footnote,386,387
- Larson, Jane (Mrs. Clarence E.),
272,277,279,280,284,293
- Lasswell, Harold D., 240,241,252
- Lauer, Karl-Friedrich, 24,26
- Laurence, George C., 364,372
- Lavallee, Jerome, 158
- Lawrence, Ernest O., 152
- Lawroski, Stephen, 369,392
- Leamon, T. M., 381
- Le Beyec, Y., 83
- Leboutte, Lucien, 150
- Leckel, Gerhart, 110
- Leddy, John M., 39
- Lederberg, Joshua, 241,243,244,
245,249,251

- Lefevre, Theo, 159
 Lefort, Marc, 71,72,73,83,84
 Lehmann, Wolfgang J., 192
 Lehnert, Bo P., 253
 Lemberger, Mrs., 98
 Lemnitzer, Lyman, 59,60
 Lenz, Hans, 18,20,90,92
 Lessard, Jean-Claude, 374,375,
 383 footnote
 Letor, Gen., 226,227
 Leussink, Hans, 112,113,121,122,123
 Levin, Herbert, 293
 Levin, N., 178,179,181
 Lewenhaupt, Axel, 220
 Lewis, Herman W., 142
 Lewis, Verne B., 261
 Lewis, Wilfrid Bennett, 364,366,
 369,370,371,376,378,381,
 383 footnote,384
 Libby, Willard Frank, 172
 Lidin, Harold J., 398
 Liimatainen, Robert C., 302
 Lim, Frida, 98
 Lim, Ilse, 98
 Lindås, Inga (Mrs. Timo), 239
 Lindås, Johan, 239
 Lindås, Mats, 239
 Lindås, Sara, 239
 Lindås, Timo, 239
 Lindell, Bo Gustaf, 222
 Linder, E. H., 250
 Lindgren, Folke, 221
 Lindkvist, Mats, 234
 Lindkvist, Peter, 228,229,240
 Lindkvist, Siv (Berglund) (Mrs.
 Peter), 223,228,229,234,239,
 240
 Lindkvist, Tomas, 239,240
 Lindner, Roland, 42,120
 Lindstrom, E., 251
 Linowitz, Sol M., 395,396
 Lippencott, W. T., 230
 Litell, Richard J., 250,252
 Livingood, J. J., 281
 Lloyd, Samuel J., 153,154
 Lock, Michael, 194
 Lock, Mrs. Michael, 194
 Locke, Eugene M., 346,348,349,353,
 355,356,357
 Locke, Mrs. Eugene M., 346,355,356
 Lockwood, Margaret, 197
 Lofthagen, Lennart, 246
 Loftness, Robert L., 80,121
 Lohse, Mrs. George, 74
 Lombardo, Bernardo, 394
 Lopez, Manuel, 395
 Lorenz, Konrad Z., 241
 Lucet, Charles E., 66,68,86,87
 Lucet, Mrs. Charles E., 66,68
 Luedecke, Alvin R., 55,310,364
 Lundell, Anna-Lisa, 223
 Lundgren, Signe, 222
 Luns, Joseph M.A.H., 161,193
 Luse, Robert A., 392

 Mabile, Jacques, 53
 Mackay, Herbert Alwyn Cochrane, 178
 Macmillan, M. Harold, 174,175,176,
 186
 Maddock, Alfred G., 98
 Maddock, Mrs. Alfred G., 98
 Maddock, Ieuan, 187
 Maeda, Mr., 262
 Maeda, Maseo, 303
 Magnuson, Warren G., 231
 Magnusson, Torsten K.A., 233,234
 Maier-Leibnitz, Heinz, 75,76,77,
 78,79,92
 Maier-Leibnitz, Mrs. Heinz, 78
 Maitek, Sue, 105
 Makins, Roger M. (Lord Sherfield),
 49,173,174,177,178,179,180,181,
 186,365
 Malcolm, George, 198
 Malék, Ivan, 241,250,252
 Malfatti, Franco Maria, 43
 Malmlow, Gothe, 233
 Malmstrom, Carl R., 98,185,186
 Mandel, Heinrich, 100
 Mandros, James J., 346,353
 Manfull, Melvin L., 30
 Manley, I. T., 195
 Manly, Gordon W., 326
 Mann, Joseph B., 116
 Mannan, Muhammad A., 346
 Manning, Winston M., 369
 Manzini, Raimondo, 128
 Marcial, Victor, 395
 Margulies, Robert, 20,150
 Marien, Pierre J., 40
 Marion, Leo Edmond, 368
 Marshak, Robert, 341

- Marshall, Robert, 195
 Mart, Marcel, 166,168,170
 Martin, Jacques, 59
 Martino, Gaetano, 40
 Marulanda, Tulio A., 394,396
 Masse, Pierre, 61
 Matheson, Max S., 369
 Mathur, Hirdaya B., 331
 Matsubara, Kyoko, 287
 Matsui, Akira, 305,306,389
 Matsumoto, Kikuo, 279
 Matthews, K. W., 200
 Mattys, Henry, 42
 Maveety, Darle (Mrs. Patrick), 106,
 109
 Maveety, Patrick, 106,109,110
 Maxfield, J. R., Jr., 394
 Maxia, Vera, 143,144
 Mayer, Max, 97
 Mayer, Roger, 72,73
 McClelland, Clyde L., 42,118,119
 232,233,242,246,250
 McClelland, Joan R. (Mrs. Clyde L.),
 118,233
 McConnell, L., 381
 McCool, Whittie J. (Jack), 272,277,
 278,279,280,284,285,289,291,294
 McCool, Woodford B., 272,276,277,
 279,280,284,285,294
 McDaniel, Paul, 378,394
 McDonald, Gordon, 194
 McDonald, Mrs. Gordon, 194
 McDonough, Jim, 395
 McFadden, Betsy, xviii
 McGhee, George C., 92,95,96,113
 McGowan, Mr., 348,351
 McHale, J., 241
 McLaren, A. Douglas, 392
 McLean, Andrew Sinclair, 186,197
 McLean, Mrs. Andrew Sinclair, 197
 McNabb, G. M., 388
 McRae, Ian F., 381
 McTaggart-Cowan, Dr., 379
 McVey, William, 213
 Mead, Margaret, 241,247,250,252
 Meany, George, 230
 Meany, Mrs. George, 230
 Mears, G. A., 207,208
 Medi, Enrico, 15
 Medici, Giuseppe, 128
 Meinke, W. Wayne, 350
 Meitner, Lise, 98,99,100,185,186
 Meitner, Philip, 98
 Meitner, Mrs. Philip, 98
 Meitner-Graf, Mrs. L., 98
 Mellon, Sydney L.W., 130
 Melville, Ronald, 195
 Menne, Wilhelm A., 94
 Meyers, Robert S., 4
 Meyvaert, F., 159,160
 Mezzetti, Lucio, 130,131
 Michael, T.H. Glynn, 382
 Michaelis, Anthony R., 185,211
 Michaelis, M. Hans, 27,31
 Michaelis, Mrs. M. Hans, 31
 Michaels, Michael I., 186
 Middendorf, J. William, 162,163
 Miklos, Jack C.F.A., 322
 Mileikowsky, Curt, 232
 Miller, Charles, 400
 Miller, J. A., 383
 Miller, William J., 211
 Millionshchikov, Mikhail D., 184,
 239,240,241,245,246,249,253
 Mitault, Gerard, 75,77,78
 Miyamoto, S., 273,275
 Moline, Mrs. Edwin G., 105
 Moljk, Anton, 226,227
 Möller, Göran, 222,228,229,230,239
 Möller, Karin (Adolfsson) (Mrs.
 Per), 222,228,229,230,233,234,
 239
 Möller, Mona, (see Forssling,
 Mona Möller)
 Möller, Per, 222,228,229,230,233,
 234,239
 Monesi, Valerio, 142
 Monnet, Jean, 48
 Monod, Jacques L., 241,251
 Moon, Derek, 195
 Mooradian, Ara J., 369,370,378,
 379,383 footnote,384,386
 Moore, Betty (Mrs. Dan), 214
 Moore, Dan, 214,215,217
 Moore, Virgil L., 346
 Moorthi, Mr., 310
 Moreland, Allen B., 381
 Moret, Hendrik, 24,26
 Morgan, J. Perry, 395,398,400
 Mori, Kazuhisa, 302
 Morovic, T., 116
 Morris, Peter A., 65,261,262,263
 Mosca, Ugo, 150
 Mosel, Ulrich, 116,117

- Mott, Nevill F., 100
 Mukaibo, Takashi, 262
 Muller, Werner, 42
 Mulley, F., 193
 Mummery, Peter W., 198
 Munekata, Eiji, 286 and footnote,
 289
 Murakami, Yoshio, 292
 Murata, Hiroshi, 267,268,269,301
 Murata, Ryohei, 305
 Murphy, George F., Jr., 100,136,194
 Murray, Peter, 178
 Muto, Toshinosuke, 287
 Muxart, Roland, 83,84
 Myrdal, Alva (Mrs. Gunnar K.), 237,
 242,247,250,254
 Myrdal, Gunnar K., 241,247,252,253

 Nabeshima, Naotsugu, 268,269,270,271
 Nabrit, Samuel Milton, 98,99,236,
 335
 Nagarajan, P. K., 331
 Nagashima, Tamotsu, 292
 Naito, Keiji, 263,264
 Nakagawa, Yasuo, 289
 Nakajima, Takao, 301,302,304,305
 Nakamura, Masao, 289
 Nakamura, Yasuji, 302
 Nakasone, Yasuhiro, 389
 Nauckhoff, Carl-Henri, 220
 Nauckhoff, Sigard, 220,240
 Néel, Louis, 77
 Nehru, Braj Kumar, 315,316,317,
 318,335
 Nehru, Jawaharlal, 312,318,329
 Nephew, Edmund A., 104,105
 Neuberger, Maurine B., 222
 Neuriter, Ted, 194
 Newcombe, Howard Borden, 368
 Newley, E. F., 179,181
 Newsome, Anthony, 195
 Newton, Johannes, 231
 N'Guyen Long Den, 72
 Nicol, J. A., 197
 Nicol, Mrs. J. A., 197
 Niekisch, Ernst A., 95
 Nijs, W. W., 155
 Nikaido, Susumu, 267,268
 Nilsson, Sam, 240,241,252
 Nishida, Shinichi, 285,287,291,
 294,306
 Nishimoto, Masaki, 281
 Nishiwaki, Yasushi, 290
 Nixon, Richard M., 120,161,168,212,
 254,275,294,400
 Nobel, Alfred, 225
 Nomoto, T., 275
 Nordlinger, Samuel G., 179,181,182,
 183
 Nowlan, N., 120

 Ober, Ralph, 400
 Öbrink, Karl, 256
 Ochi, Hirofumi, 301
 Ochsenfeld, Dr., 118
 Odashima, Masashi, 273,274,276,
 277,278,279,280,284
 O'Donnell, Lawrence F., 24,25,26,
 27,59,94,95,96
 Oganessian, Yuriy Tsovakovich,
 72,74,75,83,84
 Ogiso, Muto, 294
 Ohmi, Mikio, 303
 Oka, Takashi, 284
 Okamoto, Mr., 281,282
 Okano, Shigeo, 277
 Okita, Mr., 262
 Okrent, David, 369
 Olander, Anders, 256
 Oliver, William, 371
 Olson, Clinton L., 166
 Olson, Ethel H. (Mrs. Clinton L.),
 166
 Oosten, H. J., 159
 Opfermann, Wolfgang, 97,100,112
 Oppenheimer, J. Robert, 287
 Orellana, Jose Ruben, 394
 Orford, R. C., 179
 Ormsby Gore, W. David (Lord
 Harlech), 174,175,179,181
 Ortolini, François-Xavier, 74,79
 Ortolini, Mrs. François-Xavier, 74
 Ortona, Egidio, 125,126,144,145
 Oshima, Keichi, 262
 Österberg, Eva, 234,239
 Österberg, Karin, 234,239
 Österberg, Sven, 222,234,239
 Österberg, Ulla-Britt (Bäcklin)
 (Mrs. Sven), 222,234,239
 Osterling, Anders, 251
 Otajimi, Mr., 259
 Owen, Leonard, 173

- Pages, Monique, 72,73,83,84
 Pai, Dr., 325
 Paine, Thomas O., 379
 Pal, Lenard, 75,80
 Palewski, Gaston, 53,56,59
 Palfrey, John G., 57,97,132,133,
 134,135,262,263,315,368,369
 Palladino, Nunzio J., 65
 Palme, Sven Olof Joachim, 228,243,255
 Pantanetti, Fabio, 143
 Panton, Francis Harry, 182,197
 Panton, Mrs. Francis Harry, 197
 Paoletti, Antonio, 142
 Pappas, Alexis C.G., 245
 Parker, Mrs. Harry E., 74
 Parks, Frank, 195
 Parsons, James Graham, 221,222,233
 Parsons, Mrs. James Graham, 222,233
 Parthasarasi, G., 322
 Pascal, Maurice, 63,66
 Pastore, John O., 311,312,314,315
 Paternotte, Mr., 149
 Patt, Harvey M., 142
 Pauling, Linus, 241,243,248,250
 Pauls, Rolf, 112
 Pauly, Walter, 40
 Paynter, John, 284
 Pazdral, Nuel L., 105,113
 Paz Lora, Federico, 394
 Pearson, Mrs., 203
 Pearson, Luvie, 214
 Pease, Basil, 185
 Pecci, Jose Danilo, 394
 Pedini, Mario, 45,146
 Peirson, David E.H., 176,182,183,
 185,196,197
 Pelen, Pierre, 50
 Pelly, Claude, 173,174,178,179,
 180,181
 Pelly, Lady Claude, 179,180
 Pelser, Johannes, 153,154
 Pender, John, 191
 Penneman, Robert A., 84,119
 Penney, William George, 173,174,175,
 176,177,178,179,181,182,183,185,
 188,196,226,227,261,371,372,373
 Peppard, Dr., 83
 Pepper, Tom, 284
 Perkinson, Jesse, 395
 Perlman, Isadore, 72,74,117
 Perlman, Lee (Mrs. Isadore), 72,74
 Perrin, Francis, 51,52,53,55,57,58,
 63,65,66,69,70,84,86,87,88,325,
 326,329
 Perry, Mrs., 371
 Persson, Arvid H.E., 231,236
 Perutz, Max F., 100
 Péter, Jean, 83
 Peterson, Mr., 381
 Petrosyants, Andronik M., 226,255,
 261,262
 Petrow, Chris G., 158
 Pexton, A.F., 207,208
 Peyrefitte, Alain, 59,60
 Phillips, James D., 80
 Pickavance, Thomas G., 178
 Pierce, John R., 241,243
 Pippard, Alfred, 100
 Pippard, Mrs. Alfred, 100
 Piret, Alice M. (Mrs. Edgar L.),
 74,85
 Piret, Edgar L., 63,74,85
 Pittman, Frank, 310
 Placzek, G., 341
 Pochan, Dr., 244,363
 Pochitalin, Igor, 239,240
 Pollack, Herman, 3,114,115,136,
 267,321,323,326,331,345,353,
 379
 Pollack, June (Mrs. Herman), 3,114,
 117,136
 Pompidou, Georges, 17,85
 Pon, George A., 381
 Poole, Michael J., 178
 Poor, Russell S., 394
 Portlock, Ray L., 327,328
 Post, Jacob C., 153,154
 Pregel, Boris, 240,241,244,251,
 252
 Pregel, Mrs. Boris, 244
 Press, Frank, 186
 Pretsch, Joachim, 90,92,95,96,
 97,113,114
 Price, Harold, 310
 Prokhorov, Aleksander M., 326
 Pugsley, Alfred, 193
 Qazi, M. N., 346
 Quihillalt, Oscar A., 226,227
 Quinn, George F., 378,381,383
 footnote, 387,388
 Qureshi, M. H., 350

- Rabe, Herr, 114
 Rabi, Isidor I., 66, 68, 261, 365
 Rae, Ernest R., 178
 Ragnarson, Per, 246, 253
 Rahman, Abdur, 346
 Ralph, Gary, 381
 Ramanna, Raja, 323
 Ramberg, Elizabeth (Mrs. Walter),
 134, 139, 144
 Ramberg, Julia, 144
 Ramberg, Walter, 130, 131, 134, 139,
 143, 144
 Ramey, James T., 80, 86, 87, 96, 98, 99,
 162, 191, 192, 263, 268, 269, 310, 315,
 316, 335, 336, 343, 359, 371, 378, 383
 footnote, 384, 392, 396, 399
 Ramey, Estelle (Mrs. James T.),
 371
 Ramsey, Norman F., 392
 Ramsey, Robert W., Jr., 378, 381,
 383 footnote
 Randers, Gunnar, 226, 227, 262
 Rao, Mr., 327
 Rao, Ayyagari S., 323
 Rawlings, Leon, 167
 Recht, Pierre, 119, 120
 Rehber, Mary, 98
 Reichert, Karlheinz, 31
 Reinhard, Paul-Gerhard, 117
 Reinhardt, Frederick, 139, 141
 Reischauer, Edwin, 261
 Renou, Jean, 51, 53, 56, 62, 63, 66, 68,
 70, 85
 Renou, Mme. Jean, 85
 Reuther, Victor G., 230
 Reuther, Mrs. Victor G., 230
 Rey, Jean, 29, 30, 31, 34, 37, 38, 39,
 40, 43
 Riccio, Giorgio, 150
 Rice, William L.R., 40, 188, 197, 198,
 200, 204, 206, 210, 212, 237
 Rice, Mrs. William L.R., 197
 Richardson, Elliott, 162, 298
 Riddleberger, James, 98, 99
 Riegel, Byron, 382
 Rifflet, Raymond, 37, 38
 Riou, Michel, 71, 73
 Ritchie, Charles Stewart Almon, 365
 Ritter, G., 15
 Roberts, Chalmers, 256
 Roberts, Mrs. Chalmers, 256
 Rodger, Walton A., 118
 Rogers, Jordan T., 346
 Rogers, Kent (Mrs. Stephen H.), 197
 Rogers, Sarah F. (Mrs. Jordan T.),
 346
 Rogers, Stephen H., 197, 210
 Rollefson, Ragnar, 315
 Rollier, Mario A., 140, 143, 144
 Rometsch, Rudolf, 24, 25
 Rose, Clive M., 191, 192
 Rosen, Jack, 191, 194
 Rossillon, François, 77
 Roth, Herman, 394
 Roudaut, E., 78
 Rouleau, John, 50
 Rousso, Ada (Mrs. Samuel), 74
 Rousso, Samuel, 74
 Rowlands, John S., 174, 177
 Royer, R. J., 381
 Rubenstein, Mickey, 215, 216
 Rubin, Julius H., xviii, 30, 31, 67,
 111, 112, 136, 137, 139, 143, 144, 153,
 158, 191, 192, 195, 196, 266, 272, 277,
 278, 279, 280, 284, 285, 290, 291, 292,
 293, 294, 301, 303, 305, 336, 359, 368,
 369, 370, 378, 381, 382, 383 and
 footnote, 386, 387, 388
 Rudstam, Gösta, 257, 257
 Ruegg, Walter, 115
 Runnalls, O.J.C., 388
 Rush, Kenneth, 113
 Rushford, Fred, 400
 Rusk, Dean, 44, 175, 268, 269
 Rutherford, Ernest, 152
 Rutter, Peter, 95, 96
 Ryan, John C., 192
 Rydberg, Jan H.A., 223, 225, 257, 257
 Rydberg, Olof, 243
 Sadikov, A. S., 326
 Saeland, Einar, 24, 25, 119, 120
 Sagane, Ryokichi, 258, 263, 264,
 275
 Sahdev, Kuldip, 336
 Salam, Abdus, 241, 248, 251, 252, 253,
 340, 341, 342, 343, 344, 345, 353, 354
 Salazar, António de Oliveira, 106
 Sallent, Jose Enrique, 394
 Salomé, Jean-Marie, 24, 26
 Salvetti, Carlo, 128, 129, 130, 131,
 132, 134, 135, 136, 139, 140, 141, 142,
 143, 144, 145, 226, 227

- Salzer, Michael, 244
 Sanchez Vilella, Roberto, 394,395,
 396
 Sanchez Vilella, Mrs. Roberto, 394
 Sandahl, Ingrid, 246
 Sandberg, Mr., 250
 Sanders, Mr., 106
 Sandstrom, Sten Gunnar, 221
 Sani, A. R., 350
 Sapirie, S. R., 395
 Sarabhai, Vikram A., 319,320,321,322,
 324,325,326,329,330,331,332,333,
 335,336,337,388
 Sarabhai, Mrs. Vikram A., 325,326,
 329
 Saragat, Giuseppe, 125, 140
 Sasaki, Shuichi, 287,288,289,301
 Sasaki, Yoshitake, 303
 Sassen, Emanuel M.J.A., 15,20,24,
 27,28,29,40,150
 Sato, Eisaku, 259,262,388
 Sato, Osamu, 302
 Satoh, Kiichiro, 290,292
 Sauer, Hans, 90
 Schaafhausen, Jurgen, 115
 Schaetzel, Imogen (Mrs. John
 Robert), 31
 Schaetzel, John Robert, 30,31,37,40,
 150,184
 Schank, Charles F., 20,150
 Schank, Mrs. Charles F., 21
 Scheyven, Louis, 148
 Schill, J. O., 249
 Schmelzer, Carl C., 112,114,115,
 116,117
 Schmelzer, Mrs. Carl C., 115
 Schmerenbeck, Hans, 107,108
 Schmidt, Mr., 274
 Schmidt, R. A., 117
 Schneider, Renée (Mrs. Stanley), 85
 Schneider, Stanley, xviii,83,165,
 166,395
 Schnurr, Walther, 18,19
 Schopper, Erwin W., 115,116
 Schopper, Herwig, 116
 Schou, August, 241,248
 Schrader, Herbert, 110
 Schröck-Vietor, Walter, 103,105
 Schuff, Mr., 115
 Schuhmacher, Erwin, 250
 Schuldt, Fred, 100
 Schulten, Rudolf, 95,103,105
 Schultz, Charles, 194
 Schuman, Robert, 166
 Schürmann, Carl W.A., 162
 Schweiger, F., 95,96
 Schwettman, Harry A., 116
 Schwiller, Col., 194
 Sciuti, Sebastiano, 131,132,140,
 143
 Scott, Frank A., 261
 Scott, Robert Montgomery, 211
 Seaborg, Eric, 254,368
 Seaborg, Helen, 3,4,20,21,30,31,
 47,72,74,78,83,85,92,93,103,
 105,106,108,109,113,114,115,
 116,117,118,119,120,136,137,
 144,150,151,165,166,168,176,
 188,189,190,194,197,198,203,
 209,212,213,214,215,216,219,
 222 footnote, 226,228,229,230,
 240,253,255,321,325,326,329,331,
 335,345,346,347,348,349,353,355,
 360,371,372,398,400,401
 Seaborg, Herman Theodore, 219
 Seaborg, Jane (Rubenstein) (Mrs.
 Peter), 215
 Seaborg, Lynne, (see also Cobb,
 Lynne Seaborg), 114,371,372
 Seaborg, Selma (Erickson), (Mrs.
 Herman), 218
 Seelmann-Eggebert, Walter, 18,19,120
 Segerstedt, Torgny, 241,246,247,248,250
 Segré, Emilio, 125,126
 Sengier, Edgar, 148
 Seno, Saburo, 301,302,303
 Sethna, Homi N., 321,322,323,324,
 325,326,329,330,331,334
 Sethna, Mrs. Homi N., 321,325,326,
 329,331
 Sewell, Duane C., 392
 Shafique, Muhammad, 346
 Shank, Earl, 24,25
 Shankar, Jagdish, 323
 Shannon, Don, 284
 Shastri, Lal Bahadur, 317,318
 Shaukat, Mumtaz A., 348,350,353
 Shaukat, Mrs. Mumtaz A., 353
 Shaw, E. N., 185
 Shaw, Milton, 67,122,123,369,371,
 376,378
 Shea, Kathleen H., 31
 Shemilt, L. W., 382

- Shemilt, Mrs. L. W., 382
 Shemyakur, M. M., 326
 Shima, Hideo, 292
 Shimoda, Takeso, 268,269
 Shimoyama, Mr., 258
 Shomwra, Mr., 292
 Shore, Peter D., 186
 Shrum, Gordon Merritt, 374
 Shuckburgh, C. A. Evelyn, 175
 Shuman, Howard E., 194
 Shuman, Mrs. Howard E., 194
 Silcock, Bryan, 211
 Simon, Alan, 250
 Simpson, John Hall, 324
 Sinding-Larsen, H., 250
 Singer, Fred, 254
 Singer, Jerome R., 331
 Sjöberg, Johan Eric, 218,219
 Sjöborg, Th., 233
 Skole, Robert, 250
 Smith, Donald, 200
 Smith, Harold A., 381
 Smith, Richard G., 158
 Smyth, Henry D., 98,99,110,223,226,
 227,261,265,309,365
 Sneider, Richard L., 290,293
 Sneider, Ruth (Mrs. Richard L.),
 293,294
 Snepvangers, J.J.M., 154,155
 Sohngen, Dr., 106
 Solandt, Omond M., 379,380,382
 Somiya, Takayuki, 290
 Sowden, Ronald George, 182,187,188
 Spaak, Fernand P.J., 27,28,29,30,
 31,40,167
 Spaak, Mrs. Fernand P.J., 31
 Spaak, Paul-Henri, 152
 Spaepen, Jozef, 24,26
 Spence, Robert F., 178
 Spernol, Alfred, 24,26
 Spitsyn, Viktor I., 83
 Sporn, Phil, 286
 Sprague, G. H., 366
 Springer, Tasso, 95
 Springsteen, George, 192
 Squartini, Piero, 40
 Squires, Lom, 214
 Srinivasan, Malur Ramaswamy, 310,326
 Srinivasan, Mrs. Malur Ramaswamy,
 329
 Srinivasan, N., 323
 Staebler, Ulysses M., 226,227,301
 321,323,326,345,353,369,370
 Stahle, Nils, 251
 Stanerson, B. R., 382
 Stanley, Kim, 53
 Steinmetz, Mildred, 168
 Stephansky, Ben S., 395
 Stephens, Donald M., 366,369,370
 Stephenson, Joseph, 177,179,182,
 183
 Sternheim, A. Günther, 153,154,155
 Stevens, Chandler H., 398,400
 Stevenson, Lloyd Grenfell, 368
 Stewart, James C.C., 181
 Stieff, Lorin R., 302
 Stien, Richard, 24,25
 Stöcker, Hans-Jochen, 103,104,105
 Stoessel, Walter J., Jr., 230 footnote
 Stoltenberg, Gerhard, 94,95,96,97,101,
 102,113,193
 Strandh, Sigvard, 233,234
 Strassmann, Fritz, 92,94,97,98,99,
 114,115
 Strassmann, Mrs. Fritz, 98,115
 Stratton, Dr., 178
 Street, K., 350
 Stross, Josephine, 98
 Stubbs, F. J., 178
 Sueda, Mamoru, 272,276,277,291,293
 Suess, H. E., 119
 Suga, Reinosuke, 261,292
 Sugimoto, Kenzo, 281,282
 Sundaram, S. M., 323
 Svensson, Mr., 237
 Svensson, Bengt, 234
 Sweeney, Mary, xviii
 Takahasi, Kikuo, 302
 Takamura, Hiromi, 281,283
 Takeda, Eiichi, 273,276,281,282,
 287
 Takeru, Vivian, 280
 Takeuchi, Ryuji, 259
 Takeuchi, Mrs. Ryuji, 259
 Talbot, Phillips, 2,315,316
 Tamplin, Arthur R., 286
 Tanabe, Jun, 289
 Tanaka, Naojiro, 266,267
 Tanaka, Yoshio, 273,276,277,278,
 279,280

- Vasquez, Santiago, 400
 Veach, Mr., 280
 Verkerk, B., 155
 Vesper, Howard G., 392
 Vest, Emily C., (Mrs. George S.), 31
 Vest, George S., 30,40
 Vick, F. A., 178
 Viel, Benjamin, 394
 Vielvoye, Roger, 211
 Villaros, Pierre, 69,80,84,85
 Vinciguerra, John Vincent, 263
 Vine, Dawn V. (Mrs. Richard D.), 31
 Vine, Richard D., 30
 Vogelaar, Theodor, 27
 Von der Decken, Claus-Benedict, 96,
 104,105
 Von Heppe, Hans, 112
 von Randow, T., 110
 von Stackelberg, Herbert, 97
 von Staden, Berndt, 101
 Von Sydow, Gunnar, 221,226
 Von Weizsacker, Carl F., 102,103,252
 Voysey, Reginald G., 187

 Waddington, Conrad H., 241,245,252
 Waelbroek, François, 95
 Wakatsuki, Tetsuo, 280,281,282
 Wake, Kotaro, 302
 Wald, George, 368
 Walford, John G., 200
 Wall, Frederick T., 382
 Wallace, Frederick C., 383 footnote
 Wallauschek, Emil, 120
 Walske, Carl M., 173
 Walton, Gilbert N., 178
 Wanke, H., 115
 Waraya, Takashi, 302
 Warren, Frederick H., 231
 Warren, Leonard, 158
 Warren, Shields, 395
 Warrikoff, Alex, 100
 Warrington, Howard M., 31
 Warrington, Mrs. Howard M., 31
 Watanabe, Kiichiro, 302
 Watkinson, Harold, 173
 Watson, Donald, 383 footnote, 386
 Weber, G., 106,107
 Webster, William, 392
 Weiss, Leonard, 321,326,328
 Weisskopf, K., 211
 Weisskopf, Victor F., 341

 Wells, Algie A., 16,18,50,52,53,55,
 56,62,66,149,174,177,178,179,180,
 181,221,222,223,261,309,310,315,
 341
 Wershof, Max Hirsch, 365
 Wervers, J., 155
 Westcott, Ed, 395
 Westerling, Bengt, 236
 Wetterlundh, Sune, 226
 White, Ed, 284
 Whitman, Walter G., 309
 Wickel, James J., 290
 Wickström, Mr., 250
 Widén, Albin, 221
 Wiener, Alice, 125,126,127
 Wiener, Paul, 125,126,127
 Wiesner, Jerome B., 225,314,319,342
 Wiggins, Frontis B., 130
 Wilcox, Robert H., 394
 Wilkes, Daniel M., xviii,15,16,21,
 51,53,92,149,150,173,174,221,222,
 226,227
 Williams, I.G.K., 120
 Williams, Mary G., (Mrs. William W.),
 105,113,114
 Williams, William W., 18,19,95,96,
 97,103,105,106,108,109,113
 Wilson, Dennis, 185
 Wilson, G. D., 200
 Wilson, Robert, 185
 Wilson, Robert E., 132,133,181,
 310,315
 Wilson, Robert R., 125,126
 Winnacker, Karl, 94
 Winship, Stephen, 346,356
 Winters, Robert H., 374,375
 Wirtz, Karl E.J., 18,19,101,120
 Woesler, Mr., 42,118
 Wolff, Sheldon, 142
 Wolfle, Dael, 194
 Wolfle, Mrs. Dael, 194
 Woloshek, Mr., 106
 Wong, Mervin, 106,107
 Woodhead, Lawrence W., 381
 Woodman, Francis J., 207
 Woodward, B. E., 327,328
 Woodward, Robert F., 256
 Woodward, Mrs. Robert F., 256
 Wright, Pierce, 211
 Wright, R. F., 366
 Wüster, H.-O., 106

- Tape, Gerald F., 30,31,37,38,57,58,
66,67,86,87,97,106,125,126,128,
153,154,158,188,192,236,267,268,269,
270,321,323,324,326,328,329,331,
335,345,346,347,348,350,351,353,
356,369,370,371,372,376,392
- Tape, Jo (Mrs. Gerald F.), 30,31,
321,325,326,329,331,345,346,347,
348,353,355,371
- Tardiff, A. Nelson, 378
- Tata, Jehangir R.D., 241,252
- Tatalovich, Sam, 304
- Taylor, Geoffrey I., 98
- Taylor, John B., 185
- Terashima, Masaoki, 303
- Terry, Luther Leonidas, 368
- Tersmeden, Carl, 228,239
- Tersmeden, Monica (Mrs. Carl), 228,
239
- Tesche, Fred, 194
- Teucher, Martin W., 106
- Theune, Gerhard, 107,108
- Thode, Henry George, 368,378
- Thomas, Charles W. (Carl), 159,
310,315,262
- Thompson, Alice (Mrs. Stanley G.),
323
- Thompson, Stanley G., 117,143,323
- Thompson, Theos J., 193,194,381,
383 footnote
- Thonemann, Peter C., 185
- Thumen, A. V., 115
- Timbs, Maurice C., 4,321,322,323,
326,328
- Tinbergen, Jan, 241,252
- Ting, Jeanne, 106
- Ting, Samuel C.C., 106
- Tiselius, Arne, 221,225,240,241,
244,246,248,253
- Tkachenko, V. I., 326
- Todd, Alexander, 100
- Todd, Lady Alexander, 100
- Todd, Helen, 371
- Tohamy, Hassan M., 262
- Tombs, F. L., 207,208
- Tomei, Anthony A., 392
- Torii, Hinoyuki, 289
- Towe, P. M., 388
- Townes, Charles H., 221,326
- Treml, Karl, 97
- Tremmel, Ernest B., 371
- Trent, Floyd P., 393
- Trevithick, John P., 256,302,388
- Tribus, Myron, 194,379
- Trivedi, V. C., 335,336
- Trosten, Leonard, 100
- Troyer, F. L., 381
- Trudeau, Pierre, 388
- Truman, Harry S., 392
- Tshombe, Moise, 176
- Tsukada, Chihiro, 304
- Tsunekawa, Mr., 294
- Tsutsumi, Yoshitatsu, 293
- Tucker, P. Anthony, 185,211,
250
- Tuohy, Thomas, 203
- Tuohy, Mrs. Thomas, 203,209
- Tupper, Stanley R., 372
- Turkevich, Anthony, 72,73
- Turner, Mr., 194
- Turner, Mrs., 194
- Tuthill, John W., 20,24,28,59,150
- Tuthill, Mrs. John W., 21
- Tyler, William R., 148,153,154,
175,181
- Udenfriend, Sidney, 382
- Uehara, Shokichi, 263
- Uematsu, Kunihiro, 268,290,291,292
- Ulken, Dieter, 107,108
- Urrutia, Rafael V., 392
- Urrutia, Mrs. Rafael V., 392,393
- Ushiba, Nobuhiko, 293,294,298,299,
303,304
- Usmani, Ishrat H., 226,227,335,
336,343,344,345,348,349,350,351,
353,355,356,357,358,359,360 and
footnote, 361
- van Bueren, Hendrik G., 163,164,165
- Vandenbenden, E., 24,25
- Vanderryn, Jack, 267
- Van Der Spek, Jean H., 149
- Vander Weyden, Allen J., 366
- Vandivier, Philip F., 153,154
- Van Doren, Charles N., 302
- Van Dyken, Alexander R., 119
- van Gent, Maria, 234,239,240
- Van Hegelson, Mr., 166,167
- van Roijan, J. H., 148 footnote
- Vanstrum, Paul, 193
- van Vierssen, Herman C., 153

Yaffe, Leo, 368,386
Yamada, Tasaburo, 268,269,286
Yamaguchi, Mariko, 281,283
Yamanouchi, Yukio, 279
Yatabe, Atsuhiko, 290,291,293
Yeomans, William L., 66,195,256,
303,304
Yosano, Shigeru, 272,288
Yoshicka, Mr., 258
Yoshikawa, Hisao, 289
Yoshimoto, Koichi, 289
Yoshioka, Asao, 274
Yoshioka, Toshio, 273,274,275
Young, John Zachary, 368
Youngdahl, Luther, 255,256
Youngdahl, Mrs. Luther, 255,256
Yvon, Jacques, 53,84,86

Zinn, Walter H., 125,392,393
Zook, Donovan Q., 4,100,136,195,
395
Zuckerman, Solly, 174,184,185,186,
187,191,192,193,210
Zuckert, Eugene M., 51
Zvara, Ivo, 42

