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REPORT ON THE

to

UNITED STATES ATOMIC ENERGY INSTALLATIONS

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JANUARY 1964

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Report on the

SOVIET SCIENTISTS VISIT

to

UNITED STATES ATOMIC ENERGY INSTALLATIONS

November 16 – December 3, 1963

Prepared by EAST-WEST PROGRAM STAFF • DIVISION OF INTERNATIONAL AFFAIRS

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FOREWORD

The intent of this report is to record the visit of Chairman Petrosyants and other Soviet scientists to U.S. atomic energy facilities in the late fall of 1963. Since the report includes a number of personal observations regarding the Soviet delegation, it bears the classification "Confidential."

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REPORT

ON

VISIT OF SOVIET ATOMIC SCIENTISTS

TO U.S. ATOMIC ENERGY INSTALLATIONS

BACKGROUND

The Agreement between the USA and USSR for Exchanges in the Scientific, Technical, Educational, Cultural and Other Fields in 1962-1963 provided that the U. S. Atomic Energy Commission and the USSR State Committee for the Utilization of Atomic Energy arrange for the implementation of a program of exchanges in the peaceful uses of atomic energy. On May 21, 1963, in Moscow, Chairman Seaborg and Chairman A. M. Petrosyants signed a Memorandum on Cooperation in the Field of Utilization of Atomic Energy for Peaceful Purposes. The Memorandum sets forth a program of reciprocal exchanges and procedures for carrying out such exchanges in the course of 1963-1965.

In conjunction with the signing of the Memorandum and at the invitation of Mr. Petrosyants, Chairman Seaborg, accompanied by nine AEC officials and scientists and the Second Secretary of the U. S. Embassy in Moscow, visited 14 sites, including 10 large scientific installations. Most of the sites were in the Moscow and Leningrad areas, but the U. S. delegation did travel to Kharkov, Ulyanovsk, New Melekess, a l Voronezh. The U. S. delegation spent eleven days in the Soviet Union and all members agreed that the trip was quite rewarding and worthwhile.

During the visit to the Soviet Union, Chairman Seaborg invited Mr. Petrosyants and his colleagues to visit the United States at a time convenient to Mr. Petrosyants. Soviet officials in Moscow indicated that plans for a return visit could only be made after receipt of a formal invitation and on June 4, 1963, Chairman Seaborg formally invited Mr. Petrosyants and suggested October or November as an appropriate time to visit installations in the United States.

Mr. Petrosyants responded late in June, accepted the invitation, but did not make known the composition of the delegation, the precise dates of his visit, nor the installations he wished to see.

In August the AEC drafted a schedule of visits for the period from November 17 through December 2, 1963, similar to the itinerary which was finally adopted. This schedule was forwarded to the Soviets for comment, but it was not until October 29 that the Soviets applied for visas for a delegation of eleven persons. One Soviet for whom a visa was made available, G. N. Flerov, did not accompany the group. Members of the Soviet delegation indicated that Flerov's absence was due to ill health.

On November 14 word was received that the Soviet delegation would arrive on November 16. The itinerary proposed by the AEC was agreeable to the Soviets except that Mr. Petrosyants preferred that the visit to Oak Ridge National Laboratory be advanced to the early part of the tour and that visits to the Dresden Atomic Power Station and the Enrico Fermi Power Station be made on separate days. These changes were readily made. It was also requested that part of the delegation remain a second day at Oak Ridge and that the delegation visit the Santa Susana Laboratory. This request was not granted since remaining at Oak Ridge conflicted with the Brookhaven visit and no work comparable to that at Santa Susana was shown to the Seaborg delegation.

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At this point it is important to recall that, during the period immediately preceding the arrival of the Soviet delegation, the arrest and detainment in the Soviet Union of Professor Barghoorn of Yale University, was highlighting the news. As a result, throughout the United States, an atmosphere prevailed which could easily have been detrimental to the usefulness of the visit. For this reason, right up until the time the Soviets were to arrive it was a matter of conjecture as to whether they would, in fact, come. However, Professor Barghoorn was released on November 16 and the Soviet visitors arrived in New York the same day without incident.

The tour began in Oak Ridge on Monday, November 18 and continued at various installations until the Soviet group departed from New York on December 3. All facilities visited are unclassified and devoted to the peaceful uses of atomic energy, such as high energy physics, controlled thermonuclear research and civilian power reactor development.

During the early stages of the visit a somewhat strained atmosphere prevailed; however, as the tour progressed, the strained feeling gave way to an atmosphere of cordiality and the tour proceeded in a smooth and orderly fashion.

At each facility visited, the Soviets were given descriptive material in the form of brochures, booklets, printed instructions, publications etc. In return, the Soviets presented their hosts with souvenir medallions, picture albums, scientific publications etc.

Following the death of President Kennedy, the events originally scheduled for the San Francisco area were cancelled. No other major changes were made in the original itinerary. At the time of the President's death the Soviets reacted with quiet dignity and seemed to be genuinely sincere in their expressions of sympathy. During the hectic, confused period immediately following the President's death, as well as during the waiting period in Yosemite National Park, the Soviet visitors displayed an extremely cooperative attitude.

The Soviet delegation was comprised of the following:

PETROS[illegible], ANDRONIK M.,
Chairman, State Committee of USSR for Utilization of Atomic Energy

AFRIKANTOV, IGOR IVANOVICH,
Scientific Consultant, USSR State Committee on Atomic Energy (Power Reactors)

ARTSIMOVICH, LEV ANDREYEVICH,
Section Head, Kurchatov Atomic Energy Institute (Controlled Thermonuclear Reactions)

BELOV, ANATOLIY, IVANOVICH,
Reviewer, USSR State Committee on Atomic Energy (interpreter and translator)

BOGOLYUBOV, NIKOLAY NIKOLAYEVICH,
Laboratory Director, Joint Institute of Nuclear Research (Dubna) (High Energy Physics & Mathematics)

KAZACHKOVSKIY, OLEG DMITRIYEVICH,
Deputy Director, Physical Technical Institute, Obninsk (Breeder Reactors)

PONOMAREV-STEPNOY, NIKOLAY NIKOLAYEVICH,
Deputy Section Head, Kurchatov Atomic Energy Institute (Power Reactors)

RATNIKOV, NIKOLAY TIMOFEYEVICH,
Section Head, USSR State Committee on Atomic Energy (Administrative Planning)

SINEV, NIKOLAY MIKHAYLOVICH,
Deputy Chairman, USSR State Committee on Atomic Energy (Administration)

YAKOVLEV, GRIGORIY NIKOLAYEVICH,
Section Head, Scientific Research Institute of Atomic Reactors, New Melekess (Reactors, Radiochemist)

In addition to this group, Mr. Valentin Revin, 3rd Secretary, representing the Office of the Scientific Counselor, Soviet Embassy in Washington, D. C., accompanied the group as part of the Soviet delegation. This was considered appropriate inasmuch as Mr. Herbert Okun, Second Secretary, U. S. Embassy, Moscow, had accompanied Chairman Seaborg's party on their tour of Soviet atomic energy installations.

The Soviet delegation was accompanied during almost the entire trip by Chairman Seaborg, one of the AEC's Commissioners or the General Manager.

U. S. nationals accompanying the Soviet delegation throughout the entire trip or for a major portion of the trip were:

WELLS, A. A.,
Director, Division of International Affairs

McDANIEL, PAUL W.,
Director, Division of Research

FRITSCH, ARNOLD R.,
Technical Assistant to Chairman Seaborg

JACQUES, PHILIPPE,
Deputy Director, Division of Public Information

ABRAHAMS, MELVIN,
Special Assistant for East-West Programs, Division of International Affairs

BRAND, NORMAN H.,
East-West Programs Staff, Division of International Affairs

KRIMER, WILLIAM D.,
U. S. State Department (Interpreter)

LEWIN, JOSEPH,
Oak Ridge National Laboratory (Interpreter)

ITINERARY OF SOVIET VISIT

SATURDAY, November 16

9:00 p.m.	Soviet delegation arrived at International Airport, N. Y. and was met by Chairman Seaborg, Commissioner Palfrey, and other AEC representatives, as well as representatives from the Soviet Embassy, Washington, D. C.
10:15	Arrived at Waldorf-Astoria Hotel, New York
10:30	Reception for Soviet delegation at Walforf-Astoria Hotel - Chairman Seaborg, Host
12:00 Midnight	Overnight - Waldorf-Astoria Hotel

SUNDAY, November 17

9:30 a.m.	Breakfast - Waldorf-Astoria Hotel
10:30	Discussion of itinerary
11:15	Departed for Battery section of New York to board U. S. Coast Guard craft for sightseeing tour of New York area
3:00 p.m.	Returned to Waldorf-Astoria Hotel
4:00	Departed for LaGuardia Airport to board chartered MATS aircraft
5:00	Departed for Knoxville, Tennessee (dinner served enroute)
9:30	Arrived Knoxville Airport (mechanical difficulty enroute necessitated stop at Andrews Air Force Base, Washington, D. C., resulting in two-hour delay)
9:45	Departed for Oak Ridge via chartered bus
10;45	Overnight - Holiday Inn, Oak Ridge, Tennessee

MONDAY, November 18

7:30 a.m.	Buffet breakfast - Holiday Inn

8:30 a.m.	Briefing on Oak Ridge National Laboratory Programs by Alvin Weinberg, Director, ORNL
9:30	Tour of Oak Ridge National Laboratory
12:45 p.m.	Brief press interview with Chairman Petrosyants
1:00	Luncheon at Holiday Inn
1:45	Further briefing by A. M. Weinberg
2:30	Continued tour of ORNL
3:30	Departed Oak Ridge for Knoxville Airport
4:30	Departed Knoxville for New York via MATS aircraft (dinner served enroute)
7:30	Arrived LaGuardia Airport, New York
8:30	Attended theater - New York City
11:30	Overnight - Waldorf Astoria Hotel

TUESDAY, November 19

8:00 a.m.	Breakfast - Waldorf-Astoria Hotel
9:00	Departed for Brookhaven National Laboratory via chartered bus
10:00	Arrived for tour of BNL facilities
12:30 p.m.	Brief press interview with Chairman Petrosyants
1:00	Lunch - BNL Social Center
2:00	Continued tour of Brookhaven facilities
6:00	Social hour and dinner - BNL Social Center
8:00	Departed for New York City via chartered bus
10:00	Arrived for overnight stay Waldorf-Astoria Hotel

WEDNESDAY, November 20

7:30 a.m.	Breakfast - Waldorf-Astoria Hotel
GROUP 1 8:30	Departed by bus for Indian Point Reactor
10:00	Toured Indian Point Reactor facilities
12:45 p.m.	Lunched at Tappan Hill restaurant, Tarrytown

1:45	Departed for New York City
2:45	Arrived Waldorf-Astoria Hotel
GROUP 2 8:30 a.m.	Departed for Princeton University via private automobiles
10:00	Arrived for briefing and tour of James Forrestal Research Center
11:30	Academician Lev Artsimovich delivered lecture on Soviet Controlled Thermonuclear Reaction Program before Princeton University audience (See appendix B for text)
1:00 p.m.	Luncheon at Guest House - Princeton University
2:00	Departed for New York City
3:15	Arrived Waldorf-Astoria Hotel
GROUP 1 and 2 3:45	Attended joint session of Atomic Industrial Forum/American Nuclear Society Meeting - Americana Hotel, N. Y.
4:15	Chairman Petrosyants addressed joint meeting of AIF/ANS (See appendix A for text)
5:30	Toured Atom Fair Exhibit - Americana Hotel
8:00	Attended banquet sponsored by AIF/ANS - Americana Hotel
11:00	Overnight - Waldorf-Astoria Hotel

THURSDAY, November 21

6:30 a.m.	Departed Waldorf-Astoria Hotel for LaGuardia Airport via chartered bus
7:15	Arrived LaGuardia Airport to board MATS Aircraft
7:25 a.m. (EST)	Departed New York City for non-stop flight to Oakland, California (breakfast and lunch served on aircraft)
3:35 p.m. (PST)	Arrived Oakland International Airport
4:00	Departed by chartered bus for Lawrence Radiation Laboratory, Berkeley
4:30	Brief tour of LRL, Berkeley facilities
6:30	Social hour and dinner - University House on University of California campus
9:45	Departed by chartered bus for Fairmont Hotel, San Francisco
10:45	Overnight - Fairmont Hotel

FRIDAY, November 22

7:30 a.m.	Breakfast - Fairmont Hotel
8:45	Departed by chartered bus for LRL, Berkeley
9:45	Continued tour of LRL, Berkeley facilities
12:00 Noon	Due to the death of President Kennedy the balance of events scheduled for Friday and Saturday in the San Francisco Area were cancelled. After a hurried departure from the Fairmont Hotel, they were taken on a brief bus tour of San Francisco. Following this, the group departed for Yosemite National Park

SATURDAY, November 23

	Sightseeing - Yosemite National Park

SUNDAY, November 24

	Sightseeing - Yosemite National Park until late Sunday afternoon when the group departed for Fresno, California to board the MATS plane
5:30 p.m. (PST)	Departed Fresno, California for Idaho Falls, Idaho via MATS aircraft (dinner served enroute)
9:25 p.m. (MST)	Arrived Idaho Falls, (Fanning Field)
10:00	Arrived Westbank Motel
10:30	Brief reception Westbank Motel
11:30	Overnight - Westbank Motel

MONDAY, November 25

7:00 a.m.	Breakfast - Westbank Motel Restaurant
8:00	Departed by bus for tour of National Reactor Test Site. William L. Ginkel, Acting Manager, Idaho Operations Office gave briefing on NRTS enroute
9:00	Started tour of NRTS facilities
	Note: At Chairman Petrosyants' request the Soviet delegation witnessed the proceedings of President Kennedy's funeral on television for a short period
12:00 Noon	Luncheon at Central Facilities Cafeteria

1:00 p.m.	Continued tour of NRTS facilities
4:30	Departed NRTS for Idaho Falls Airport (Fanning Field)
5:45	Arrived Idaho Falls Airport
6:00	Departed Idaho Falls via MATS aircraft for Lincoln, Nebraska (dinner served enroute)
10:15 p.m. (CST)	Arrived Lincoln Air Force Base, Lincoln, Nebraska
10:45	Arrived Cornhusker Hotel, Lincoln, Nebraska
11:00	Brief reception - Cornhusker Hotel, hosted by Consumers Power Company
11:30	Overnight - Cornhusker Hotel

<u>TUESDAY, November 26</u>

7:30 a.m.	Breakfast - Cornhusker Hotel
8:30	Departed by chartered bus for Hallam Reactor Facility
	<u>Note:</u> Academicians Artsimovich and Bogolyubov left the <u>group</u> at this point and departed for Argonne National Laboratory via commercial airline from Lincoln to Chicago
9:30	Arrived for briefing and tour of Hallam Reactor Facility
11:15	Departed Hallam for Lincoln, Nebraska
12:15 p.m.	Press interview of Chairman Petrosyants at Lincoln Country Club
12:30	Luncheon - Lincoln Country Club
1:30	Departed for Lincoln Air Force Base
2:00	Departed Lincoln via MATS aircraft for Des Moines, Iowa
3:00	Arrived Municipal Airport, Des Moines
3:15	Departed by chartered bus for Ames Laboratory, Ames, Iowa
4:15	Arrived for briefing and tour of Ames Laboratory facilities
6:00	Departed Ames Laboratory for Des Moines Municipal Airport
7:10	Departed Des Moines for Chicago, Illinois via MATS aircraft (dinner served enroute)
8:30	Arrived Chicago (Midway Airport)
9:30	Arrived Argonne Guest House
10:00	Brief reception Argonne Guest House

11:00	Overnight - Argonne Guest House

WEDNESDAY, November 27

7:30 a.m.	Breakfast - Argonne Guest House
8:30	Started tour of ANL facilities
12:30 p.m.	Luncheon - Argonne Guest House
1:30	Continued tour of ANL facilities
4:45	Short rest period
5:30	Reception - Argonne Guest House
6:00	Departed for tour of Chicago via chartered bus
8:00	Dinner at the Stockyards Inn, Chicago
10:00	Returned to Argonne Guest House

THURSDAY, November 28

7:00 a.m.	Departed for Dresden Nuclear Power Station (breakfast enroute - Manor Motel on Route 66)
9:30	Arrived for briefing and tour of Dresden Nuclear Power Station
12:30 p.m.	Departed Dresden facility for Midway Airport
2:40	Departed Chicago Midway Airport for Detroit, Michigan (Willow Run Airport)
4:40	Arrived Detroit (Willow Run Airport)
5:00	Departed via chartered bus for Dearborn Inn, Detroit
6:30	Reception and Thanksgiving dinner - Dearborn Inn
10:00	Overnight - Dearborn Inn

FRIDAY, November 29

8:00 a.m.	Breakfast - Dearborn Inn
9:00	Departed for Enrico Fermi Atomic Power Plant
10:00	Arrived for briefing and tour of Enrico Fermi Atomic Power Plant
12:30 p.m.	Luncheon - Enrico Fermi Plant cafeteria

2:00 p.m.	Departed Enrico Fermi Plant for tour of Ford Museum, Dearborn, Michigan
4:00	Departed Ford Museum for Willow Run Airport, Detroit
5:05	Departed from Willow Run Airport for Washington, D. C. (dinner served enroute)
6:45	Arrived Andrews Air Force Base, Washington, D. C.
7:45	Arrived Statler Hotel, Washington, D. C.
9:00	Late dinner - La Fonda Restaurant, Washington, D. C.
11:30	Overnight - Statler Hotel, Washington, D. C.

SATURDAY, November 30

7:45 a.m.	Breakfast - Statler Hotel
10:00	Departed Statler Hotel via chartered bus for USAEC Headquarters, Germantown, Md.
11:00	Arrived Germantown for meeting with Commission and staff, a. Review of Petrosyants visit b. Implementation of Exchange Program c. Briefing by Frank Pittman, Director, Division of Reactor Development, on U. S. Civilian Power Development Program.
11:45	Meeting with Press Representatives
12:45 p.m.	Luncheon - Executive Dining Room, Germantown, Md.
2:00	Departed by chartered bus for Arlington Cemetery to lay wreath at grave of President Kennedy at the request of Chairman Petrosyants
5:00	Returned to Statler Hotel
5:45	Departed for reception and dinner at Chairman Seaborg's residence
9:00	Returned for overnight stay - Statler Hotel

SUNDAY, December 1

9:30 a.m.	Breakfast - Statler Hotel
10:30	Departed via chartered bus for sightseeing tour of Washington, D. C.
1:30 p.m.	Luncheon - Watergate Inn, Washington, D. C.
2:30	Continued sightseeing tour

4:30 p.m.	Returned to Statler Hotel for short rest period
7:00	Buffet dinner - Statler Hotel
8:00	Attended movie "How the West Was Won" at the Uptown Theater, Washington, D. C.
11:00	Returned for overnight stay, Statler Hotel

MONDAY, December 2

7:00 a.m.	Breakfast, Statler Hotel
8:00	Departed Statler Hotel for Andrews Air Force Base to board MATS plane
9:00	Departed Andrews Air Force Base for New York City
10:15	Arrived LaGuardia Field, New York
11:00	Arrived Waldorf-Astoria Hotel
12:00 p.m.	Afternoon devoted to shopping at various New York stores, Soviet delegation split into small escorted groups
8:00	Dinner - Mamma Leonies Restaurant
10:30	Unscheduled walking tour of Times Square etc.
Midnight	Overnight - Waldorf-Astoria Hotel

TUESDAY, December 3

8:00 a.m.	Breakfast - Waldorf-Astoria Hotel
9:00	Visit to Columbia University cancelled - Soviet delegation continued shopping in New York City
1:00 p.m.	Luncheon - Delegates Lounge, United Nations Building (Chairman Petrosyants, Deputy Chairman Sinev and Oleg Kazachkovskiy, accompanied by A. A. Wells and W. Krimer, attended United Nations luncheon. Balance of Soviet delegation continued shopping)
4:30	Departed Waldorf-Astoria Hotel for Idlewild Airport
7:00	Soviet Delegation departed United States for Paris, France via Air France Flight #700

INFORMATION ON SITES VISITED

SATURDAY, November 16

The visiting party was greeted at Idlewild Airport at 9:00 p.m. by Chairman Seaborg, Commissioner Palfrey and other AEC representatives. The visitors' flight was delayed four hours in Stockholm due to mechanical difficulty.

After arrival at the Waldorf-Astoria Hotel, a light buffet supper was served, following which Chairman Seaborg and Dr. Fritsch, accompanied by the interpreters, took the Soviet party for a walking tour of the Broadway district.

SUNDAY, November 17

Following breakfast, the group met with Chairman Seaborg to discuss the itinerary. Chairman Seaborg explained that the AEC was able to grant the Soviet request for a visit to Oak Ridge National Laboratory on November 18, and that full-day visits to the Dresden and Fermi Reactor facilities also would be provided. Chairman Petrosyants indicated that the itinerary was satisfactory, commented on the see-sawing of the international scene, and then introduced the members of his party. Thereupon Chairman Petrosyants presented Chairman Seaborg with a miniature replica of the Serpukhov Accelerator, currently under construction in the Moscow outskirts, and with core samples from the First Atomic Power Station at Obninsk. The members of the hosting party were also presented with medallions of I. V. Kurchatov, after whom the Atomic Energy Institute is named.

The party then left for the Battery section of New York City, stopping en route to visit the top of the Empire State Building. At the Battery a Coast Guard tug was boarded for a tour up the Hudson River.

During the return to the Waldorf-Astoria Hotel, at the request of Chairman Petrosyants, a brief stop was made at the United Nations to permit the Soviets to photograph the buildings. The group then departed for LaGuardia Field for a late afternoon flight to Oak Ridge.

The MATS aircraft, "The Columbine," developed engine trouble shortly after take-off which necessitated landing at Andrews Air Force Base, Washington, D. C. The Special Air Missions of the Air Force provided a back-up plane, and the party proceeded on to Knoxville, Tennessee, arriving at 10:00 p.m. On arrival, the group was met by Mr. S. R. Sapirie, Manager of the Oak Ridge Operations Office, Mr. H. Roth, Director of Research and Development, and other local AEC officials.

A social hour, planned by Union Carbide for the group was cancelled because of the delayed arrival. The party retired to their rooms on arrival at the Holiday Inn.

OAK RIDGE NATIONAL LABORATORY
MONDAY, November 18

Breakfast for the group was hosted by A. M. Weinberg, Director of ORNL and Mr. C. E. Larson, Vice President of Union Carbide. Mr. Weinberg presented a briefing of the programs at the laboratory. Following this, the group departed for a tour of Oak Ridge National Laboratory.

Oak Ridge Isochronous Cyclotron (ORIC)
Robert S. Livingston

Livingston described the ORIC from a model and then took the visitors on a tour involving the control room, cyclotron vault, and east experimental room. The external beam on an aluminum target with fluorescent material to accentuate the beam was demonstrated for the first time; closed circuit television (camera in vault room and screen in control room) was used. Beam strength was indicated as 28% of the internal circulating beam. Livingston described the console and the controls on the potentiometers (helipots) which are used as trimming coils on the cyclotron magnet field. He was asked about the magnetic field strength, and he indicated an average field of 17,000 gauss and a maximum field strength of 22,000 gauss.

In the cyclotron vault, Livingston pointed out the target (previously irradiated), the RF system, the switching magnets, and the focusing quadrupoles. The locations of the future analyzing magnet and the future wall ports for passage of the beam into the east and west experimental rooms were pointed out. The party then moved to the east experimental room where they were shown the large gun mount on which will be placed the analyzing spectrograph. One of the Soviets inquired about the energy and radial instabilities. It was pointed out that the energy of this cyclotron is not high enough for these instabilities to occur. The energy for this cyclotron was indicated as ranging from 75 MEV for protons or equivalent down to zero.

As will be noted all through this report, Sinev was interested in construction details; in this case it was the Oak Ridge practice of having the cyclotron D's and magnet pole faces in a vertical plane versus the more common practice of having these in a horizontal plane. Livingston gave the following technical evaluation: (a) Much of the accumulation of dust in the D's can be avoided, thus reducing sparking; (b) engineering problems of supporting the D's are not as difficult; (c) this has been the Oak Ridge practice. The Soviets merely "grunted" and seemed to accept reason (c) as governing.

Also a flexible method of using metal shaped channels ("unistruts") as a flexible means for wall pipe hangars and common type metal chase for carrying electrical chases, which support and at the same time reduce electrical interference effects, was noted by Sinev.

High Voltage Building (Substituted for the Radioisotope Area at visitors' request)
P. H. Stelson, C. D. Moak, and J. L. Fowler

Stelson used a diagram to describe the Tandem Van de Graaff, and then pointed out the salient parts. The Soviets were quite interested in the techniques of reversing the charge on the accelerated particles and the control used to vary the number of electrons stripped on bromine, iodine, and other atoms. Moak provided a chart indicating multichannel analyzer results, identifying the charge on the atoms being accelerated and including an isotopic difference. Much of the detailed interest in the Tandem was lost when the visitors saw the High Voltage Engineering plaque on the accelerator. They did inquire as to the extent of equipment shop - made or fabricated at ORNL in the experimental setups utilizing the beam. The flexibility available using the various bending magnets was described. Fowler described the equipment available in the target room of the 3 MEV vertical Van de Graaff, and Moak described the machine for automatic processing of data from tapes (punched directly from multichannel analyzer pulses) to computed nuclear cross sections, including curves for cross sections versus energy.

Fission Product Development Laboratory (FPDL)
Arthur F. Rupp

The cells in the plant were described, including the fact that the building is divided into two parts--one for the chemical purification and the other for mechanical handling of the products. The major products processed in this plant are Sr-90, Cs-137, Ce-144, and Pm-147, but there is continuing interest in all fission products. The technique of remote welding in one of the cells was described. The visitors were interested in the total activity which the plant is capable of handling. They were told 1,000,000 curies of Ce-144. The visitors were shown ceramic pellets and some powder of $SrTiO_3$ of various specific activities. The samples, as much as 30,000 curies each, exhibited a red glow. The visitors wanted to know if the material was molten, and they were told no. Considerable questions on darkening of cell windows were raised. The visitors seemed doubtful that the windows in this plant were not darkening due to radiation. They were told these windows are solid glass containing stable cerium. Sinev asked details of construction of the cell. He was told the cells were constructed of barytes concrete with the faces of the cell clad with lead. Sinev also examined the manipulators very carefully and inquired if only steel tapes are used. He was told that both rods and tapes are used. He also wished to know if the manipulators are old or new models. He was told they are relatively new.

Oak Ridge Research Reactor (ORR)
William R. Casto

The reactor was described in general terms, and the visitors were permitted to view the reactor from the rolling platform. The reactor was at full power, and Cerenkov radiation was clearly visible. The various loops entering the top of the reactor were identified. Afterwards, the visitors were shown the equipment in the gas-cooled loop. The visitors expressed their interest in the reactor fuel and attained burnup. They were advised the fuel is 93% enriched uranium in aluminum with aluminum cladding. Here again the visitors showed considerable interest in construction details. Of particular interest were the scram annunciators. They were taken into the control room, and the various instruments were described.

Molten Salt Reactor Experiment (MSRE)
R. B. Briggs

Prior to visiting this site, the visitors wished to be assured that there would be an MSRE model available for use in the explanation. ORNL had already thought of this, and one was ready and described by Briggs. The visitors were interested in and given the chemical content of the fuel with their percentages (1 UF_4, 5 ZrF_4, and 68 Li^7F mol percent with BeF_2 remainder), construction materials of the primary system (INOR-8) with alloy constituents (5 Fe, 7 Cr, and 17 Mo percent) coolant (BeF-LiF) to air. Sinev remarked that this is a lot of

Mo. In addition, the visitors were interested in the operating temperatures, viscosities, and stresses used in the design. Briggs pointed out that, rather than using a maximum permissible tensile stress, the designs were based on a maximum permissible creep at 1400°F. Sinev asked many detailed questions on pumps (centrifugal pumps working in a partially filled vessel in which the free surface of the fuel is in contact with helium). The visitors also asked about control rods. They were told that there are some control rods but the main shutdown control would be accomplished by dumping the fuel. The visitors asked when the MSRE was started. They were told the design began in 1960 and construction (modification of the Aircraft Reactor Test Building) began in 1961. The visitors inquired about the Oak Ridge Homogeneous Reactor. They were told that it had been abandoned. There had been reports that the Soviets were working on a molten salt reactor at the New Melekess installation. On being asked about this, no firm answer was received; but on being asked directly about the fuel, the visitors replied UO_2SO_4. On viewing the reactor pit, the Soviets inquired about the large flanges, apparently thinking they were expansion joints. They were advised that these are remotely disconnecting flanges, and descriptions of the flanges were given.

High Flux Isotope Reactor (HFIR)
A. L. Boch

The visitors were provided "hard hats" prior to entering the HFIR building, which is still under construction. Apparently the visitors did not understand the need for the hats but did adjust quickly to wearing them. Boch described the 100 MW thermal reactor with a maximum thermal flux of 5×10^{15} n/cm^2/sec. The visitors asked questions about the design data on the maximum heat flux. Some questions arose at this point on understanding of the British versus the C.G.S. system of defining the heat flux--60 cals/cm^2/sec. A dummy fuel element was available for the visitors' inspection, and a description was given, including a printed handout. Boch gave a general description of the fabrication techniques involved in the fuel element. After the visit, Boch remarked that the Soviets seemed to be more interested in the fuel than anything else. They were told the fuel is U_3O_8 in aluminum alloy with aluminum cladding.

Lunch
Holiday Inn

1. S. R. Sapirie, Manager, Oak Ridge Operations Office, expressed his appreciation of having the visitors in Oak Ridge and his hope that this would lead to further exchange. He read a telegram from Chairman Seaborg expressing his regret on the forced landing of the Columbine at Andrews Air Force Base.

2. Commissioner G. A. Tape expressed the words of welcome from Chairman Seaborg received by telephone.

3. Mr. Alvin Weinberg gave a brief description of ORNL conclusions on water desalinization. These include:

   a. Unit costs of reactors decrease with increasing size
   b. Fossil fuel power plants also have decreasing unit costs with increasing size of plant
   c. The unit costs on nuclear power plants (at smaller sizes generally higher than fossil fuel plants) decrease more rapidly with increasing size than fossil fuel plants
   d. The crossover point is at about 10,000 megawatt

Mr. Weinberg also stated that ORNL is studying a 25,000 megawatt plant (three each, 8,000 megawatt reactors) which would provide electrical power from the primary heat and use the reject heat for desalinization. Weinberg indicated that, as of this date, the project lacked a customer. He believes that the project should be feasible in areas where fossil fuel costs are high and in desert areas where water costs are high. The visitors offered little comment.

Following the luncheon, the Soviet gr up continued its tour of ORNL facilities.

Controlled Thermonuclear Research (CTR) Program
A. H. Snell, P. R. Bell, R. A. Dandl, and J. L. Dunlap

Mr. Snell described in three parts the ORNL CTR project as follows:

DCX-1 - J. L. Dunlap
Ion density obtained - with arc: 2×10^9 per cm^3
without arc: 2×10^8 per cm^3
Containment time - with arc: 5 milliseconds
without arc: 10-40 seconds
Limited by volume of DCX-1 because of plasma expansion

DCX-II - P. R. Bell
Ion density - with lithium arc: 2×10^6 per cm^3
without arc: 5×10^7 per cm^3
Containment time: 5 milliseconds
Limited by charge exchange processes

Electron Heating - R. A. Dandl
This has reached a beta greater than 0.2 in the excitation of plasma produced by lithium arc by means of RF heating from a microwave cavity

The group was then given a brief walk-through visit of work areas and shown DCX-I, DCX-II, and the Electron Heating Device. The tanks, power sources, and magnets were pointed out. The principal questions raised were magnetic field strengths and injection energies used.

Stable Isotopes Program
T. O. Love

While the main group of visitors went on to the EGCR, Artsimovich and Bogolyubov, accompanied by Commissioner Tape, continued their visit of CTR (9201-3) and then visited the Stable Isotopes Production Area (9204-1). En route to Building 9204-1, Artsimovich indicated that the Soviet electromagnetic separators had vertical magnetic fields; that they used four tanks with three arcs per separator with a single yoke--the number of such setups was not indicated; and that linear shims were used on the first pass magnetic separators while circular shims were used on the high purity (second pass) mass separators. It was not clear whether this work was done on uranium or stable isotope separations.

After the visit, Artsimovich indicated that the Soviets have done about everything the U. S. has but perhaps not to the same purity. The visitors were shown the calutron tracks. Artsimovich asked to view the beam received on the calutron pockets. They were taken up on top of the tracks and were shown chromium and calcium arcs and an arc in which SiS_2 was undergoing simultaneous isotopical separation. It is not clear that Artsimovich got the point of the simultaneous isotopic separation of Si and S. He was told the total currents obtained are 25-75 ma of Ca, 28-29 ma of Si, and 30-36 ma of S. They were shown a calutron source unit, and its parts were pointed out briefly; these were given as 35 KV plus and minus to ground. Artsimovich asked about the field strengths used, and these were given as 6,000 gauss. Artsimovich advised the Soviets are using 9,000 gauss. He asked what enrichments are being attained. When told that these vary, he specified lead. He was told we get 80-90% in one pass.

During the ride to the UT-AEC Laboratory, Artsimovich indicated that initially all information the Soviets had was the Smyth Report and that, at the time, he did not believe the application of the electromagnetic method to uranium separation was feasible. He said the biggest problem the Soviets faced was a choice of the magnetic field strength to be used.

Gas-Cooled Reactors and EGCR
L. H. Jackson and D. F. Cope

The visitors evinced great interest in the U. S. gas-cooled reactor program, particularly the EGCR. Three members of the party, Afrikantov, Ponomarev-Stepnoy, and Sinev, preferred to miss the discussions on the controlled thermonuclear project and to spend the time in discussions with Jackson and Cope on the ORO reactor program.

At the EGCR Jackson described to the whole group, except those at the Stable Isotope Building, the flow diagram of the reactor, using a model. The reactor containment, the small reactor core model and a mockup fuel element consisting of seven elements in a graphite sleeve with simulated pellet fuel, including plastic mockup of the MgO pellet core, were described in detail. The visitors were taken through the air lock (at elevation 795 ft.) and then on the elevator to the service machine floor (at elevation 910 ft.). At this point the visitors could see the head of the reactor pressure vessel, including the nozzle stubs. The construction contractor had just finished the process of relieving stresses introduced during fabrication. They were then shown the service machines and one of the steam generators (Braun) which transfer the reactor generator heat in the helium gas to steam.

There were general discussions of dimensions, operating conditions, and materials of construction. The visitors were quite interested in the one-half inch diameter stainless steel tubes which come out of the head of the reactor. These tubes provide the burst slug detection and the pneumatic temperature monitoring systems.

The visitors appeared quite knowledgeable on the U. K. and French gas-cooled reactor programs. They were not greatly interested in the Magnox stations nor the French EDF gas-cooled reactors. They felt that the Dragon Project has potential but that there are a number of difficult problems to be solved before it becomes a practical power producing reactor. They were greatly interested, however, in the U. K. Windscale AGR, which is the U. K. counterpart of the EGCR. They were also interested in a comparison of the sodium graphite concept with the GCR concept, exemplified by the AGR and the EGCR. They are, therefore, looking forward to the Hallam visit for discussions on the AEC experience with this particular reactor. The visitors indicated that they are running some loop tests with the various gases and have a cooperative effort with Czechoslovakia on construction of a small gas-cooled reactor; however, their efforts in the GCR area are very limited.

Specifically, a number of questions were asked about the relative properties of helium versus CO_2 and the reasons why the U. S. had selected helium as the coolant gas for the EGCR and for Peach Bottom rather than selecting CO_2 as the British had done for AGR. The Soviets plan on using CO_2 as the coolant gas for the USSR-Czechoslovakia reactor and wondered whether we foresaw major difficulties in using this coolant gas. They asked whether any work had been done in this country on using disassociative gases such as NO_2 and CO_2, etc. The Soviets have performed some studies and find the thermodynamic properties of the disassociative gases to be quite favorable but they have not performed any work on compatibility, corrosion, mass transfer properties, etc. of these various gases. Although the language difficulties made the point somewhat obscure, it appeared that they were somewhat more interested in NO_2 and CO_2 than any of the other disassociative gases.

A number of questions were asked regarding the EGCR fuel and particularly the burnups which might be expected. The visitors recognized that a burnup of 10,000 MWd/T did not offer sufficient economic incentive for GCR's and this must be improved by a factor of two at least. They were also aware that the AGR is optimistic of obtaining burnups of about 20,000 to 25,000 MWd/T with their metal-clad fuel.

They questioned the status of compressor development and were interested in knowing whether the U. S. was doing any work on gas bearing compressors. They were aware that the Dragon Project plans on using gas bearing compressors and that so far Dragon has not selected a vendor for supplying these units. They were surprised to learn that the AEC had embarked on the EGCR without doing more preliminary development and testing work, particularly with helium loops and major components such as compressors, blowers, etc.

With respect to their own needs, Sinev, who was the most vocal of the visiting group as far as reactors were concerned, indicated that many areas of their country do not have easy access to fossil fuel and that, therefore, the cost of conventional power is high. This provides an incentive to build nuclear power plants and the USSR must face up to this decision in the near future. He feels that at present the Soviets are carrying on too many concepts without making a firm decision on which one is to be developed into power producing plants. He feels that this is expensive and, therefore, they must make an evaluation and a decision in the near future as to which concept is to be used for their near future power producing facilities. They are not favorably impressed with the pressurized water or boiling water reactors and wondered why this country continued development of these particular concepts. Sinev placed these reactors in the same category as the British Magnox reactors. Again, he reiterated their interest in the sodium graphite concept and stated that the Soviets have considerable experience in the handling of sodium. It was Cope's impression that the visitors are very seriously considering whether they should get into GCR's and are trying to make an evaluation of the merits of this concept as compared to the sodium graphite concept.

Transuranium Program

A. Chetham-Strode

At the luncheon, and later while the main body visited the Controlled Thermonuclear Program, Chetham-Strode discussed the production of transuranium material in the Soviet Union with Yakovlev. Yakovlev indicated that 10 grams of Pu-242 in the form of an oxide powder in an aluminum matrix was being irradiated in the Soviet High Flux Reactor. It is anticipated that the sample will be removed sometime next year and that 100 micrograms of californium will be produced. They plan to insert more target material into the High Flux Reactor sometime in the future but at present there are no firm plans. Most of the material that is produced is sent to Flerov in Moscow for heavy ion bombardment and other studies. There were no indications that the New Melekess Institute undertakes any basic research with the material. It appears that this institute functions entirely as a production operation. Chetham-Strode was surprised that there was so little interest in transuranium research at New Melekess.

BROOKHAVEN NATIONAL LABORATORY
TUESDAY, November 19

Enroute from New York City to Brookhaven National Laboratory, Dr. Charles Falk, Associate Director of the Laboratory, briefed the visiting group on various BNL program activities.

Upon arrival at the Laboratory at about 10:00 a.m., the visitors were met by Dr. Maurice Goldhaber, Laboratory Director, and other Laboratory staff. After introductory discussions, the visitors were escorted on a tour of the following BNL facilities: Alternating Gradient Synchrotron; 80" Bubble Chamber; Computer Center; High Intensity Radiation Development Laboratory; Heat Transfer Loops; Brookhaven Graphite Research Reactor; High Flux Beam Reactor.

GENERAL OBSERVATIONS

Alternating Gradient Synchrotron (AGS)
G. K. Green

Chairman Petrosyants and the visiting delegation spent approximately one hour viewing the general accelerator complex. They were shown the ring, the east area, the southwest area, and the north area. Many routine questions were asked. One interesting questions was asked by Chairman Petrosyants: "What was the total quantity of metal used at the AGS per BEV?" - I did not provide an answer. It was quite evident that he was fishing for some calibration of the impact of a super accelerator on the economy.

Bogolyubov seemed most interested in the high-energy experiments in progress at the AGS. He particularly discussed the neutrino experiment, asking about the difference between the experiment planned here and the one recently done at CERN.

80"Bubble Chamber
W. B. Fowler

We had set up the 1/8 scale model of the magnet and chamber, and the 1/4 scale model of the chamber, plus two full size 80" long by 30" wide photographic prints showing 6 BEV/C II beam from the AGS. A general description of the chamber was given using models and the two chamber photographs were described. The party then toured around the chamber and was shown the beam entry from the accelerator. Chairman Petrosyants was the chief questioner and asked about fifteen questions. The questions were all of a minor nature, such as the thickness and size of the window, etc. An undue amount of interest was shown by others of the party in the closed circuit television equipment.

Computer Center
P. V. C. Hough

The visiting scientists were shown the Brookhaven Mark I Flying Spot Digitizer. The principles of operation were explained briefly and some samples of pictures which had been transmitted to the computer and redisplayed on a cathode ray tube were shown. A new picture was displayed in real time on the low resolution Memoscope at the console of the Mark I.

High Intensity Radiation Development
D. S. Ballantine

In a general sense, I would say that there was rather keen interest both in the facilities themselves and in various aspects of the research work. Most interest seemed to be centered on the problem of radiation damage to shielding glass. I was surprised that the phenomenon was completely new to these Soviet scientists since it is rather well known both here and in other countries. This may be due to the fact that the visiting scientists were not personally familiar with this area of radiation work or it may indicate that the Soviets do not have any high intensity radiation facilities where such a problem would be encountered.

Most of the questions regarding the facility were asked by Messrs. Petrosyants and Artsimovich, but most particularly by Kazachkovskiy.

Liquid-Metal Heat Transfer Facilities
O. E. Dwyer

The group evinced a great deal of interest in the liquid-metal heat-transfer work as far as instrumentation and hardware were concerned. They showed little interest in experimental results. They bombarded us with questions, 90 percent of which came from Sinev, Kazachkovskiy, Ponomarev-Stepnoy, Afrikantov, and Chairman Petrosyants, in that order of decreasing curiosity. The type of question they asked showed real acquaintance with liquid-metal technology. This was particularly true of Sinev and Kazachkovskiy. The type of question asked was very similar to what a visiting engineer from one of our sodium-cooled reactor projects might ask.

Chairman Petrosyants, Kazachkovskiy, and Sinev showed particular interest in the electrodynamic pump on our NaK loop. Chairman Petrosyants was very disappointed when we were not able to show him drawings of the working parts. Their questions dealt with such matters as: materials of construction, energy levels, heat flux, flow rates, manufacturers' names, pump capacity, temperatures, pressures, insulation, attainment of high heat fluxes, valve performance in alkali metals, types of liquid metals used in our studies, the purposes of each of our heat transfer projects, "wetting vs. nonwetting" effects on heat transfer, etc.

Sinev and Ponomarev-Stepnoy seemed very much interested in our boiling-potassium heat-transfer project. Ponomarev-Stepnoy asked whether the work was related to some particular project or was carried out for the purpose of getting fundamental information. We replied it was the latter. In our discussion on the boiling-potassium work, Sinev showed great awareness of the problem of getting high fluxes, i.e., approaching 10^6 Btu/hr/ft^2. At that point, I asked him about boiling-liquid-metal heat-transfer work in the Soviet Union. He replied that such work was going on with sodium and natrium. He mentioned these two liquid metals two or three times which led me to suspect what he actually meant was sodium and potassium. When we were looking at the NaK loop a few minutes earlier, John Chen asked Ponomarev-Stepnoy about boiling-liquid-metal heat-transfer work in the Soviet Union, and he replied that he was not familiar with that subject and was concerned principally with the over-all utilization of atomic energy. Sinev's statement was the first indication we have had of boiling-liquid-metal heat-transfer studies in the Soviet Union.

Sinev stated that in their boiling-liquid-metal heat-transfer work they are planning to obtain high fluxes by electron beam heating. As far as I know, the only ones in the United States planning to use this type of heating for this purpose is the Heat Transfer Group at Argonne National Laboratory. Kazachkovskiy told Sheldon Kalish that the Soviets are having difficulty with the valves in their sodium-cooled reactor plant. The difficulty seems to be that after a few cycles, the valves cannot be completely shut off (leakage at valve seat).

When leaving Building 820, Sinev asked for some copies of our recent results so that he could pass them on to V. I. Subbotin, a well-known liquid-metal heat-transfer researcher in the U.S.S.R.

Brookhaven Graphite Research Reactor (BGRR)
R. W. Powell

The delegation toured the Graphite Reactor, and were shown our new data handling system which is installed in the old Sigma Center on the second floor of the reactor. This data handling system is built around a small computer and has the unique feature that it can handle data from two separate experiments simultaneously. I explained these features to the delegation and they seemed very interested in this new application of computers for data handling.

Petrosyants inquired of Powell about the facilities at the Graphite Reactor for routine washing and checking of radioactivity from pile operators. Chairman Petrosyants tried to imply that the facilities were not very extensive, but Powell would not accept this point of view and made a point of explaining, in detail, all the steps through which an operator must go after he finishes his shift.

I had brief conversations with several of the group, spending the most time with Sinev. He admitted to being the turbine designer of the ice-breaker Lenin and was very proud of this fact. In this respect, he pointed out that the turbine speed on the Lenin remained constant while the load varied from 0 to 100%. He said that no other ships like the Lenin would be built and that the next ship would be a substantial advancement over the Lenin. He pointed out that the Lenin had essentially a spare reactor and that he did not believe that this was necessary for future ships.

High Flux Beam Reactor (HFBR)
T. V. Sheehan, J. M. Hendrie, and W. E. Wensche

Chairman Petrosyants asked when the HFBR would be completed. When told the scheduled date is April 1, he laughed heartily and expressed doubt that we would make it.

Ponomarev-Stepnoy was asked what ultimate application they had in mind for their research in high temperature liquid metal technology. He replied that the application is not important.

Yakovlev inquired what constituents we expected to remove in the heavy water cleanup system. He also asked where the design data concerning performance of the ion beds came from.

It was noted that Ponomarev-Stepnoy is interested in reactor shielding, reactor vessel material, fuel elements and process conditions, while Sinev is interested in heavy equipment, pumps, heat exchangers, etc.

It was noted that Kazachkovskiy and Afrikantov were very interested in fast reactors and referred several times to their BR-5 reactor. They both stated that they were strongly in favor of conventional engineering and design in fast reactors and that they felt that there are not great additional problems in fast reactors as compared with thermal reactors. They do not believe in testing such as is done at ARCO on the SPERT program. They indicated that they have design work proceeding on a 100-megawatt fast reactor to be tied into a distribution grid. Since they seemed so strong on conventional design, it would appear that this would be oxide-fuel clad in stainless steel and cooled with sodium.

They asked several questions with regard to our philosophy on double-walled heat exchangers where the heat from sodium is transferred to water. I told them that I had not studied this situation and did not know of the US viewpoint. They indicated that they did not think double walls were necessary. They use a U-tube arrangement and have a helium blanket at the top of the sodium which protects the welded joints. They expressed considerable interest in the Settled Bed Reactor and asked for additional details. They did not respond to questions with regard to other refractory fuels other than to indicate that the next fuel for BR-5 would be uranium monocarbide clad in stainless steel.

PRINCETON UNIVERSITY
WEDNESDAY, November 20

At approximately 10:00 a.m. the following Soviet visitors arrived at Princeton University to tour the Plasma Physics Laboratory: Lev. A. Artsimovich, N. N. Bogolyubov, G. N. Yakovlev and V. Revin.

After a greeting by H. D. Smyth, L. Spitzer and M. G. White, the group proceeded to the Visitors Gallery of the C stellarator facility where Mr. Spitzer spoke for approximately 20 minutes. At this point Academician Bogolyubov, whose primary interest is in high-energy physics, left the group accompanied by M. G. White of the Princeton Pennsylvania Accelerator. The remainder of the group inspected the C stellarator and the Q-3 cesium plasma device in the company of Spitzer and members of the Plasma Laboratory Staff.

At 11:20 a.m. the group departed from the Plasma Physics Laboratory for Sayre Hall, where they were rejoined by Academician Bogolyubov. At Sayre Hall Academician Artsimovich spoke to an audience of about 100 on Soviet programs in controlled thermonuclear research. (See appendix B for text of Artsimovich address).

Following the session at Sayre Hall, a group luncheon was held at the Lowrie House and the visitors departed for New York City.

<u>General Observations</u>

During the course of the Princeton visit, Yakovlev left the group to visit with Professor Turkevich at the Nuclear Chemistry Laboratory. They discussed the beta ray spectrometer and Yakovlev remarked that he knew all about it, liked it and was building some since several Soviets had studied in Copenhagen where this spectrometer was developed.

Artsimovich informed L. Spitzer that there were three stellarators under construction in the Soviet Union--one at the Kurchatov Institute, one at the Lebedev Institute, and one at Kharkov. The one at Kharkov has dimensions about the same as the Model C stellarator at Princeton, but with a somewhat smaller magnetic field, in the range from 25 to 40 kilogauss. Artsimovich remarked that he had personally advised against building so many stellarators.

INDIAN POINT
NUCLEAR POWER PLANT
WEDNESDAY, November 20

The visitors were escorted from New York City to the Indian Point Nuclear Power Plant by Mr. W. M. Leonard, Public Relations, Consolidated - Edison Company, and overall guide for the Indian Point tour.

Following a briefing of the plant layout and operation, the group was shown various sections comprising the Indian Point reactor site.

Key officials who acted as hosts, leaders and spokesmen included:

R. Frank Brower - Vice President, Engineering and Rates
M. L. Waring - Vice President, Purchasing, Fuels, Stores Real Estate and Insurance
M. M. Ulrich - Vice President
Donald Crawford - Vice President
George E. Quinn - Manager, Production
Richard F. Freyberg - General Superintendent, Indian Point Station
Joseph A. Prestele - Assistant General Superintendent, Indian Point Station

General Observations

Mr. Petrosyants seemed to be very knowledgeable concerning nuclear power and he was very disappointed, as well as the rest of the group, when they were not admitted to those areas in which radiation was present, i.e. inside the containment vessel. The Con-Ed Company does not permit any outsiders (US or foreign) to visit these controlled or exclusion areas. They did not make an exception for this delegation. However, the Company did make one exception when they permitted the Soviets to take photographs in the control room. The prohibition against such photographs is company policy and is not for security reasons.

Sinev was very inquisitive regarding scale on the control rods and wanted to know their design and the material of the last seal. Throughout the visit he repeatedly came back to the subject of hermetically sealed control rods. He also requested information concerning the main pumps and asked if he could have a manufacturer's brochure or instruction manual concerning the pumps. He inquired as to what material was in the journal bushing of the pumps, how it was machined and whether or not graphite bearings were used. He was told that the bearings were graphite. He was primarily interested in the design and materials used. However, he was not interested in the boiler feed pumps on the steam side of the plant, but did ask if they were conventional.

Sinev, together with Afrikantov, discussed in detail the primary purification system. They were particularly interested in the temperatures involved, the ability to remove particulates from the coolant and the efficiency of the chemical exchange resin. Afrikantov questioned why a cooler preceeded the ion exchange bed and was told that the temperature of the resins could not exceed 120°. The Soviet comment was, "just like ours." He also made a number of references to the purification inlet filters as to their purpose and construction. The fact that this filter is of a cellulose type was of interest to him. He was also particularly interested in the mechanical filter at the ion exchange outlet and why this had to be 15 micron mesh. The answer was to prevent breakthrough of the ion exchange medium.

The Soviets wanted to see the fuel handling equipment. Because this equipment was already wrapped in polyethylene and sealed during the normal storage, it was not available for viewing.

The Soviets were not particularly interested in the thorium-dioxide/uranium-dioxide fuel which comprised the first core of the Indian Point reactor. They were not surprised that the control rods were ganged and that the fuel distribution was a symmetrical pattern. They did query as to why the second core was being made of slightly enriched uranium dioxide. The answer was based purely on economics. The first core utilized fully enriched uranium and the rental charges were extremely high. The second core will cost $2,000,000 as compared to the $5,000,000 cost of the initial core.

Afrikantov was very much interested in the troubles experienced with No. 14 steam generator which permitted primary water to leak into the secondary system. This is the U-type heat exchanger, 18 feet long. The straight portion of the tube is welded to the curved portion. This was due to inability to draw tubes of adequate length at the time these heat exchangers were constructed. The Soviets proudly said that they can draw the tubing up to 12 meters. No comments were made by the Soviets concerning stress corrosion and there were no discussions concerning zirconium cladding.

Sinev was particularly interested in the fast that the Con-Ed people required over two weeks to wash out the condensate of the primary system. It was not clear to Sinev why this was necessary.

The Soviets were very interested in the amount of cobalt present in the primary coolant and questioned as to what the total activity of the primary water was. When hearing that it was 10^{-2} microcuries per milliliter they were somewhat surprised that it was so low. They came back to this point and again asked how much cobalt-58 and cobalt-60 was present. The answer was 1×10^{-6} parts, respectively. The Soviets then asked the material composition of the system and when told that a special stainless steel was used (for which the company paid a premium) containing less than .05% cobalt, they all shook their heads knowingly -- it was evident why there was such a low cobalt content in the coolant.

They were very much interested in the superheater principle but were not concerned with the construction details of the conventional superheater equipment. They inquired as to the cost of the plant due to the superheater installation. The superheater cost was approximately $80 per kilowatt whereas the nuclear portion cost was $300 per kilowatt. These are capital costs. They were told that the plant produces electricity at a cost of 14 mils/kw-hr which they considered a bit expensive. They remarked that in the USSR the cost of a nuclear power plant is about one and one-half times that of a conventional plant.

Afrikantov was very much interested in the construction of the reactor vessel. He asked whether it had a lining and how the internal lining was applied. This inner liner is rolled directly on the plant and in the areas of the nozzle a sealed overlay is applied. He was interested in determining that the liner was also spot welded to the main vessel.

On departing from the plant, Petrosyants inquired about the voltage level of the power lines coming to the substation. These lines are 138 kilovolts and 345 kilovolts and he was told that the voltage was this low due to the short distance to their consumers. The Soviets mentioned that they were considering power transmission at the 1,000 kilovolt level.

It was indicated by the Soviets that the Novovoronezh power station is expected to become critical in late December. They expect it to operate at low power for a month before steam is produced.

At one point the Soviets asked if the area surrounding the plant was monitored for radiation.

LAWRENCE RADIATION LABORATORY - BERKELEY
THURSDAY, November 21

The visitors arrived via USAF Special Air Mission aircraft of MATS, at Oakland International Airport about 3:20 p.m., November 21.

The party was escorted to LRL-Berkeley by Mr. E. C. Shute, SAN, and E. M. McMillan and H. A. Fidler of LRL.

Following arrival, the group started on a program of visits which included brief stops at the bevatron, bubble chambers, data processing and computers and the 88" cyclotron.

Following the late afternoon visit to LRL facilities, Chancellor Strong entertained with cocktails and dinner. The group then departed for an overnight stay at the Fairmont Hotel in San Francisco.

LAWRENCE RADIATION LABORATORY - BERKELEY - continued
FRIDAY, November 22

The LRL program began about 25 minutes late, but, as planned, with some minor changes. When word about President Kennedy's assassination was received, the people in Mr. McMillan's office who were working on arrangements for the subsequent days were stunned. A confirming report was sought by telephone, a TV set was located and wheeled in and radios were tuned in. Mr. Fidler informed the visiting party. The program was stopped until new plans could be formulated. The USSR group mostly stood by outside Bldg. 70A with many members of LRL. An accurate accounting of the next hour would nearly be impossible as each person's reaction to the terrible tragedy was beginning to affect him and hence his activities. One factor remains clear: Chairman Seaborg remained saddened but calm and carefully considered each aspect of the many suggestions he received. He kept the physical safety and interests of the USSR group uppermost.

Mr. Petrosyants was advised by his Embassy to place himself in the hands of Dr. Seaborg and staff and cooperate in every respect, which he and his party certainly did for the next three days. They were sincerely saddened and sympathetic to the U.S. They were interested in the early reports that started linking the assassination to a person with a Communist background.

Chairman Seaborg had by this time evaluated the pros and cons of the many aspects of safety and interest. His decision was to cancel all previously planned activities and have the group go to Yosemite National Park until Sunday evening. He asked Mr. Wells to assume duties as U. S. host in the interim, assisted by Paul W. McDaniel and Arnold Fritsch. Dr. Seaborg then left for Washington, D. C.

Following small group departures from the hotel and baggage loading and checkout, the group boarded the bus and a tour was made around the Embarcadero, through Fisherman's Wharf, across the Marina, over the Golden Gate Bridge and back. The tour continued around Land's End and the Great Highway to Golden Gate Park. The group then proceeded on a direct route to Yosemite National Park.

Following supper in Modesto, California, the visitors arrived at Yosemite Lodge about 12:30 a.m. The Lodge had made changes to quickly adapt to the situation and had rooms ready.

YOSEMITE NATIONAL PARK
SATURDAY, November 23

The entire day was devoted to leisure and sightseeing along the lines of the following schedule.

11:30 a.m.	Assemble to discuss program
12:05 p.m.	Travel to Village Store
12:50	Return to Lodge
1:45	Luncheon in cafeteria
2:40	Museum lecture and tour
3:40	Visit Ansel Adams Studio
4:00	Visit to Mirror Lake
4:30	Return to Lodge
5:30	Cocktail party in Redwood Room
6:10	Dinner
7:45	Movie, "This is Yosemite," in Lounge
8:15	Ranger naturalist talk in Lounge

YOSEMITE NATIONAL PARK - continued
SUNDAY, November 24

On Sunday, sightseeing in Yosemite Park continued and the tour covered most of the points of interest in the valley. In the late afternoon the group departed from Fresno, California en route to Idaho Falls, Idaho.

NATIONAL REACTOR TESTING STATION
MONDAY, November 25

Following a group breakfast in the Westbank Motel, Idaho Falls, the Soviet visitors departed by bus for a tour of NRTS facilities. Academicians Artsimovich and Bogolyubov, being interested primarily in controlled thermonuclear reactions and high energy physics, remained at the Westbank Motel and watched President Kennedy's funeral services on television. Paul McDaniel, Director, Division of Research, Headquarterr emained with them.

Enroute NRTS, Mr. William L. Ginkel, Acting Manager, Idaho Operations Office briefed the Soviet visitors on various programs at NRTS. Included in the tour were the following major NRTS facilities:

- Experimental Breeder Reactor II
- Mobile Low Power Nuclear Power Plant (ML-I)
- Special Power Excursion Reactor Tests (SPERT)
- Materials Testing Reactor (MTR)
- Engineering Testing Reactor (ETR)
- Advanced Testing Reactor (ATR)
- Experimental Breeder Reactor (EBR)
- Zero Power Critical Facility (ZPR-III)
- Boiling Reactor Experiments (BORAX-V)

NRTS Tour

Television sets were installed at the EBR-II and at the Central Facilities cafeteria at the suggestion of the Soviet delegation. The tour party watched a portion of the funeral preliminaries prior to touring EBR-II and part of the service following the tour. Approximately one hour was consumed observing television at EBR-II in addition to time spent during lunch. Mr. Yakovlev stayed at EBR-II to watch the remainder of the funeral service before rejoining the group at lunch time. The Soviet visitors were preoccupied with technical and mechanical details to the exclusion of discussion of the overall technology or broader aspects of the test station programs.

At ML-I, MTR-ETR and BORAX several of the Soviets indicated extreme interest in data and information on ion-exchange systems for water purification, much of which seemed elementary to briefers and guides.

At EBR-II the principal interest was in materials handling equipment within the Fuel Cycle Facility cells.

At ML-I more pictures were taken by the visitors than at other facilities. Messrs. Revin and Ratnikov were the most active photographers in this area. In response to some broad hints, Mr. Sowards (AGN) presented Mr. Petrosyants with a model of the ML-I mounted on a section of HO gauge railroad track.

At SPERT the only special interest noted was in the laminated vessel structure of SPERT-III.

At the Test Reactor Area the guides were subjected to intensive questioning regarding details of the experiments and loop designs, which information was generally refused the party. No special interest was shown in the ATR construction.

At EBR-I, ZPR, BORAX the primary interest was in the BORAX fuel element problem. They were apparently aware of the problem prior to arrival. Near the end of the day (when time was running short) several of the visitors, although not identified as understanding English, were listening to the guides and pursued discussions and asked questions without waiting for the English-to-Russian translation.

Mr. Sinev, Deputy Chairman, took copious notes throughout the tour. His interests also were in engineering and fabrication details and were most intense in the ML-I area.

Highlights of Conversation Between Dr. A. J. Vander Weyden, Deputy Director, Division of Reactor Development and Oleg D. Kazachovskiy

Superheat Fuel. Earlier, at the BORAX V site, there were a number of questions by the Soviets on the performance of the superheat fuel elements and they were told that a completely satisfactory cladding material has not yet been developed. They asked specifically about various stainless steels and nodded, knowingly, when it was mentioned that 304 stainless steel does not appear to be satisfactory. Since no one else raised the obvious question, I asked what they had found to be satisfactory cladding for their superheat elements and the question was not answered. In the later conversation with Kazachovskiy I raised the question again and he said that they do not have the problem solved either, but that they have developed a chrome molybdenum steel which appears to be much better than the 304 stainless steel. He said that since he was not a metallurgist, he was not familiar with the specific composition.

Status of Power Economics and Fast Reactors. Kazachovskiy said that the "state of the art" in USSR is such that they believe that they will be able to build water reactor plants which will produce power competitive with fossil fuel plants by 1967 and that they have, as a target, economic power from fast reactors by 1973. He said that the latter will depend upon success in certain developments such as carbide fuel (or possibly nitride): (1) they have been worried about the problem of carburization of stainless steel and now are working with hypostoichiometric monocarbide; (2) they plan to test carbide fuels soon in their small fast reactor; (3) they are also investigating niobium as a cladding material for fast reactor fuel.

In summary he said that they believe all of the fast reactor technology is now "do-able" particularly in light of the favorable results in the technology of handling sodium which they have learned about in the U. S. The principal outstanding problem is the development of an economic fuel cycle.

Chemical Processing. Kazachovskiy asked if we had any programs on aqueous processing of uranium carbide and commented that he thought this type of process would work although it may not be the best. I told him that the only work on processing carbide fueled by aqueous methods with which I was familiar was on a laboratory scale, but agreed that it appears possible to handle such fuel by such a process.

He asked if we were considering electrochemical processing of fast reactor fuels in molten salt. He implied that it would be possible, by careful control of electro-potential to selectively separate the products from such a system. On the other hand, their experience with aqueous processing has been very good and he commented that the process probably will work for fast reactor fuels, but it may be too slow to achieve reasonable economics. He said that their work on non-aqueous processing in general is not as advanced as ours, and that they have only done some laboratory investigations on fluoride volatility.

Possible Soviet Program on Reactors for Space Application. Two questions were asked by the Soviets which imply that they have a program on reactors for space application. The first one was whether or not we are looking at power plants substantially smaller than ML-I; namely, in the range of a few kilowatts. This question was asked by Chairman Petrosyants at the ML-I site and the Aerojet man replied that they had no work going on in smaller size units. The second question, which was asked by Kazachovskiy, was how extensive is our experience on liquid metal systems at temperatures above 2000°F. I "ducked" this question by replying that we are investigating, in our fast reactor program, temperatures only up to 1200°F because of "hot spot" limitations on stainless steel.

General Observations

In spite of the difficult circumstances of the timing of the Idaho Falls stop immediately following the President's assassination, the visit schedule proceeded smoothly and all objectives were accomplished; however, the agenda was extremely rigorous. Consistent with ID planning and in accordance with the visitors' wishes, local press coverage was minimum and newspaper articles and TV news programs were "played down" and generally appropriate to the circumstances. There was apparently no significant or general adverse reaction in the community to the conduct of the visit. Argonne and Fluor Corporation (constructor of the ATR) observed Monday, November 25th as a non-work day but Phillips and Aerojet facilities were staffed to normal levels at the time of the tour.

Because of the very demanding schedule of facility visits, several proposals were made to the delegation to eliminate one or more facilities in the interest of more extensive and reasonable coverage of those visited. However, in response to each such proposal, the delegation indicated a strong desire to complete the schedule in total and this was accomplished by extending the time approximately one-half hour. Compared to other high level foreign visitor groups and to the previous Soviet delegation in 1959, this group was significantly more oriented toward technology and even mechanical details rather than broader scientific or programmatic aspects. Except for a discussion between Chairman Petrosyants and General Manager Luedecke in the general area of reactor safety and siting philosophy, the group evidenced no significant interest in or awareness of management, programmatic or organizational aspects of the Test Station overall. The only significant probing into areas outside the exchange program came in the inquiries into details of test reactor experimental programs, some of which are classified and a discussion was tactfully avoided.

HALLAM NUCLEAR POWER FACILITY
TUESDAY, November 26

Following a group breakfast at the Cornhusker Hotel, Lincoln, Nebraska, the Soviet party proceeded to the reactor site which is located approximately 15 miles southwest of Lincoln.

The evening before, Academicians Artsimovich and Bogolyubov had expressed the desire to pass up the visit to Hallam in favor of devoting more time to the Argonne National Laboratory. Arrangements were hurriedly made and the two Soviets were put on a commercial flight from Lincoln to Chicago, Illinois where they were met and hosted by A. Crewe, Director of ANL.

Upon arrival at Hallam, the visitors were given a briefing and general orientation of the nuclear facilities, the control room, the conventional facilities and the administration areas.

Key officials present for the briefing and tour included:

Frederick H. Wagener - President, Consumers Public Power District
Guy L. Cooper - Secretary, Board of Directors
Wayne E. Barber - Executive Director
R. L. Schacht - General Manager
R. S. Kamber - Power Supply Manager
J. D. Cochran - Plant Superintendent at Sheldon Station
James E. Owens - Superintendent, Field Operations - Atomics International
W. M. Soule - Site Representative, AEC
Emerson Jones - Special Consultant to the General Manager of Consumers Power District

General Observations

A number of questions were raised on the building and structure itself. The intent of the questions seemed to be in connection with containment. The visitors all nodded when it was explained that the structure was designed for leak tightness with leakage into the building, but was not a containment area.

Considerable interest was displayed in the area of sodium purity specifications, the total volume of sodium in the primary system, what the retention volume in the fill tanks was, how the initial unloading and fill was accomplished, and whether the initial fill sodium was filtered. They also expressed interest in the area of how much make up was required in the sodium systems and how often it was required.

Interest in the reactor bellows fabrication was quite pronounced. Apparently, they were concerned with the construction problems since they asked about the materials involved, how it was actually fabricated, how many convolutions it had, etc.

Most of the group were very interested in all aspects of the fuel handling machine, especially in the sealing of the unit to the loading face shield. They expressed profound interest in the methods used to index the machine, the gas lock mechanism and the rotation. One comment made which was of interest was the fact that they covered the entire floor area. They seemed amazed at the fact that no protective clothing was normally required in the high bay area.

There were questions asked regarding the construction details of the steam generator. They were quite interested in the duplex bayonet heat transfer tube construction. They commented on the expense of such a design.

Most of the group appeared impressed with the temperature scan unit in the control room. A number of questions were asked on the operation of this device.

Several questions were asked about the control of the fuel outlet temperature. They wanted to know if the orifices were automatic, if they could be adjusted from above the floor, what type of thermocouples were used, where the thermocouples were placed, if the orifices could be adjusted while operating and construction details of the orifice mechanism.

They were quite interested in the opinion of personnel here concerning the future of the sodium graphite concept.

Several questions were asked about the reactor cavity cooling system. They were interested in concrete temperatures and flux exposure values at various locations in the shield material.

A number of questions were asked about the fuel cladding, methods of fuel fabrication, the annulus between the fuel and cladding and operating temperatures. They seemed amazed that type 304 stainless was used for the clad material. They asked if we knew that it was no good above 600°C. This point came up again and again during the tour, bus ride and lunch. Even after explanations were made concerning the operating temperatures of the fuel, sodium pressures and temperatures, they still did not seem to appreciate the facts and continued to express concern on the use of type 304. These comments eventually extended to the primary piping, reactor vessel, etc.

One of the two groups was very interested in the sodium pump drive motors and the electromagnetic couplings. They wanted to know details on the type and size of the prime mover, why the AC type with the variable speed coupling was preferred over the DC type and what the economics were. Both groups were interested in the pumps themselves. They wanted to know if they were stock items, built by commercial firms or Atomics International and expressed approval when told they were built by Byron-Jackson.

They were interested in primary system piping layout. Specifically, they seemed interested in whether expansion loops or bellows were used. Apparently, they prefer bellows in order to reduce size.

A few questions were raised on the use and operation of the plugging meters. They inquired about the normal, maximum and minimum plugging temperatures. Several questions were asked about the carbon and hydrogen content of the sodium. They seemed surprised that hydrogen content was not constantly measured.

They wanted to know what the control rod helium system leakage was. One visitor proudly announced that they were building hermetically sealed control rods with a four meter travel. These would be nearly the same length as those used at Hallam.

Some questions were asked about the ability to operate the conventional and nuclear plants in parallel. They also wanted to know about the economics of the operation of the two facilities, the individual and total cost and cost study breakdowns.

Several questions were raised concerning the maximum and average hot spot temperatures for the U-Mo and UC fuel elements.

One visitor, Sinev, was quite interested in what the United States was doing in the field of gas turbine application. He seemed very enthusiastic about the concept of using gas rather than steam and implied that gas cooled reactor systems using gas turbine drives were very practical. He said that the USSR is working on a 50 and 100 Mw gas turbine design. It was not clear whether these were related to a reactor project.

In summary, the Soviet group was interested in just about everything, especially mechanical design, fabrication techniques, types of materials, stress calculation and design criteria. They commented on the fact that the United States and the USSR were trying to stir too many pots at once. They implied that it would be better to pick one concept, develop it to the maximum extent and then build many of them before proceeding to another concept. They mentioned the U. K. gas cooled program as an example of intelligent programming.

Most of the visitors appeared to prefer sodium plants over water-cooled systems. They said that they were doing extensive work on fast reactor concepts and plutonium production breeders and converter concepts. They spoke freely of the emphasis they placed on plutonium production. All of the visitors appeared impressed by the cleanliness and layout of the plant.

AMES LABORATORY
TUESDAY, November 26

Upon arrival at Ames Laboratory, Ames, Iowa, a briefing session was held in the Office and Laboratory Building. Key officials participating as hosts, leaders and spokesmen included the following:

Morton Smutz, Assistant Director
A. F. Voigt, Assistant Director
H. A. Wilhelm, Associate Director
O. N. Carlson, Metallurgy Division Chief
W. H. McCorkle, Reactor Division Chief
J. D. Powell, Senior Chemist
W. E. Dreeszen, Administrative Aide
A. E. Edwards, Laboratory Business Manager
R. W. Fisher, Administrative Aide
W. H. Smith, Information & Public Relations Asst.

Included in the briefing were discussions on the ion exchange process for separating rare earths, the reduction and purification of metals and the forming of metals. Following the briefing, the main group visited the Metals Development Building and the Reactor. Kazachovskiy and Ponomarev-Stepnoy visited the hot loop area and reactor. Yakovlev and Valentin Revin, visited the radiochemistry facilities and the Metals Development Building.

The main group also saw the ion exchange pilot plant, the large-scale metal reduction equipment, the electron beam melter, horizontal zone refiner, iodine-metal purification apparatus, extrusion press, high speed forger and the Ames Laboratory Research Reactor. Yakovlev saw the radio-chemistry cells and the neutron generator.

General Observations

A large number of questions were asked about the details of the equipment and apparatus seen on the tour. These questions seemed to be the same type of questions asked by the usual visiting groups.

Kazachovskiy and Ponomarev-Stepnoy seemed especially interested in the apparatus of circulating molten metals through metal loops. Both appeared to be quite familiar with the apparatus and equipment used in circulating molten metals.

There were no unusual conversations or discussions.

ARGONNE NATIONAL LABORATORY
WEDNESDAY, November 27

Following a group breakfast in the Argonne Guest House, Albert V. Crewe, Director, Argonne National Laboratory, gave a general orientation briefing on the various activities at Argonne. The delegation was then divided into two groups to visit the following unclassified ANL facilities: Chemistry Division, Applied Mathematics Building, Zero Gradient Synchrotron, Fuel Fabrication Facility, CP-5 reactor and Liquid Metal Research. At the conclusion of the tour, the group assembled for discussions of the A^2R^2 and Faret reactor concepts.

Key officials participating as hosts, leaders or spokesmen included the following:

Albert V. Crewe, Laboratory Director
Kenneth A. Dunbar, Manager, Chicago Operations Office, AEC
Stephen Lawroski, Associate Laboratory Director
Morton Hamermesh, Associate Laboratory Director

General Observations

Chemistry Division
W. M. Manning

The entire group of Soviets arrived at the Chemistry Division as scheduled and were provided with a 20-minute briefing on the work we are presently engaged in. Following the briefing, the group was taken on a tour of the facilities. The first thing that occurred was during our visit to the "Cave". A number of comments were made by the Soviets concerning the lack of stainless steel lining in the cave. They were told that we do not use stainless steel lining since it will corrode as any other metal. I explained that the interior was painted and was equally as effective as the Soviet use of stainless steel; furthermore, it was much less expensive. Chairman Petrosyants agreed that it probably was if it was as effective as stainless steel. Chairman Petrosyants then got down on his hands and knees and began chipping the paint covering off the floor and commented, "you say this is new, but look how easily it chips". It was explained that it does not chip if you use it as designed and it will not adhere to the wheels of vehicles and it does not adhere to foot wear and does provide the protection we require even using hot materials.

The Soviets also demonstrated an appreciable amount of interest in the robots and battery-powered carts used in the hot laboratories. Chairman Petrosyants asked how would we cope with a battery-powered cart that failed if it had become contaminated? It was explained that the job would be handled through the use of our robots. Chairman Petrosyants also asked why we did not have electronic slaves as the Soviets had. Kazachkovskiy asked on two occasions if we had neutron emitters. He also asked a number of questions about Radon compounds. At the time we were showing the robots, Chairman Petrosyants asked for figures on the cost and the source of our procurement. One member of the group asked about the levels of activity we could handle in the laboratory.

Kazachkovskiy asked why we did not make use of remote TV when we were moving hot materials on the battery-powered carts and also asked why there was not more use of remote manipulations. He commented that it was a hazard to rely on the seal in the master slave. He also commented that we should make use of electronic slaves when handling alpha activity.

After the formal tour was over Yakovlev remained for nearly an hour and a half. He asked a number of questions which included "what work are we doing in cross sections? particularly in Curium ^{244};" how did we expect to improve yield from our chain reactions?; had we investigated cross sections of the isotope Californium ^{249} by radiating Curium ^{248}?; what yields were obtained in the isotope separator?; he also asked about the vapor pressure of heavy elements and if we thought volatility could be used to separate on a continuous basis.

Yakovlev said that they were looking at fluorides, since a temperature of 2000° Centigrade was not good in the separation process. Yakovlev said that they are doing a lot of solvent extraction work. He said there is no oxidation reduction of organic solutions. He said that they were just starting work in the Mossbauer effect and paramagnetic resonance. He also said that the Soviets are doing absorption spectra work, but only in solution.

Yakovlev was interested in the construction of our glove box. He said that they used epoxy resin. I told him that we did not because of possible poison toxins, which may result, and he asked where we obtained the polyester resin that we use.

Zero Gradient Synchrotron
L. C. Teng

The Soviet Group arrived at the ZGS facility during the afternoon and were given a short briefing on the operation as well as a tour of the accelerator. Only two people in the group had any familiarity with the accelerator; namely, Chairman Petrosyants and Bogolyubov. They asked all the questions and the balance of the group did not appear to be interested.

Chairman Petrosyants was interested in the details of costs. He asked about the specific cost of the rig for measuring the magnetic field in the blocks. He asked whether the blocks were manufactured locally or whether they were commercially produced. He asked detailed questions about the cost of the parts of the accelerator such as coils, blocks and controls.

During the tour of the control room many questions were expected but none asked. It was surprising since entering this control room and the one at Dubna is like viewing a vintage model and modern model automobile. It was also mentioned that we were planning to operate the accelerator with automatic controls and this raised no curiosity.

CP-5 Reactor
S. C. Foote

The Soviets were scheduled to visit the CP-5 reactor for over 30 minutes but spent only 10 minutes there and did not appear to be the least bit interested in this aspect of the tour. Consequently, they spent more than their alloted time in the "hot metals" laboratory.

Generally the Soviets were concerned with construction problems and were not interested in either operations or experiments that were shown to them. Chairman Petrosyants and Sinev did most of the questioning.

It was most apparent that the group was interested in welding and this included welding of any kind. During the tour we stopped each time that we came to an item which had been welded. Questions were asked on the type of metals that were welded, the temperature at which the metals had been welded and the use of the welded items. Questions relating to the welding were generally asked by Sinev.

Sinev asked for one sample of two pieces of steel which had been welded and used in the sodium heated steam generator. There was one welding job which involved welding of 75 tubes in one conduit, which is admittedly a difficult task since each tube has to be welded individually. The Soviets were intrigued by this and asked a multitude of questions concerning the procedure we used to make the welds.

The Soviets were also interested in anything available concerning the construction of the Plutonium Fabrication Facility and particularly the construction of the building. Sinev said that the Soviets are getting ready to construct a similar facility. This indicated that previous plutonium fabrication had been done in the weapons laboratory as it had been done in the U. S. but the Soviets are apparently now ready to construct a research facility as we have here.

Liquid Metal Research Building
R. C. Vogel

The Soviet Group visited the Liquid Metal Research Building and were provided with a short briefing on the scope of our work. They seemed interested in most aspects of powder metallurgical development. They were specifically interested in the volatility processes and asked a number of questions which related to this subject. Sinev asked what was being done in the pilot plant, what scales of temperature were experimented with, and those processes being tried in the pilot plant.

The Soviets were shown a five hundred-pound tungsten crucible which was designed and built here at the laboratory. Not one question was raised by the Soviets concerning the crucible which was surprising since it was felt that the Soviets did not possess anything like it.

The Soviets were quite interested in the Model 3 master slave manipulator. Chairman Petrosyants had to try the operation and every Soviet in the group took a turn at operating it. The Soviets also expressed interest in the process of direct conversion of heat to electricity.

DRESDEN NUCLEAR POWER STATION
THANKSGIVING DAY--November 28

The visiting group was assembled in the Dresden Station Exhibition Building for lectures on the plant costs, operating experience, and equipment operation.

Key officials participating as hosts, leaders or spokesmen included: Murray Joslin, Vice President, Commonwealth Edison; H. C. Hoyt, Plant Superintendent, Dresden Nuclear Power Station and C. B. Vitek, Assistant Plant Superintendent, Dresden Nuclear Power Station.

A movie was shown entitled "Inside the Dresden Sphere." This movie shows the fueling operation including reactor head removal, removal of turning vane, fuel handling and equipment, the loaded core, and replacement of reactor turning vane and head. The movie was made during the initial core loading when all equipment and fuel were handled "dry."

After the movie was shown, the visitors were divided into two groups. Each group toured the following areas: fuel building viewing gallery, access control building which contains the "hot" and "cold" chemical laboratories, administration building, inside the sphere on elevation 529' and elevation 565', turbine room (walked past the turbine), condensate pump room, west auxiliary bay which contains the make-up demineralizer, emergency diesel generator, 480 V. equipment, exciters and small pumps, primary feed pump room, control room; each group returned to the Exhibition Building to view models of plant, control rod drive, control rod, fuel, core, fuel handling equipment, and model of recirculating loop.

General Observations

Questions were asked about the methods used to process our make-up and waste water and our experience with resins.

The party was informed that we used full flow demineralizers on the feedwater going to the primary system (reactor, primary drum and recirculating loops), demineralizers for make-up water, demineralizers for a small clean up loop on the primary system, and a demineralizer to reprocess radioactive water for re-use as make up.

They asked if the clean-up demineralizer was operated periodically or continuously. We answered "Continuously."

They were also told that the condensate demineralizer resins were regenerated using acid and caustic solutions.

They asked how we made a seal on the in-core instrumentation at the reactor vessel head. We explained that all tubes of an in-core string were seal welded to a single connection and this connection was held tight by a threaded cap.

They asked how the seal was made on the reactor head. We explained that we used two silver plated "O" rings which fit into grooves machined in the vessel and head flanges.

A great deal of interest was shown in the make-up demineralizers and Mr. Sinev stopped here to ask how the demineralizer worked. He was told that the tanks contained anion and cation resins that removed the positive and negative hardness ions dissolved in the water. He was also told that the system was operated automatically.

In the control room Mr. Sinev concentrated on the layout of the graphic panel. The four recirculating loops and equipment were described. Mr. Sinev then mentioned that they have a reactor with six recirculation loops. He also asked how we place a reactor recirculation loop in service without introducing cold water to the reactor. We told him we had a small 1/2" warm up line used to preheat each loop.

A few of the men were quite interested in the in-core monitoring system.

We were quite surprised at the general lack of interest in the control room instrumentation other than the reactor operation area.

Mr. Sinev mentioned that they were building a 100 - 200 MWE nuclear plant and would be ready for startup soon.

ENRICO FERMI NUCLEAR PLANT
FRIDAY, November 29

The visiting group assembled at the Information Center for an orientation briefing. Key officials and staff members acting as hosts, leaders and spokesmen included:

The Detroit Edison Company
Walker L. Cisler, President
Harvey A. Wagner, Assistant Vice President
Harvey E. Bumgardner, Assistant to the President
Atomic Power Development Associates Inc.
Alfred Amorosi, Technical Director
Wayne H. Jens, Assistant Technical Director
John V. Morabito, Head, Design Division
John G. Yevick, Projects Administrator
Power Reactor Development Company
John F. Anderson, Assistant to General Manager
Clarence H. Clark, Plant Superintendent
Robert W. Hartwell, General Manager
Walter V. McCarthy, Jr., Assistant to General Manager

Following the briefing, which included discussions on results of nuclear testing to date, general operating experience to date, equipment performance and future plans, the visiting Soviets were escorted through the reactor building, fuel and repair building, steam generator building, control room, and turbine-generator building.

General Observations

Chairman Petrosyants asked for further explanation on the sodium worth experiments. He wanted to know specifically if we had encountered bubbles in the sodium used.

Kazachovskiy asked what is the B-10 enrichment in the control and safety rods? "You talk about using Stellite. Where do you use such material and what other surface preparations have you used in the sodium system?"

Sinev asked how is double containment supported in the primary system. Noting that double piping was used in the primary system, he asked why wasn't double piping used in the steam generators.

Ponomarev-Stepnoy showed a great deal of interest in the gas-cooled reactor and felt that the graphite-moderated reactor is better than the D_2O-moderated one which they now have. He felt that the Peach Bottom design in which the graphite is mixed with the fuel is an important advance.

During the tour, Chairman Petrosyants and Kazachkovskiy asked questions regarding the operation of the various components. These did not indicate any particular area of interest. They were the type of general question which any technically-trained person would ask. Numerous operators had assembled in the control room out of curiosity. Chairman Petrosyants wanted to know why so many operators were needed to run the Fermi Plant. I explained they were assembled more to see the Chairman of the Soviet Atomic Energy Commission rather than to operate the plant. Kazachkovskiy asked about the very sharp bends in our steam generator tubing.

Afrikantov seems to be a very capable mechanical engineer with a clear understanding of the problems of building a sodium-cooled plant. We discussed the operation of BR-5 and compared the difficulties we had encountered at Fermi with those BR-5 has experienced. Afrikantov volunteered that it would certainly be helpful to have more extensive discussions with groups such as ours. Of this delegation most of the pertinent fast reactor questions were asked by Kazachkovskiy and Afrikantov.

Sinev asked many questions about minor details which had been covered during the presentation and were included in the written material made available. Sinev was the man who seemed to be most intrigued with the hangers used for supporting the primary coolant piping.

In response to questions regarding the 50 Mw prototype, Chairman Petrosyants and Afrikantov both indicated that the results of work on BR-5 had made this construction unnecessary. This is the same type of answer Afrikantov gave during the Vienna discussions in June. I personally gained the impression that there is a program change in the Soviet Union; one that may be dictated by money considerations and also by the slowness with which technical information has been developed.

IV-BIOGRAPHICAL INFORMATION AND PERSONAL OBSERVATIONS ON SOVIET VISITORS

The biographical information set forth below was obtained from a number of sources and while it is reasonably current, it may be incomplete in many respects. For the most part, the personal observations listed were recorded by Mr. Joseph Lewin of ORNL who accompanied the Soviet delegation throughout the entire tour as one of the interpreters. Because of his language capability, Mr. Lewin had many opportunities to engage the Soviets in informal discussions.

PETROSYANTS, Andronik Melkonovich

Current Position:	Chairman, State Committee for Utilization of Atomic Energy USSR, Supreme National Economic Council 1962-63
Background and Education:	Born 8 May 1906, Ordzhonikidze, RSFSR; graduate of Ural Polytechnical Institute, Sverdlovsk 1933
Career:	Deputy Minister, Ministry Medium Machine Building 1955-62
Remarks:	Said to be a mechanical engineer by profession, Petrosyants' background has been in the armaments industry. He has been a vocal proponent of peaceful development of atomic energy and of international cooperation in nuclear research. He and Glenn T. Seaborg, the Chairman of the U. S. Atomic Energy Commission, signed a three-year agreement providing for a cooperative program in nuclear studies and for U. S.-Soviet exchanges in the field of atomic energy, during the latter's trip to the Soviet Union in May 1963. He has been a member of the Communist Party of the Soviet Union since 1932.
Honors:	Awarded the Order of Red Star in 1942 and 1943 for exemplary fulfillment of government tasks in production of tanks, tank diesel engines, and armored tank hulls; awarded the Order of Kutuzov, first class in 1945 for successful fulfillment of tasks of the State Committee on Defense in production of tank armored bodies, self-propelled artillery and tank aggregate units.

Personal Observations

A tough incisive administrator of limited technical depth, interested principally in economics and efficiency; probably an inner party man and member of the Council of Ministers of the USSR (dating at least from April 25, 1962).

Mr. Petrosyants is a very personable, cheerful man; one who operates smoothly. He was flexible to all changes encountered on the trip. He controlled the members of his party very nicely, seemingly in a friendly manner, except that Mr. Sinev always managed to be late. Some of his questions indicated that he had a fair technical knowledge of certain aspects of reactor design but most of his questions were of policy nature.

SINEV, Nikolay Mikhaylovich

Current Position: Deputy Chairman, USSR State Committee for Utilization of Atomic Energy, Supreme National Economic Council 1961-63

Background: Born 10 December 1906, Vysokoye, USSR; Doctor Technical Sciences

Honors: Awarded State (Stalin) Prize, second class in 1942 for improving the designs of heavy tanks

Personal Observations

Sinev was educated and worked until 1941 in Leningrad. He worked on experimental turbo-jet aircraft engines of 4500 lb. static thrust until 1941 when he was seriously wounded by an aerial bomb. After evacuation from Leningrad and recovery, he worked on heavy tank production in Siberia throughout the war. He has been in work related to nuclear energy since about 1947. Chief present interest is in power reactors and selection of one optimum system for widespread utilization under USSR conditions.

A warm, somewhat coarse, friendly individual, subject to some human frailties but of remarkable physical vitality.

He studied American newspapers avidly and did not avoid reading editorials that were critical of the Soviet Union. He is considered a pleasant person, probably an outer party man and in terms of political conviction, a pragmatist.

It was Sinev, who, the day after President Kennedy's assassination, rose at dinner and from memory recited a most appropriate selection:

"Say not that he has died - he lives!
Though the chalice be broken,
The flame still flares;
Though the rose is plucked,
It still in color blooms;
Though the harp is smashed,
The chord rings on."

ARTSIMOVICH, Lev Andreyevich

Current Position: Member, Institute Atomic Energy imeni I. V. Kurchatov, Academy of Sciences USSR, Moscow 1944-63 (Head, Controlled Thermonuclear Research 1958-61; Head, Plasma Research Department 1962-63); Member, Moscow, Moscow State University imeni M. V. Lomonosov 1955-63 (Head, Chair Atomics Physics and Electron Phenomena 1955-56); Academician-Secretary, Department of General and Applied Physics, Academy of Sciences USSR 1963

Background and Education: Born 25 February 1909, Moscow; graduate of Belourussian State University imeni V. I. Lenin, Minsk; Doctor Physico-Mathematical Sciences

Career: Elected corresponding member of the Academy of Sciences USSR in 1946; elected active member of the Academy of Sciences USSR in 1953; Member, Presidium, Academy of Sciences USSR 1957-62; Academician-Secretary, Department of Physico-Mathematical Sciences, Academy of Sciences USSR 1960-61

Scientific Specialties: Nuclear Physics; controlled thermonuclear reactions; cosmic electrodynamics; plasma physics; electromagnetic wave pencils and light rays for space communication; electronic optics; theory of chromatic aberrations of the electron optical system; radiation losses in the betatron; shock; x-ray quanta; high-energy electrons; Bremsstrahlung effect; pulse discharges

Travel: Attended the Symposium on Electromagnetic Phenomena in Cosmical Physics, Stockholm, Sweden, August 1957; attended Fifth International Conference on Ionization Phenomena in Gases, Munich, West Germany, August 1961; attended Conference on Plasma Physics and Controlled Nuclear Fusion Research, Salzburg, Austria, September 1961; attended Tenth Pugwash and Ninth COSWA Conference of Science and World Affairs, London, United Kingdom, August 1962; attended Conference on Low Energy Nuclear Physics and Meeting of the Chulham Laboratory Study Group on Plasma Instabilities, Harwell, United Kingdom, September 1962; attended Meeting of the Science and World Affairs Continuing Committee, London, United Kingdom, February 1963; attended Eleventh Pugwash and Tenth COSWA Conference of Science and World Affairs, Dubrovnik, Yugoslavia, September 1963

Honors: Awarded Lenin Prize in 1958 for research into the problem of obtaining high-temperature plasma by means of powerful discharges into gas; reportedly won State (Stalin) Prize in 1953

Personal Observations

A man of remarkable independence of thought, of amazing breadth of knowledge of history, a cynic with deeply repressed human, typically Russian, warmth that occasionally can be enticed to show itself at the surface of the personality. In addition to his eminence as a physicist, he could well have become an eminent historian or philosopher.

Shortly after President Kennedy's assassination was announced, Artsimovich was asked whether he still thought that natural sciences were more important than some science to interpret and control human beings. He replied:

> "If some such social science were possible, it would be most important right now--but human beings are unpredictable and human history is a series of random, illogical events."

BOGOLYUBOV, Nikolay Nikolayevich

Current Position:	Head, Laboratory Theoretical Physics, Joint Institute Nuclear Research, Dubna 1956-63; Member, Mathematics Institute imeni V. A. Steklov, Academy Sciences USSR, Moscow 1949-62 (Head, Department Theoretical Physics 1949-60); Academician-Secretary, Department of Mathematics, Academy of Sciences USSR 1963
Background and Education:	Born 21 August 1909, Gor'kiy, RSFSR; Doctor Physico-Mathematical Sciences
Career:	Elected active member of the Ukrainian Academy of Sciences in 1948; elected active member of the Academy of Sciences, USSR in 1953; head, Chair Theoretical Mechanics and Statistical Physics, Moscow State University imeni M. V. Lomonosov 1953-60
Scientific Specialties:	Non-linear mechanics; kinetic theory of gases; theory of superconductivity; direct methods of the calculus of variations; relativistic quantum field theory; asymptotic methods in theory of non-linear oscillations
Travel:	Head of the Soviet delegation to the International Congress on Theoretical Physics, Seattle, Washington, September 1956; attended the following: International Conference on Many-Body Problems, Utrecht, Netherlands, June 1960; Tenth Annual Conference on High Energy Nuclear Physics, Rochester, N. Y., August 1960; Tenth International Conference on Applied Mechanics, Stresa, Italy, August 1960; Eighth Conference on Science and World Affairs, Stowe, Vermont, September 1961; National Academy of Sciences Annual Meeting, Washington, D. C., September 1961; Eleventh International Conference on Science and World Affairs, Dubrovnik, Yugoslavia, September 1963
Personal:	Speaks English
Honors:	Awarded State (Stalin) Prize, first class in 1946 for scientific works in the field of statistical physics; awarded Lenin Prize in 1958 for development of new methods in quantum field theory and statistical physics which served as a substantiation of the theory of superviscosity and the theory of superconductivity

Personal Observations

Academician Bogolyubov is the author of numerous scientific papers of which 31 are indexed in Nuclear Science Abstracts alone for the period 1957-1961.

He is a person of broad knowledge and thought but who, unlike Artsimovich, is placid emotionally with all mental energies concentrated on scientific questions.

KAZACHKOVSKIY, Oleg Dmitriyevich

Current Position:	Member, Institute of Physics and Power Engineering, Obninsk 1948-63 (Head Engineer, BR-5 Fast Reactor 1960-61; Deputy Director, the Institute 1963)
Background and Education:	Born 3 November 1915, Dnepropetrovsk, UkSSR; graduate of Dnepropetrovsk State University imeni 300th Anniversary of the Union of Russia and Ukraine 1938; advanced study at Dnepropetrovsk Physico-Technical Institute, Dnepropetrovsk State University 1941; Doctor Physico-Mathematical Sciences 1958
Career:	Member, Moscow Engineering Physics Institute 1958-61 (Associate Professor 1958; Member, Chair Physics 1961)
Scientific Specialties:	Fast neutron reactors; atomic power stations, economics of nuclear fuel; BR-5 reactor; thermal shocks at the fuel-element jackets; plutonium; radiative capture cross sections
Travel:	Member of the Soviet delegation to the First International Conference on Peaceful Uses of Atomic Energy, Geneva, Switzerland, August 1955; attended Fifth World Power Conference, Vienna, Austria, June 1956; member of the Soviet delegation to the Second International Conference on Peaceful Uses of Atomic Energy, Geneva, Switzerland, September 1958; visited Burma, Thailand, Indonesia, Ceylon, January-February 1959 as one of a group of Soviet atomic specialists; inspected atomic energy installations in the United Kingdom, January 1960; attended inauguration of five new nuclear installations at Trombay, India, January 1960
Honors:	Awarded Lenin Prize 1960 for participating in scientific research on nuclear reactor physics using fast neutrons
Remarks:	Member of the Communist Party of the Soviet Union since 1943

Personal Observations

Kazachkovskiy is a person of restrained and gentlemanly manner, in the British tradition. He is, of course, well known for his work with fast reactors and in many respects appeared to be the most versatile member, at least in technology, of the entire delegation.

He was willing and able to converse on a wide variety of subjects, including literature, aviation, the War, automobiles and old American comedians like Buster Keaton and Harold Lloyd. He had been in the artillery through the entire battle of Stalingrad and remembered well the "Boston" airplanes given to Russia by the United States (Douglas B-26 twin-engined bombers).

AFRIKANTOV, Igor' Ivanovich

Current Position:	Scientific Consultant, USSR State Committee for Utilization of Atomic Energy, Supreme National Economic Council 1960-63
Background:	Born 21 September 1916, in Pushkarka, Gor'kiy Oblast, RSFSR
Scientific Specialties:	Co-author of an article on the nuclear ice-breaker "Lenin", published in 1958
Travel:	Visited Norway in May 1958 at the invitation of the Institute of Atomic Energy; attended Second International Conference on Peaceful Uses of Atomic Energy, Geneva, Switzerland, September 1958
Personal:	Was a delegate to the 22nd Party Congress, CPSU, October 1961

Personal Observations

Afrikantov is also Professor of mechanical engineering at the Gor'kiy Technical Institute. Formerly group leader in charge of design of reactor and equipment installation in icebreaker "Lenin".

Spent World War II in defense work in the city of Gor'kiy.

Intrinsically a gay, friendly individual with great interest in the U. S. and the American way of life, but apparently one of the least politically informed members of the delegation.

YAKOVLEV, Grigoriy Nikolayevich

Current Position: Head, Radiochemical Laboratory, Scientific Research Institute Atomic Reactors, New Melekess 1963

Background: Born 16 December 1914, Rostov, RSFSR

Career: Member, Institute Atomic Energy imeni I. V. Kurchatov, Academy Sciences USSR, Moscow 1957

Scientific Specialties: Separation of plutonium and neptunium; preparation of thin films of transuranium metals by electrolytic method; nuclear spin and magnetic moment; chemistry of americium; methods of remote control in radiochemical laboratories of the USSR; radiochemistry; ion exchange method; spectrophotometry

Travel: Member of the Soviet delegation to the Second International Conference on Peaceful Uses of Atomic Energy, Geneva, Switzerland, September 1958

Personal Observations

Radiochemist in charge of chemical separation of isotopes and the transuranium laboratory at New Melekess; author of many scientific papers on chemical separation of elements.

Yakovlev is a veteran of the siege of Leningrad in which he was seriously wounded early in the war. He is a quiet, mild mannered man who seems to be totally absorbed in the science and technology of chemical separations. He did, however, display an awareness of the political when he mentioned the following:

"After Dr. Seaborg's visit to New Melekess we received a large group of the so-called 'democrats,' from Czechoslovakia, Hungary, Germany, etc. They felt that if we showed New Melekess to the Americans we had to show it to them also. Well, one from Czechoslovakia got so drunk that when they took them for a ride on the hydrofoil ships along the Volga, he fell off and was drowned. You can imagine the fuss that created."

PONOMAREV-STEPNOY, Nikolay Nikolayevich

Current Position:	Member, Institute Atomic Energy imeni I. V. Kurchatov, Academy of Sciences USSR, Moscow 1961-63 (Deputy Head of a Section 1963)
Background:	Born 3 December 1928, Pugachev, RSFSR
Scientific Specialties:	Design of power reactors; fast-neutron flux; temperature of a fuel element; reactor zone profiling
Travel:	Member, Soviet delegation visiting atomic sites in England, May 1961; member, Soviet delegation visiting scientific research institutes in the German Democratic Republic, December 1961

Personal Observations

Group leader in reactor core design at Kurchatov Institute. Author of a number of papers on core design.

The youngest member of the delegation, he appeared to be the happiest as well.

RATNIKOV, Nikolay Timofeyevich

Current Position: Head of a Section, USSR State Committee for Utilization of Atomic Energy, Supreme National Economic Council 1963

Background: Born in 1920 in Gorokhovets, RSFSR

Travel: Attended European Organization for Nuclear Research (CERN) Symposium on High Energy Accelerators and Pion Physics, Geneva, Switzerland, June 1956; attended Second International Conference on Peaceful Uses of Atomic Energy, Geneva, Switzerland, September 1958

Personal Observation

Assistant to Chairman Petrosyants, with exact duties and responsibilities not clear; exhibits a great knowledge of personnel in the Soviet nuclear energy program with details of their location, recent transfers, state of health and current scientific tasks. Ratnikov has traveled more widely in the Soviet Union than any other member of the delegation except, possibly, for Mr. Petrosyants.

Ratnikov was in the battle of Stalingrad and alluded to other traumatic experiences but which he did not explain.

He was the only member of the delegation to voice dogmatic opinions about the U. S. and to exhibit the preconceived notions about stereotyped "monopolists," "profiteers," "suppressed workers," etc. He exhibited, at times, extreme nervous tension.

Although he was clearly the least qualified and least educated member of the delegation he nevertheless seemed to command a comparable income. Although his manners were boorish and his speech coarse, he nevertheless did show some friendliness and appreciation toward the end of the trip for the reception accorded him in the U. S.

BELOV, Anatoliy Ivanovich

Current Position: Reviewer and Interpreter for USSR State Committee for Utilization of Atomic Energy

Background: Born 10 August, 1930, Gzhatsk, USSR

Remarks: Served as interpreter for the Soviet delegation. No further information available

Personal Observations

An energetic, friendly young man with an apparently sincere desire to improve Soviet-American relations.

REVIN, Valentin A.

Current Position: Third Secretary, Scientific Division, Soviet Embassy, Washington, D. C; assumed his position in June 1963

Background: Born September 16, 1932; married

Scientific Specialties: Two articles written by a man by this name "The determination of the Separation Factor for Lithium Isotopes in Ion Exchange". "The determination of the Height Equivalent to the Theoretical Plates in Counter-current Ion Exchange". Authored this article in 1961 at the Moscow Chemical Institute imeni D. I. Mendeleev

Personal Observations

Revin was one of the first exchange students from the USSR to the United States and studied in 1959-1960 at the University of California.

He is a friendly, gentlemanly person apparently well disposed toward the United States.

V. TECHNICAL IMPRESSIONS

The technical impressions set forth below are general in nature and are included as a supplement to the information provided in the preceding sections which was largely developed from observations submitted by individuals assigned at the atomic energy facilities visited.

Nicolai Sinev told Dr. Frank Pittman, Director, Division of Reactor Development, that the principal consideration in Soviet economic analyses at this time is capital investment, which must be kept to an absolute minimum in the nuclear energy field because of vast competing demands. This was, of course, stated in another way by Chairman Petrosyants in his speech at New York on November 20, in which he pointed out that the Soviet Union has both fossil fuel and hydroelectric resources for power production that are in competition with nuclear energy for the limited available investment capital.

The following points appeared to be the areas of keenest technical interest to the Soviet visitors:

1. The most economic single system for power production and the economics of converters and demonstration reactors
2. The anticipated doubling time for fast breeders on the U238-Pu239 cycle
3. Technical innovations that pe mit a lessening of capital costs as well as operating costs
4. The use of advanced computers and automated data analysis systems

Power Reactors and Breeders

There appeared to be considerable discussion among the visitors about the reasons for construction in the U. S. of "unprofitable" reactor power stations. To some extent the conditioning of Soviet citizens to expect "private" companies to operate only for reasons of "profit" was no doubt responsible for the doubts expressed about the accuracy of information presented. As a result the visitors frequently repeated questions. It appeared that in every case they were finally convinced of the reasons for a project and of the rationality of those reasons under American conditions.

Kazachkovskiy told Dr. Pittman that Soviet expectations are for a breeding ratio of 1.50 and a plutonium doubling time of about eight years in a fast, U238-Pu239 breeder. This, of course, was in sharp contrast to Dr. Pittman's prediction of breeding ratios of 1.20 and doubling times of 18 to 20 years. It may be wishful thinking on the part of Soviet engineers, but the strong impression was created that they would like very much to avoid construction of any large number of converters and proceed directly to breeding at a rate sufficient for their anticipated growth plans.

In an article in "Atomnaya Energiya," in late 1961, Leipunskiy, Kazachkovskiy and Pinhasik gave some figures for a 750 Mw(th), sodium-cooled fast reactor "under design" in the Soviet Union. Sinev repeated that such a station is "in the works" and "will be built" and that breeding will be attempted. However, Sinev mentioned a thermal power of 1000 Mw.

Sinev, although he spoke a good deal on many topics, often referred to his preference for sodium-cooled systems. The entire delegation seemed to show the liveliest interest in all details of sodium technology from heat exchanger design to costs and inventories of sodium. By contrast, boiling water and pressurized water systems seemed to arouse the keen interest of only some of the visitors.

It was also obvious from remarks made by the visitors, as well as from the Soviet literature, that the power stations under construction in Czechoslovakia and East Germany are to a substantial extent Soviet projects and therefore add to Soviet reactor experience.

Sinev mentioned that consideration of such huge power blocks, as outlined by Dr. Weinberg in his discussion of desalinization reactors, was simply a little beyond Soviet interests at the moment. He spoke of 500 Mw(e) as an optimum for the Soviet for a number of years to come. As to desalinization, the turning of the Northern Rivers (Pechora, Pechenga, etc.) would probably have to come first.

Sinev also mentioned attempts to simplify sodium technology by use of "electron beam heating" rather than resistance heating.

Technical Innovations and Design Details

Chairman Petrosyants was keenly aware of technical details that appeared to him to be different from Soviet practice. He incessantly questioned members of his own delegation about such differences with emphasis on the relative costs of alternative technical solutions to a problem. Members of the Soviet delegation were thus at times on the defensive. At other times, individual members seemed anxious to point out equipment that they felt they needed but had not been granted.

Sinev once said: "When we come to our comptrollers with a request for funds for some item, they say, 'The Americans don't even have such a convenience as yet. Why then are you asking for it?' Now we can say that we have seen it in America."

The number of such technical details that aroused interest and comment was quite large. Among them were the following:

Small-diaphragm-operated valves that controlled sodium flow in the Alkali Metal Laboratory at Brookhaven National Laboratory. The questions here were rather typical for many similar cases: "Were the valves manufactured at Brookhaven or supplied by the vendor? How long does it take to obtain such an item? What is the cost? What materials are used?" The only unusual features of the valves in question were their small size and the apparent fact that while the valve controllers, diaphragms and stems were of standard vendor manufacture, the valve bodies seemed to be of special design, thereby making a hybrid assembly. This apparently did not get by the visitors' eye for technical detail.

The lining employed on the inner walls of plutonium and transplutonium element processing chambers caught Chairman Petrosyants' fancy. He was fairly agitated by the contradiction between Soviet practice of lining such chambers with expensive stainless steel and the alternative shown at Argonne National Laboratory of a layer of vinyl over a base coat of epoxy resin. The chipping away of some of the vinyl and epoxide did not help him resolve the contradiction. It was, however, interesting to note that he quickly detected crevices that had not yet been covered over and could therefore have become collection points for radioactive matter that would be difficult to clean out.

The entire question of safeguards against fire and radioactive contamination seemed to puzzle the visitors. The consensus seemed to be that their "firemen" and "dosimetrists" would not allow some of the materials found in American "hot labs." By contrast, the use of hardhats, not used in the Soviet Union, aroused some humorous comment. All the visitors, however, seemed to feel that the use of hardhats is justified.

The radio-controlled carts in the "hot lab" at Argonne aroused comments of admiration as did many of the auxiliary handling devices seen on the trip. Much admiration was expressed for the finish put on such mundane things as pipe insulation, pump, motor and turbine housings, as well as offices and laboratories. "Your offices are full of things, and somehow gay," said one of the visitors; "Ours are somehow emptier and more somber."

There was a great deal of discussion between Chairman Petrosyants, Yakovlev, Kazachkovskiy and others about the darkening of leaded glass. There seemed to be some confusion about cerium in the glass that the visitors use. Some said that their glass also contained cerium and still darkened while someone seemed to say that cerium content was not controlled. This discussion began in Oak Ridge at the Fission Product Laboratory and continued at the Hi-Level Isotope Source Laboratory at Brookhaven. Yakovlev, at one point, began to discuss his experience with glass darkening but was restrained by Chairman Petrosyants. The impression was created that they have not had sources as intense as the source at Brookhaven, but that they have achieved the integral doses of 4×10^8 rads to glass over much longer periods of time than that required at Brookhaven. Either there is a time effect for darkening or Soviet leaded glass has contaminants that darken it with increasing integral dose.

The Soviet visitors exhibited a high degree of interest in filtration problems and purity requirements for both gases and water. The wide variety of air filtration materials available to Americans seemed to confuse the issue, especially since in the short time available it was difficult to interpret the fine differences between the various stages of filtration and the filter materials. The visitors seemed quite anxious about this and at one of the Idaho facilities their requests for some samples of the "total filter" produced some irritation in the host.

The Sciaki electron beam welder shown to Kazachkovskiy and Ponomarev-Stepnoy at Ames Laboratory aroused their interest as it well might arouse the interest and admiration of any American. Ponomarev-Stepnoy said later that electron beam welders existed in the Soviet Union, as they no doubt do. However, the striking difference in the availability of technical innovations was perhaps epitomized by a subsequent discussion in the bus. Said one of the visitors: "Our people know all about this." "They know, they know," said one of his higher placed compatriots, "but they don't do." The rapidity with which private companies seize upon technical innovations in the United States and transform them into readily available commercial items is undoubtedly very impressive.

The plutonium fuel rods and fertile material rods, with the remote facilities for canning and uncanning shown at Idaho and at Argonne, aroused the keen interest of the visitors. "See!" said Chairman Petrosyants to Kazachkovskiy.

In addition, the visitors were keenly aware of the various fuel possibilities, such as uranium monocarbide, liquid uranium alloys and uranium vapors, and of all the difficulties produced by radiation damage.

Computers

The digital computers and their attendant automatic data input, printout and display systems that we saw at Brookhaven, Berkeley and Argonne invariably aroused the keen interest of the visitors. Kazachkovskiy and Ponomarev-Stepnoy, as well as Bogolyubov, seemed well acquainted with the features of computers and their potential uses. The comments, however, imparted the impression that in the Soviet Union such sophistication in computers was not yet available.

At one point Ratnikov commented, "That is why we have Academgorod. This will be our computer center." He was referring to the new "science city" at Novosibirsk.

One curious dispute occurred among the visitors at the IBM 7094 computer at Brookhaven. The rate of operations for this machine was given as an average of 80,000 arithmetic operations/minute. Afrikantov asked of his group the rate achieved by the M20 Soviet computer. A curious dispute followed in which Mr. Petrosyants insisted that the M20 could perform 20,000 operations/minute while several of the visitors maintained that the M20 really operated at a rate of 8,000 to 10,000 operations/minute.

The CDC-3600 high speed machine shown at Argonne aroused great admiration among the visitors, particularly Kazachkovskiy and Ponomarev-Stepnoy. The scanner mesh of 4096 x 4096 aroused the attention of Kazachkovskiy who was immediately conscious of the fact that this mesh density was almost equivalent to the discriminating powers of the human eye.

The hybridization of an analog computer with an IBM 704 shown at Argonne also won words of praise and admiration for the technical initiative and ingenuity involved.

An inference that is tempting to draw is that although people like

Kazachkovskiy, Ponomarev-Stepnoy, and of course Bogolyubov and Artsimovich, are keenly aware of the potentials of computer systems and well acquainted with their characteristics, they do not have available to them anything like the wealth of equipment they saw in the United States.

APPENDIX A

Address By Chairman Petrosyants

Before Joint Session

Atomic Industrial Forum

And

American Nuclear Society

New York City

Mr. Chairman,
Ladies and gentlemen!

Our delegation, the delegation of the USSR State Committee for Utilization of Atomic Energy has been invited by the managing director of the "Atomic Industrial Forum" Mr. Charles Robbins to attend your esteemed meeting and to present a brief report on the work being done in the Soviet Union for the peaceful use of atomic energy.

My task is made easier by the fact that half a year ago the Soviet Union was visited by the delegation of the Atomic Energy Commission of the USA led by Glenn Seaborg, my host and the host of our delegation.

As you know the AEC delegation had an opportunity to visit many of our research centers, conduct useful talks with many leading scientists and thus receive rather comprehensive information as to what we are doing in various fields of atomic science and engineering. And so, I believe that, first of all, I must discuss some problems of the development of nuclear power in the Soviet Union.

I think that considering the composition of your Forum this will be undoubtedly of interest to the majority of those present here.

Progress of Electrification in the USSR and Role of Nuclear Power

In the general perspective of the further development of electrification in the USSR the nuclear power holds a special place of its own.

To correctly define this place and understand this problem one must proceed from the general tasks and the present development of power industry in the USSR.

It is well known that in its Program adopted at the 22th Congress (in 1961) the Communist Party of the Soviet Union has elaborated the plans for the development of the Soviet power industry over a period of 20 years (1961-1980).

This program envisages high tempoes of power production growth in the USSR:

in 1965 the power produced will equal 520 billion Kwh;
in 1970 " 950 billion Kwh;
in 1980 " 3000 billion Kwh;

For reference:

The total power production in 1960 was 292 billion Kwh, 370 billion Kwh in 1962, in 1963 it will be about 411 billion Kwh.

Thus, it is planned that power production in the USSR will be doubled on an average of every five years. This calls for the high rate of construction and commissioning of new power plants.

Whereas in 1961 the capacity of the newly installed plants was 7.2 million kilowatts, in 1963 this figure will run to 10 million kilowatts and the total installed capacity will equal 93 million kilowatts.

In 1965 the total capacity of all power station in the USSR will reach 113 kilowatts.

A single-shaft 500,000-Kw turbine is to be installed in the Nazarovskaya power station in Siberia and a doublt-shaft 800,000-Kw turbine within the Donbass power grid in the Ukraine in 1965. Boiler units with appropriate steam capacity are being developed for these turbines.

The new power stations are constructed out of large units (boiler-turbine) by standard projects, with extensive use of prefabricated reinforced concrete structures; their capacities run up to 1 million kilowatts and even higher.

All this makes it possible to cut down the capital costs on thermal power stations per one kilowatt of newly installed capacity, the fact that has to be reckoned with by all of us, working in the field of atomic power. However, this is not enough.

As you know hydro-power stations, largest in the world, with a capacity of 2.5 and even 5 million kilowatts each are also being constructed in the USSR (in Bratsk, Krasnoyarsk and other places). The Krasnoyarsk hydro-power station will have 10-12 turbo-generator units each rated at 500 megawatts and above.

The power industry of the Soviet Union is characterized by continued unification into large power systems aiming at creation, in the nearest future, of country-wide power grid. For instance, the unified power grid covering the European part of the USSR accomplishes parallel operation of 50 local power systems with a total capacity of more than 36 million kilowatts. The power stations of the central districts in the Urals and in the South of the country are interconnected by powerful transmission lines with a voltage of 500 kV. The first part of a D. C. transmission line with a voltage of 800 kV between Volgograd and Donbass extending over 375 km was commissioned in 1962.

The Soviet Union is extremely rich in organic fuel (coal, oil, gas, peat) and in hydro-power sources. For hundreds of years to come we are not threatened by fuel hunger.

However, due to the non-uniform distribution of fuel resources over various regions of the country and considering the fact that the most economical and cheapest coals are located in the East, ever increasing amounts of fuel will have to be brought to the European part of the USSR from distant places and superdistant high-tension transmission lines will have to be built on an ever growing scale from Siberia and the Middle East in the coming twenty years and, especially, after that period.

Under these conditions the development of atomic power industry in the European part of the USSR offers particularly promising results.

Moreover, the Soviet Union has a number of vast remote areas in Siberia, Far East and Far North where the power grids will not reach and where the transportation of fuel is difficult and costly. Therefore from the technical and economic point of view these areas are highly suitable for widescale employment of atomic power stations of low and medium capacity.

The use of small and medium atomic power plants in the remote and Arctic regions of the country will play an important role in the development of natural resources, in the further growth of the national economy in the Far North of the Soviet Union.

With the tempoes of the power industry growth which have been achieved so far and are planned for the coming twenty years the atomic power industry, within a certain period of time, will merely supplement the conventional power sources where this is economically warranted, but the basis of the Soviet power industry will, for a long time, be formed by large thermal stations using organic fuel and by hydro-power stations.

Nevertheless, we aim at creating such atomic power industry which, in the coming ten years, will be more economical, at least for the conditions existing in the European part of the USSR, than thermal stations using expensive Donbass coal or other types of fuel brought from faroff places or the energy delivered by means of superdistant transmission lines.

To achieve this, two basic conditions must be fulfilled:

1. The atomic power must be developed on a large scale; this implies development, selection and continuous improvement of not more than two types of the most efficient reactors on which the serial production and construction will be based.

2. Considering the progress of the conventional large-scale power industry which has been scored up to now and which is envisaged for the future the atomic power stations in the USSR will apparently be competitive only if they employ large reactor units (above 500 MW) which provide the total capacity of about 1600 MW and above.

The economic analysis of atomic power stations shows that the specific capital expenditure for production of one kilowatt of electric power in an atomic power station can not be discussed absolutely or comparatively without considering the capital expenditure involved in the fuel cycle (extraction, metallurgical treatment, isotopic enrichment, regeneration, manufacture of the fuel element, disposal of waste).

Likewise, when making comparisons with a conventional thermal power station consideration must be given not only to the capital expenditure on the station proper but also on the fuel supply and transport. Economic calculations make it clear that in certain regions of our country the capital expenditures on fuel cycle for atomic power stations are considerably below (by two or three times) the capital expenditure on the fuel supply of conventional power stations.

The beginning of the practical peaceful use of nuclear power was marked by the commissioning, on July 27, 1954 of the atomic power station, first in the world, in the town of Obninsk. This station was equipped with a water graphite reactor. Now as before this station serves as an experimental base for carrying out various physical and nuclear research, particularly into such problems as the nuclear superheating processes, water boiling in heat-transfer passages and so on.

The experience gained from this first station was used in designing the reactors for the Beloyarsk atomic power station named after I. V. Kurchatov, now under construction in the Urals. The first reactor of this station with an electrical capacity of 100 MW, the so-called reactor AMB-1, went critical on September 3, 1963 and at present is at the physical start-up stage. The operation at power will begin at the end of December of this year and the practical employment of this reactor, in which nuclear superheating of steam (up to 510°C) will be used on a wide scale for the first time, will start from 1964.

The second reactor of the Beloyarsk power station, AMB-2, with an electrical capacity of 200 MW is now being constructed and its installation is to be completed in 1965. This water-graphite reactor is a further improvement of Soviet water-graphite reactors of the channel type which first appeared in June 1954. Due to the use of direct cycle the capacity of the second reactor of the Beloyarsk atomic power station (AMB-2) is twice as great as that of reactor AMB-1 though it has the same dimensions and the same number of channels.

Specific features of reactors installed at the Beloyarsk power station are: channel-type design, which makes it possible to obtain practically any desired unit capacities; safety with respect to contamination of the primary circuit by radioactive fission fragments (in emergencies); nuclear superheating of steam which provides possibilities for effective use of supercritical conditions of steam at the direct cycle with large modern turbogenerators.

Before this year expires, or, to be more precise, at the end of November of this year, the physical start-up of the first unit in the Novovoronezh atomic power station is to begin. The pressurized water-cooled water-moderated reactor of this unit has electrical capacity of 210 MW. The construction of the second unit rated at 360 MW will begin at this site in 1964.

The design and physical research carried out in our country suggests the possibilities for considerable improvement of water-cooled water-moderated reactors, further increase of the power output of one unit, lowering of the cost and raising of economic indices.

The Research Institute for Atomic Reactors (in Melekess) under the USSR State Committee for Utilization of Atomic Energy is now building an experimental atomic power station with a water-water reactor of the boiling type (VK-50) rated at 50 - 76 MW. Provisions are made for checking operation both with direct and with dual cycle of steam generation. We plan to complete the construction of this station in 1964 or 1965.

The Soviet Union cooperates with the German Democratic Republic in construction, in the GDR, of a 70-megawatt atomic power station with a water-water reactor using slightly enriched uranium, and with the Czechoslovakian Socialist Republic in building the first atomic power station in Czechoslovakia. The type KS-150 natural-uranium reactor to be installed at this station is rated at 150 MW and uses heavy-water moderator and carbon-dioxide gas coolant, the pressure in the primary circuit being 60 kg/cm^2. At present this station is under construction in the Czechoslovakian Republic. We believe that this type of reactor offers interesting and promising results.

Along with the construction of large atomic power stations to meet the power requirements of the remote regions in Siberia, Far East and Far North, the Soviet Union develops and operates low- and medium-power atomic power stations with various types of reactors: water-water, water-graphite and organo-organic.

The organo-organic reactor of small unitized APS "Arbus" went critical in June 1963 and in August of the same year the "Arbus" began to operate at full design power of 750 Kw.

This installation is a small prototype of atomic power stations designed for use in the Arctic and other remote regions of our country.

For convenient shipping and installation the entire equipment of the station is divided into transportable units weighing from 6 to 16 tons.

The low pressure in the primary circuit, the possibility of using the parts made from carbon steel and small induced activity of the coolant along with the provisions for continuous regeneration of the coolant suggest great possibilities for the use of this type of reactor in small atomic power plants.

During the recent years various testing and research reactors have been, and are being built, in many physical research centers of the USSR in order to solve the problems posed by the progress of nuclear physics, reactor engineering and nuclear engineering. In particular, extensive work is carried out on water-water research reactors with a thermal capacity up to 10,000 Kw, equipped with beams, loops and other facilities for research purposes.

Especially noteworthy is a unique loop reactor SM-2 operating in the Research Institute for Atomic Reactors in Melekess. This reactor is rated at 50,000 Kw, has neutron flux of $2x10^{15}$ neutron/cm^{2}sec and is used for the material testing and for physical and engineering investigations. At present this reactor is unsurpassed in the world in the power of the neutron flux.

Intensive neutron fluxes obtained in reactor SM-2 make it possible to conduct various research connected with the material testing and with the nuclear physics and reactor engineering.

An original fast pulse reactor (IBR) designed for the research work in the field of nuclear physics has been in operation since 1960 at the Joint Institute for Nuclear Research. In this reactor a disc with uranium-235 rotating between plutonium rods at a speed of 5000 r.p.m produces, several times a minute, high supercriticality on prompt neutrons resulting in the appearance of neutron pulses with a flux as high as 10^{18}neutron/cm^{2}sec. This is virtually a neutron whirlwind!

A vast scientific and technical experience has been accumulated in building power reactors. The analysis of Soviet and foreign designs of nuclear power plants and of completed power reactors now in operation shows that with every type of thermal reactor-graphite-water, water-water, graphite-gas or heavy water there are wide possibilities for further development and improvement, for increasing the unit power and lowering the cost along with the methods of roughly equalizing the cost of electric power production.

However, depending on its specific conditions and capabilities each country makes its own choice of one particular type of the reactor on which it bases the national program for the building of nuclear power industry over a definite period of time.

We, in the USSR, have not yet adopted any long-term program for the development of atomic power and are still carrying on extensive investigations of all technical and economical aspects of this problem. We do not show any undue haste as the large natural resources, rich deposits of conventional fuel (coal, oil, gas, peat, etc.) available in our country permit us to prepare for the building of atomic power industry with more thoroughness and without any haste.

Perhaps it would be timely to direct greater efforts to solving a more difficult and time-consuming problem of building breeder reactors.

The main road for the wide development of nuclear power industry, its main perspective is inseparably tied in with the fast breeder reactors.

The development of large fast power reactors poses a large number of scientific and technical problems which involve an extensive and expensive program of research and development.

Our scientists and engineers have done much theoretical and experimental work on the fast reactor physics, methods for calculation of these reactors, refinement of constants, kinetics and problems of safety.

Fast reactors BR-1 with a thermal capacity of 50Kw and BR-2 with a capacity of 150 Kw have been built in the USSR Physicoenergetics Institute (Obninsk) for fast reactor physics.

A test fast reactor BR-5 with plutonium-oxide fuel elements and sodium coolant was commissioned in 1958. The thermal capacity of this reactor is 5000 Kw. The five years of successful operations of this reactor have confirmed that the line of research the use of ceramic nuclear fuel and sodium coolant has been chosen correctly. It is now planned using this reactor, to study the specific features of uranium monocarbide and find out whether it can be used as fuel. Preparation of monocarbide core will be soon completed.

A special test stand BFS has been built in the same Physicoenergetics Institute for the research on the physics of large fast power reactor cores.

The compatability of materials and of the corrosive effects of liquid sodium are thoroughly investigated on the thermo-physical and engineering liquid-metal stands; these stands are also used in developing the instruments and equipment of reactor installations in liquid sodium at working temperatures necessary for large fast reactors.

The experience obtained as a result of all work carried out in the field of fast power reactors makes it possible to begin designing large fast reactors for power production, which might provide the basis for the future wide employment in the power industry.

At present we are developing an atomic power plant with a fast reactor rated at 300 MW having a breeding factor of about 1.5. The reactor will use a sodium coolant with an outlet temperature of 500°C.

We hope to build one or two such reactors and gain some experience in their operation by 1970. Design outlines are being made for fast reactors of still greater capacities.

I would like to make a special mention of the construction and 4 years of operation of the world's first peaceful atomic-powered ship - the icebreaker "Lenin".

The use of atomic power on the icebreaker has proved highly successful in the conditions of the Soviet Union. The rigorous Arctic nature, short time during which various areas are accessible, the need for a large number of fuel bases hinder the development of the natural resources on the vast territories of the Far North of the Soviet Union.

The atomic power plant has made the icebreaker "Lenin", the first in the world, a fully self-contained ship capable to accomplish any sea-going missions without calling at any ports for refuelling.

The wide use of atomic power on icebreakers along with the building of small atomic power plants in the Far North will undoubtedly help the speedy development of these areas.

The nuclear power plant of the icebreaker "Lenin" is fine achievement of Soviet scientists, technicians and workers.

The power plant of the icebreaker consists of three identical reactors each with a thermal capacity of 90 MW. The reactors are of the pressurized water type similar to the reactor installed at the Novovoronezh atomic station which was also designed under the guidance of Kurchatov Atomic Energy Institute.

In the reactors of the icebreaker "Lenin" the ordinary water at a pressure of 20 kg/cm^2 functions as a neutron moderator and as a coolant. The steam produced by the steam generators is fed to four D. C. turbogenerators which power the propulsion motors. The total power developed by the turbines of the "Lenin" icebreaker is 44,000 h.p. with all three reactors operated at 70% power or with two reactors operated at full power.

Each reactor is loaded with 80 kg of enriched uranium-235. This amount of fuel permitted the icebreaker to sail for three years without fuel reloading. At the present time the "Lenin" icebreaker whose reactors received the second load of the fuel is engaged in the fourth, the most strenuous navigation in the seas of the North Arctic Ocean. During this year alone (as of the 10th of November) the icebreaker has covered above 11,000 miles, out of which 9500 miles was of heavy ice, and has brought through more than 80 ships.

In the first part of 1963 the fuel was changed in all three reactors after the total power produced reached 25,000 MW.

Up to now the icebreaker "Lenin" has covered 61,000 miles (110,000 km) and has brought more than 200 ships through heavy ice. The experience of these four navigations proved that an atomic-powered icebreaker can sail in any season of the year and all year round.

The constant displacement and the possibility to operate at a large power whereever necessary without any fear of running out of fuel determine the enormous advantages of an atomic-powered icebreaker over modern icebreakers with diesel-electric power plant which consume huge amounts of fuel in the course of one navigation.

The old types of icebreakers (diesel-driven) have to waste a considerable part of time, so valuable during arctic navigation, waiting for better ice conditions. These icebreakers could take through ice caravans of transport ships when the ice thickness did not exceed 70 - 90 cm, and were unable to give any help to transport ships when the ice reached two points. The "Lenin" icebreaker retained the full maneuverability and remained completely operative under similar or even heavier conditions.

APPENDIX B

Address By

Academician Artsimovich

Princeton University

Experimental research on the physics of high-temperature plasma is being conducted in the Soviet Union on a very broad front. The basic purposes of this research are:

1. To determine the conditions under which plasma can--at a high temperature--be maintained in a state of stable equilibrium;

2. To develop effective methods for heating plasma.

It would be extremely difficult for me to give an adequately complete picture of the research into the physics of high-temperature plasma being conducted in our country, because this work is being carried out in a variety of different directions.

I shall therefore limit myself to telling you something of the results achieved during this past year at the Institute for Atomic Energy, and I shall select those lines of research which, it seems to be are making a significant contribution to the solution of problems involving the stability and heating of plasma.

First of all I should mention the work in which plasma behavior was studied in magnetic fields having a so-called hybrid geometry. At the basis of this direction of research there lies a clearly new physical idea. And its substance is this:

Plasma can retain its high temperature only if it occupies a confined area in space, and is in contact--on all sides--only with a high-level vacuum. Such a suspension of a plasmoid in a vacuum can be accomplished with the aid of a magnetic field. The duration of plasma retention may be of sufficient length if conditions exist which are needed to insure a stable equilibrium of the plasmoid. If we take into account the fact that a volume of plasma confined in a magnetic field is analogous to a liquid dia-magnetic of very low density, then we can see at once one natural condition for plasma stability: the intensity of the magnetic field must increase in all directions from the area occupied by the plasma. An analysis of the laws of motion as they apply to particles of plasma confined in magnetic fields, gives us one more condition. It can be formulated as follows: The intensity of the magnetic field inside the area in which the plasmoid is confined, must not become zero. In the vicinity of those points in space where the intensity of the field passes through zero, certain general laws which cover the smooth travel of particles in a magnetic field, are violated. Such areas, in a way, can then be regarded as centers of particle scattering. And the existence of such centers would cause an intensive escape of plasma particles.

The simplest way to create a magnetic system satisfying the above two requirements, and therefore, a priori, guaranteeing a stable confinement of the plasma, is shown on Fig. 1. The magnetic system, in such cases, consists of coils A and B, through which current flows in the same direction, and rectilinear conductors, arranged symmetrically around the common axis of the two coils. Considered individually, such coils set up what is known as a "mirror type" magnetic field. The energy lines of such a field are shown on Fig. 2a. In this case, the intensity of the magnetic field increases on either side of the lines of force, but declines in the radial direction, i.e. away from the axis. Meanwhile, alternating current flows in the straight-line conductors, setting up a magnetic field the structure of which is shown on Fig. 2b.

As a result of the superposition of both magnetic fields, the magnitude of the resulting vector H increases in all directions from the center of the area intended to be filled with plasma. Experiments with magnetic systems of such type (we shall call them hybrid traps) were begun by M. S. Ioffe and his co-workers at the Institute for Atomic Energy as far back as 1961. To fill the trap with high-temperature plasma, the method used was one which had been evolved earlier and which is known under the name of ion magnetron. Plasma created as a result of the ionization of a gas, (hydrogen or deuterium) by the flow of electrons from the heated cathode inside the small discharge area (located in the axis of the system, behind one of the magnetic mirrors), spreads in the direction of the magnetic field, forming a stream of concentrated plasma (see Fig. 3 for a view of the cross section of an experimental installation). Between this plasma beam, acting as anode, and the wall of the chamber, there is applied--for a short time interval (20 to 30 microseconds)--an electric current on the order of 30 to 40 kv., which draws the ions out of the plasma and accelerates them. After this current is applied, the plasma beam splatters, so to speak, and the trap is filled with fast ion plasma. The energy of these ions, after the current has been cut off, is on the order of several kev.

The purpose of these experiments was to investigate the properties of the trapped plasma after the current had been cut off--and, above all, to determine the length of time for which it had been possible to maintain the existence of the trapped plasmoid. The basic results of these experiments, carried out this year on an installation with a hybrid magnetic field, known as PR-5, are shown on Fig. 4a, b, and c.

The first drawing shows how, in the presence of a good vacuum, the concentration of plasma trapped in the magnetic field of a hybrid trap, changes as a function of time (Curve 1). For comparison purposes, a dotted line shows the disintegration of the plasma in the case when current is applied to the rectilinear conductors and the magnetic field is created only by the basic coils (this is the field of a simple trap with magnetic mirrors). The average life of the plasmoid in a hybrid trap, with a vacuum on the order of $1 \cdot 10^{-8}$mm. is about 50 milliseconds. With an ordinary mirror trap this time does not exceed 100 to 150 microseconds. Fig. 3b shows how the time of plasma confinement in a hybrid trap is a function of the residual gas pressure p_0. We find that the value is proportional to p_0^{-1}. From this we conclude that the only process which limits the life of fast ions is transfer of charge of such ions to neutral atoms.

Fig. 3c shows the relationship of the life time of the plasma and the magnitude of the current applied to the rectilinear conductors in the face of an assigned value of the current in the basic magnetic field, set up by the coils.

As can be seen from this drawing, the value of τ jumps sharply to many times its former value after the magnetic field strength from the rectilinear conductors reaches a certain minimum. These results indicate that under the conditions of the experiment as reviewed, the plasma is confined quite stably in the trap. The shape of the oscillograms showing the change in the parameters of the plasma is also indicative of this. High-frequency oscillations, which are the usual sign of the development of instability, are absent in the oscillograms of the measuring equipment.

The significance of these experiments lies in the fact that they prove, for the first time in the entire history of high-temperature plasma research, the possibility of stably maintaining such a plasma (with fast ions) in a magnetic field. Until now, experiments were conducted at an initial plasma concentration from 10^9 to 10^{10} and an ion temperature of approximately 4 kev. Of greatest interest at the present time is an expansion of the information derived toward the realm of high concentrations. It is very important to raise the plasma density level by at least one order of magnitude in order to penetrate that region of concentrations in which, according to theoretical predictions, we may find a new type of instability linked with the building up of plasma oscillations at frequencies close to the Larmor frequencies of ion rotation in a magnetic field. Theoretical analysis shows that this instability may arise in the case where the condition

$$\rho >> \frac{H}{4\pi c^2} \qquad (I)$$

is satisfied, where ρ is the plasma density (the product of concentration and ion mass).

The first steps in this direction have already been taken. In the spring of this year experiments were begun in which the plasma trap was filled using a method somewhat different from the one described above. In the new series of experiments, injection of a plasma with fast ions into a hybrid magnetic field occurs through the use of unique electrostatic instability which may appear, under certain conditions, in the flow of cold plasma and create a natural mechanism of ion acceleration (without the application of high voltage). It was seen that, at certain parameters of the arc discharge which produces the plasma flow, high-frequency electrical fields originate in this flow and lead to the ejection and acceleration of the ions. The average energy of the ions in this case is considerably less than with the use of an external voltage. It reaches approximately 0.5 kev after the arc discharge which creates the plasma flow has been turned off. However, the energy of the ions is not essential for an explanation of the basic question of maintaining stability at increased concentrations. In the first experiments on building up ions from a plasma flow with high-frequency oscillations it was possible to bring the average ion density within the trap to a value of $3.10^{10}cm^3$. This is approximately one order of magnitude higher average concentration than that which was ordinarily achieved using the magnetron method of plasma buildup. Signs of instability are absent as before, although condition (I) is apparently satisfied. It should be emphasized, however, that the above results are only preliminary.

One of the traditional trends at the Institute for Atomic Energy is the investigation of processes of resistance heating of a plasma with quasi-stationary discharges under conditions when the plasma column and current are in a strong longitudinal field, the intensity of which is many times greater than the field intensity created by the natural current of the plasma. /Footnote: This is the basic and very real distinction between the experiments described here and experiments performed with devices similar to the English "Zeta" apparatus./ The strong longitudinal field serves to suppress the more dangerous forms of instability of a plasma column with current. The standard experimental apparatus used in these investigations is schematically shown in figure 5.

A toroidal chamber, within which a ring-shaped plasma column is formed, is set on the cores of an iron transformer. The voltage which maintains the current in the plasma is created inductively. In the tests described, the half-period duration of plasma current varies from 5 to 30 msec for different equipment and different discharge modes. The coils of a longitudinal magnetic field are placed on the toroidal chamber. The intensity of the longitudinal field may be changed within wide limits. Until now, fundamental experiments have been conducted with fields from several kilo-oersteds to 25 kilo-oersteds and current in the plasma from 10 to 70 kilo-amperes.

In order that the plasma formed by a discharge in hydrogen or deuterium not become contaminated by impurities which may be desorbed from the walls, it is necessary to clean the walls by extensive heating. This may be done in a chamber with two walls. The inner wall (liner) is made of thin stainless steel and may be heated either by means of induction currents or by conditioning with frequent electrical discharges. The liner is insulated from the outer shell of the chamber, which is made of thick copper. The thick copper shell is necessary in order that the ring-shaped plasma column and current, which attempts to expand under the action of electrodynamic forces, be kept in equilibrium. Eddy currents originating in the copper shell create a force which compensates for the stretching of the column. The space between the liner and the outer shell is placed under a high vacuum. This construction provides the vacuum hygiene necessary for the experiment but at the same time has one very essential shortcoming. A plasma column hidden behind a number of shells is very difficult to reach with measuring apparatus. This is one of the peculiar examples of the "indeterminancy principle" which so strongly complicates all experimental works on the physics of high-temperature plasmas.

Apparatus of the above design has received the name "Tokomak." An entire series of such equipment has been built. Figure 6 shows the largest installation of this series -- the T-3. It was placed in operation last year. The basic data for this device are: maximum intensity of the longitudinal magnetic field = 40 kilo-oersteds; maximum current in the plasma - 250 kiloamperes; duration of the first half-period of discharge = 10-20 milliseconds. The diameter of the toroidal chamber is 200 cm, and the diameter of the cross-section of the liner is 40 cm. For the purpose of decreasing the interaction between the plasma and the liner surface, the latter contains a molybdenum diaphragm to limit the cross-section of the plasma column. The diameter of the opening in the diaphragm was 30 cm in the majority of experiments with T-3 device.

Before mentioning the present status of research on a stabilized discharge, I would like to say several words on the initial stage of these investigations. In the earlier stages of tests with the first models of the apparatus and at a field intensity from 5 to 10 kilo-oersteds we were unable to obtain plasma columns with a sufficiently high electron temperature.

The conductance of the plasma was no more than 3 to $4 \cdot 10^{14}$ cgse, which indicated an electron temperature not exceeding 10-15 ev The following points were characteristic of the behavior of the plasma column in these experiments:

a) a high intensity of plasma emission at which intense lines belonging to the atoms and ions of different impurities were sharply distinguished;

b) strong, high-frequency oscillations in oscillograms of the electrical parameters of the discharge (figure 7a);

c) a very rapid drop in electron concentration. It began to decrease before the current reached a maximum (figure 7b).

It is natural that, in attempting to explain these peculiarities in the behavior of a plasma, we had to consider different mechamisms of origination of plasma instabilities. Of these mechanisms the classical case of magnetohydrodynamic instability of a plasma column with current was long ago isolated and theoretically investigated in detail. This form of instability is not related to the specific properties of a plasma. It is equally characteristic of any conductor with current which is deprived of rigidity, that is, one which has no resistance to changes in its shape, such as a liquid conductor. Concrete manifestations of this instability are well known. During the passage of a large current, a conductor, first, is divided into staggered sections of expansion and compression and, secondly, it buckles and twists.

The most effective means of combating the development of such deformations is the use of a strong longitudinal magnetic field. The resilience of the force lines of such a field imparts to the conductor placed in it a hardness necessary for stability--under the condition that the intensity of the longitudinal field is sufficiently large in comparison with the intensity of the field produced by the current flowing through the conductor.

For a conductor placed inside a shell with well-conducting walls, the shell also can play a stabilizing role. Foucault currents arising in the shell during shifting of the conductor prevent the development of bending deformations.

Let us consider a ring-shaped filament with cross-sectional radius , and ring radius R located in a toroidal chamber with conducting walls in which produced a longitudinal field of intensity H. Theoretical analysis shows that the quantity $q = \frac{H_z}{H_J}\frac{a}{R}$ is a parameter on which the stability of the plasma depends.

Here H_J is the intensity of the magnetic field of the magnetic field of the plasma current on the surface of the column. If $q \leq 1$, the plasma column must be completely unstable. It will twist spirally and, in so doing, will come in contact with the walls of the chamber (liner).

If $q > 1$, then the most dangerous spiral instability should disappear. In that case, only certain forms of deformation may appear on the surface of the plasma column in which case its axis does not shift. The larger q is, the more effectively all possible forms of classical magnetohydynamic instability should be suppressed. It may be practically stated that for q 4 the plasma filament is guaranteed to be completely free from the effect of classical instability.

In the first stage of the investigations with the "Tokomak" apparatus the intensity of the longitudinal field did not exceed several kiloersteds, and for sufficiently high values of q it became necessary to follow the course of limiting the current in the plasma. As a result of this, the quantity of energy released in the discharge was also limited, and therefore it was difficult to heat the plasma to a high temperature. When q was increased, it was possible to observe a significant weakening of the instability, expressed in a decrease in the amplitude of the oscillations in the oscillograms. However, even for large values of q it was not possible to obtain sufficiently smooth oscillograms; neither was it possible to lesser the speed of the decrease in concentration of charged particles. Therefore, we are inclined to the belief that, besides the simple magnetohydrodynamic form of instability, other mechanisms must exist which do not lead to an instantaneous disruption of the plasma column but gradually "corrode" that column, draining off charged particles to the walls of the chamber. In other words, it could be postulated that we have encountered a phenomenon of "anomalous" diffusion of a plasma. This anomalous (with respect to its speed) diffusion can be conditioned by the very varied mechanisms of instability of the plasma in a magnetic field. A lack of theoretical ideas to explain anomalous diffusion has long existed; therefore, it was possible to consider a large number of possible explanations for the capricious behavior of the plasma column in a discharge chamber, and we immediately considered very seriously the analysis of these possibilities. However, it subsequently appeared that the majority of the effects, which at first were ascribed to the action of "anomalous" diffusion, at the same time resulted from a much simpler cause. This cause is the variable position of the plasma filament relative to the chamber. The plasma filament can be stationary relative to the chamber during an entire discharging process only under certain definite conditions, which, for practical purposes, are never obtained. Under actual experimental conditions the plasma column at the time of discharge moves within the limits of that free space determined by the opeining of the diaphragm. If the column comes in contact with the edge of the diaphragm and continues to move further toward that edge, then - first - a cooling of the plasma occurs, and - second - the radius of the column begins to decrease (the plasma is truncated by the diaphragm). The decrease in the cross-section of the column during its movement can be very significant; therefore, the true value of a will differ considerable from the radius of the opening of the diaphragm. This means that the parameter of stability q, during movement of the column, may decrease significantly compared to the value it should have, the current being equal, for the case in which the plasma occupies the entire free cross-section of the diaphragm.

A decrease in q leads to a development of instabilities, which can be seen in oscillograms of the discharge. Moreover, the decline in the radius of the plasma column when the plasma is exposed to radio waves, gives the same effect as a decline in concentration and hence may be incorrectly interpreted as a manifestation of anomalous diffusion. From the foregoing it is clear that before we can take up the question of laws of plasma diffusion, we must determine the causes which produce displacement of the plasma column and either eliminate these causes or control them accurately during the experiments.

The shifting of the plasma column wi in the toroidal chamber has a number of causes. Among these, one of the principal ones in the majority of cases, is the imperfection of the geometry of the magnetic field. The movement is reflected in the appearance of a component of the outer field which is perpendicular to the direction of the current in the plasma. Let us call this component $H_\perp$. It acts upon a unit length of the plasra column with a force $F = H_\perp \frac{J}{c}$, where J is the energy of the plasma flow (in cgse units).

The force F averaged out over the entire length of the plasma column, causes a displacement of the latter with respect to the chamber. As for the value of $H_\perp$, it is contributed to, in the first place, by the coils of the longitudinal field (due either to construction flaws or to inaccurate positioning); secondly, by scattered fields of the primary transformer winding supplying the discharge, and, thirdly, by the current flowing in the liner. A simple computation taking into account the stabilizing effect of Foucault currents in the copper shell of the chamber upon the movement of the plasma column, shows that in the presence of an average (with respect to cross section) transverse field component $H_\perp$, the column shifts a distance equal to $\frac{b^2 H_\perp c}{2J}$ where b is the radius of the copper shell. With a current of 10 ka. and 25 cm. shell radius, the displacement will amount to $\approx 0.3 H_\perp$. In this case the apparent displacement of the column must be observed at a relatively very low value for the transverse component of external field (recall that the potential of the longitudinal field reaches tens of thousands of oersteds). Aside from transverse fields, another factor causing column shifting may be changed in plasma pressure, caused by heating and also by redistribution of current over the cross section of the column, i.e., a change in the effective value of a. Several simple experiments, carried out about two years ago, ...ly confirmed the hypothesis that filament movement in the chamber is largely the result of those effects which were previously ascribed to the unsolved mechanism of plasma instability. Therefore, steps were taken to decrease as far as possible the value of transverse magnetic fields in operating units. On the T-3, which by this time was already assembled, we confined ourselves to making it possible, with the aid of auxiliary windings, to compensate the mean value of component $H_\perp$ from the winding of the longitudinal field and change this component in value and direction. Compensation of the transverse component of the external field must be carried out with great accuracy, since even relatively very small shifts of a plasma filament in the chamber may be significantly reflected in the properties of the plasma (owing to its interaction with the edges of the diaphragm, which may lead to intense desorption of impurity atoms). Furthermore, a new unit T-5 was constructed with a very carefully prepared longitudinal field winding, built to reduce to minimum the transverse components of this field. Inside the chamber of unit T-5 is situated a system of conductors with which it is possible to control the position of the plasma column, creating field with a preassigned law of change during discharge.

In both T-3 and T-5 the position of the plasma column is controlled during discharge with a system of magnetic probes distributed in the chamber. With the aid of these probes it is possible to measure the momentary position of the axial line of the plasma column with an accuracy of up to several millimeters, and to observe how this position changes during the entire process.

Improvement in the geometry of the magnetic field and utilization of additional windings to compensate led to a significant change in basic characteristics with whose aid it is possible to appraise the behavior of the plasma column. This change was manifested first of all in the character of the relationship of plasma conductivity to the potential of the longitudinal field. Measurements, carried out on Unit T-3 without using $H_\perp$ compensating turns gave a relation of σ to H which is characterized by the presence of a conductivity maximum at $H \sim 15$ kiloersteds. The value σ at maximum during discharge in hydrogen at an initial pressure of 5×10^{-4} to 1×10^{-3} mm is $2 \times 10^{+15}$ cgse (conductivity is calculated on the assumption that the plasma column fills the entire cross section of the diaphragm). By connecting in the compensating turns with the properly selected current strength (proportional to H_0), the conductivity is markedly increased and the maximum on the $\sigma(H_0)$ curve disappears. At $H = 25$ kilooersteds, the value σ, calculated for a column filling the cross section of the diaphragm (i.e., minimized as compared to the true value) comprises $1 - 2 \times 10^{16}$ cgse at the above stated initial pressure. This corresponds to a plasma electron temperature in the range of 100 to 140 ev. These figures themselves are in a sense a record. For the first time a plasma column was obtained with the conductivity of metal.

On units with improved field geometry and compensation of $H\perp$, the oscillograms of all electrical characteristics of the discharge at sufficiently large values of H_z become smooth; i.e., the external symptoms of instability disappear. Also, the nature of the relation of plasma concentration to time is changed. In contrast to a rapid drop in n_e, which was observed earlier, radiointerferometric measurements on the new units do not indicate great decrease in n_e during that interval of time when the discharge current maintains its high value. Therefore, the question on the existence of "anomalous" diffusion still remains open.

However, at the present time it would be premature to assert that in experiments on "Tokomak" units conditions have been definitely established under which a stable plasma filament is formed with a temperature increasing in accordance with the simple laws of Ohmic heating. In order that this assertion be fully justified, it still remains to prove that under the conditions of our experiments the process of the formation of "blown" electrons, i.e. electrons continuously accelerated by the electrical field, does not play a substantial role. If it were found that a considerable portion of the current in a plasma is transmitted by such electrons, then our concept of the process of heating of a plasma should have changed completely. Namely, it would not have been possible to establish an identical connection between the measured conductivity and the electron temperature of the plasma.

At the present time an analysis of the entire aggregate of available experimental data testifies against the concept of the considerable role of processes of continuous acceleration of electrons in "Tokomak" installations, but this conclusion is still not sufficiently convincing. We hope that experiments which are slated for next year will definitely solve this problem.

In addition to clarification of the role of "blown" electrons, it is also necessary to understand the nature of certain peculiar phenomena connected with movement of the plasma filament at the time of discharge. In the course of investigations conducted on "Tokomak" installations quite some time ago it was noted that on the oscillograms of the discharge voltage there exist characteristic features of the "crack" or "break" type (See Fig. 8a). An abrupt, short drop of voltage is not accompanied by a corresponding decrease in the magnitude of the current. On the contrary, at this very moment there is observed a temporary increase in the value $\frac{dJ}{dt}$. Measurements of the position of the plasma filament with the aid of magnetic proves made it possible to establish a direct connection between the "cracks" on the oscillograms of voltage and transpositions of the plasma filament.

Fig. 8b illustrates a time-phased oscillograph voltage curve which shows how the position of the axis of the plasma filament changes with time in the equatorial plane of the chamber. The value of the displacement Δ is computed from the center of the opening of the diaphragm. Positive values of Δ correspond to an outward movement of the filament, i.e., an increae in the radius of the plasma ring. We note that prior to the moment of the appearance of a crack on the voltage iscillogram the plasma filament moves outward. After this an abrupt decrease occurs in Δ i.e., the filament seems to be deflected inward. Simultaneous with the decrease of Δ there occurs a sharp increase in the radius R of the filament cross section. This designates that the inductance of the plasma loop, which is proportional to $R \ln \frac{b}{a}$ drops abruptly. Specifically this is an instantaneous drop of inductance (due to the simultaneou change of and a) and is the cause of the "cracks" on the voltage curve. The origin of these phenomena has not as yet been established. It should be noted that at high values of H_0 and low values of the initial pressure p_0 no special features are observed on the voltage oscillogram.

The next problem of experimental investigations on the "Tokomak" installations is the transition to even stronger fields. Increasing H_0 will make it possible for us to increase the magnitude of the current in a discharge without danger of the appearance of instabilities, and an increase in the current should, in turn, result in further increase in the temperature of the plasma.

FIGURES*

*Figures not available for this report

APPENDIX C

Remarks By Chairman

Petrosyants Upon His

Return To The Soviet Union

Upon his return to the Soviet Union, Chairman Petrosyants was asked by correspondents of the Soviet newspaper IZVESTYA to give his impressions of the stay in the United States. His remarks as set forth in the newspaper article are as follows:

THE PEACEFUL ATOM IS A BRIDGE OF FRIENDSHIP

The program of our trip was a very full one. We visited the main atomic centers of the U.S. and learned about the research work under way at them on peaceful uses of atomic energy. We visited several atomic power plants and took part in the winter meeting of the American Atomic Industry Forum -- a gathering of atomic scientists and industrialists manufacturing equipment for atomic science and engineering. At this meeting I made a report on various Soviet projects in the field of peaceful uses of atomic energy and answered questions. Some members of our delegation studied the scientific research under way at the famous Princeton University where Academician L. A. Artsimovich delivered a very interesting lecture on Soviet research on thermonuclear fusion.

Most interesting, in my opinion, were our visits to atomic power plants: Indian Point with a hydrogen-water reactor, Dresden with a boiling water reactor, Hallam with a reactor on sodium coolant and the Enrico Fermi plant located 40 miles from Detroit. The fuel for this plant is enriched uranium and the coolant is metallic sodium; the reactor operates on fast neutrons.

Among scientific establishments I may mention the Argonne National Laboratory where about 5,000 persons are employed. Interesting research is being done there on the transuranium elements. Of great interest are the studies in the field of radiochemistry. A laboratory is being completed for processing highly active "tvely" -- the heat-releasing elements of reactors. A great deal of work is being done in the U. S. in the construction of several powerful research reactors with high neutron flows.

I consider that the most important result of our trip was the establishment of closer contacts between atomic scientists of both countries and the further progress of our cooperation in this field of science. We reached an understanding on long-term exchange of delegations and scientists, particularly between such organizations as the Institute of Theoretical and Experimental Physics and the Argonne National Laboratory.

Everywhere in the U. S. the Soviet delegation met with a fine and friendly reception.

C[redacted]

C[redacted]

[redacted]

C. A. Nelson, Director of Inspection
ATTENTION: Dr. Marvin Mann

June 22, 1959

Harry S. Traynor, Assistant General Manager

INTRODUCTION OF RADIOACTIVE MATERIAL INTO THE U.S.

Attached herewith are the communications which I received on June 19th from the Acting Commissioner of Customs in my capacity as AEC Representative on the U.S. Intelligence Board. These pertain to the subject which was discussed with you and other members of the AEC on Friday, June 19th.

Subsequent to the meeting in my office, I took up the matter with the Director of Licensing & Regulation, who then contacted you on the telephone.

It is now my understanding that the Division of Inspection, thru the New York Operations Office, and with such contact as is thought to be necessary with the Department of State, will obtain such facts on the introduction of the package in question by Mr. Dorofeev for a determination of what action, if any, should be taken by the AEC.

If you have no objection, I would plan to informally advise Mr. Yeagley of the Internal Security Division, Department of Justice, of the action which the AEC is taking, as well as to inform the members of the U.S. Intelligence Board at their weekly meeting on Tuesday, June 23rd, if such information is requested by members of this Board.

Encls.

1. Cy of memo dtd 6/19/59 - Traynor to Files (CONFIDENTIAL)
2. Distribution List for encls. 3 and 4
3. Cy of ltr dtd 6/16/59 - Actg Comm'r of Customs, Treasury, to J. Patrick Coyne, NSC (CONFIDENTIAL)
4. Cy of ltr dtd 6/2/59 - Asst. Surveyor, Treasury, to Comm'r of Customs, Treasury (CONFIDENTIAL)

Information copies furnished:--

Director of Military Application
Director of Security
Director of Intelligence
Director of Licensing & Regulation
General Counsel

1A1-4 #36

[redacted]

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THE PROVISIONS OF EO 12958, DATED 4/17/95
JRShea
(Declassification Authority Number)
10/20/1997

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