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A BRIEF SUMMARY OF DR. GLENN T. SEABORG'S VISIT TO THE U.S.S.R., AUGUST 1971

Joseph Lewin

[redacted]

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Neutron Physics Division

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Joseph Lewin

JULY 1972

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37830
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Union Carbide Corporation
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Abstract

Dr. Glenn T. Seaborg, at the conclusion of his term of office as Chairman of the U. S. Atomic Energy Commission, visited a number of nuclear research facilities and construction sites in the U.S.S.R. A summary of the locations visited and some pertinent data are presented here.

PROLOGUE

There are several fundamental requirements for a satisfactory spaceship. First, it must have an adequate source of energy which will last throughout the trip. Next, it must have an adequate food supply or means of producing food for the crew throughout the journey. The air and water reserves in the ship must be kept pure and adequate for all needs. Wastes must be reprocessed or disposed of in ways which will not contaminate the ship. And, finally, the crew must not be allowed to increase in numbers and it must remain unified throughout the journey. Divisions into warring rival subcrews or interpersonal conflicts between crew members would be catastrophic in a spaceship on an extended voyage.

"The Earth as a Spaceship,"
from *Man on a Spaceship,*
by William G. Pollard,
The Claremont Colleges, 1967.

Permission received - Monday, December 13, 1971.

INTRODUCTION

This visit to centers of peaceful nuclear science and technology in the Soviet Union concluded the third set of reciprocal visits by chairmen of the U. S. Atomic Energy Commission and the U.S.S.R. State Committee on Atomic Energy.

Each of these visits followed the signing of a Memorandum on Cooperation in the peaceful uses of atomic energy pursuant to agreements between the United States of America and the U.S.S.R. on exchanges in scientific, technical, educational, cultural, and other fields, and each visit has been followed by expanded exchanges of visits by specialists and of information on various aspects of the peaceful uses of atomic energy.

In July 1959, Chairman John A. McCone and his American group visited nine nuclear research sites and the nuclear-powered icebreaker "Lenin." In November of that year, a Soviet group, headed by Vasilii S. Emel'yanov, visited comparable installations in the United States.

In May 1963, Chairman Glenn T. Seaborg led another American delegation that visited eight sites in the Soviet Union, while in November of that year Andronik M. Petrosyants led a Soviet delegation to the United States.

The intervening years also witnessed the steady growth of contacts between the scientific and technological communities of the two countries through attendance at international meetings and congresses and through visits by individual scientists. Appendix A lists the participants and the itineraries of some of the official USAEC-SCAE exchange visits.

In April 1971, Chairman A. M. Petrosyants again led a delegation on a formal visit to the United States. It consisted of the following persons:

A. M. Petrosyants - Chairman, USSR State Committee for the Utilization of Atomic Energy

A. G. Meshkov - Deputy Chairman, SCAE, and Director, Main Directorate for Atomic Generating Installations

N. A. Prozorov - Assistant to the Chairman, SCAE

V. I. Subbotin - Deputy Director of Institute of Physics and Power Engineering, Obninsk

B. A. Semenov - Deputy Chief, Division for International Relations, SCAE

F. M. Mitenkov - Professor, Gorkii Polytechnical Institute

N. I. Yermakov - Section Chief, State Combined Design Institute

V. F. Gordeyev - Chief of Section, SCAE

V. F. Menshikov - Interpreter, Division of International Relations, SCAE

This group visited the following locations:

Oak Ridge National Laboratory in Tennessee

Argonne National Laboratory, National Accelerator Laboratory, Dresden Nuclear Power Plant, and the General Electric Co. Mid-West Fuel Reprocessing Plant, in Illinois

National Reactor Testing Station in Idaho

Liquid Metal Engineering Center at Atomics International in Santa Susana, California

Gulf Energy and Environmental Systems Co. and the San Onofre Nuclear Power Plant in California

Fort St. Vrain Nuclear Power Plant in Colorado

Enrico Fermi Fast Breeder Reactor Installation in Michigan

Indian Point Nuclear Power Plant in New York

The Soviet delegation also had an overflight of the Plowshare (Nuclear Explosives for Peaceful Purposes) Test Site in Nevada, and visited New York City.

The American group that flew to Moscow from London on August 4, 1971, consisted of the following:

Glenn T. Seaborg - Chairman, USAEC

Julius H. Rubin - Special Assistant to the Chairman, USAEC

Robert E. Hollingsworth - General Manager, USAEC

Robert D. Duffield - Director, Argonne National Laboratory

Lombard Squires - Member, General Advisory Committee of USAEC

John J. Taylor - General Manager, Breeder Reactors Division, Westinghouse Electric Corporation

Rodney L. Cool - Department of Physics, Rockefeller University

Edwin E. Kintner - Assistant Director for Reactor Engineering, Division of Reactor Development and Technology, USAEC

Robert L. Hirsch - Controlled Thermonuclear Research Program, Division of Research, USAEC

Joseph Lewin - Engineer, Neutron Physics Division, and Quality Assurance Coordinator for Special Research Facilities, Oak Ridge National Laboratory

At the invitation of Chairman Petrosyants, three American ladies accompanied their husbands on the trip: Mrs. Helen Seaborg, Mrs. Emily Rubin, and Mrs. Maggie Hollingsworth.

We hope that this report contains few errors, but we are sure it must contain some. We offer our apologies for errors of fact, for our misunderstandings and misinterpretations that may be implicit in the text. Finally, we can only hope that this report fits into the framework defined in 1644 by the great English poet, John Milton: "Where there is much desire to learn, there of necessity will be much arguing, much writing, many opinions; for opinion in good men is but knowledge in the making."

LIST OF ABBREVIATIONS USED

AEC - United States Atomic Energy Commission

SCAE - U.S.S.R. State Committee on Atomic Energy

IHEP - Institute of High Energy Physics at Protvino, near Serpukhov

INP - Institute of Nuclear Power at Minsk

JINR - Joint Institute of Nuclear Research at Dubna

APS - Atomic Power Station

SBAPS - Atomic Power Station at Sosnovyi Bor

ITEP - Institute of Theoretical and Experimental Physics, Moscow

IAR - Scientific Research Institute of Atomic Reactors at Melekess

KIAE - "Kurchatov" Institute of Atomic Energy

BAPS - Beloyarsk APS

VVER - PWR-type plants

PPI - Physics and Power Institute at Obninsk

BFS - Fast Critical Facility

NII - Scientific Research Institute

GAE - "Glavatomenergo" - Directorate of Atomic Power of the Ministry of Electrification of the U.S.S.R.

LMFBR - Liquid Metal Fast Breeder Reactor

Geneva I - First International Conference Sponsored by the United Nations Organization on the Peaceful Uses of Atomic Energy, Held at Geneva, Switzerland in 1955

Geneva II - Second International Conference Sponsored by the United Nations Organization on the Peaceful Uses of Atomic Energy, Held at Geneva, Switzerland, in 1958

Geneva III - Third International Conference Sponsored by the United Nations Organization on the Peaceful Uses of Atomic Energy, Held at Geneva, Switzerland, in 1964

Geneva IV - Fourth International Conference Sponsored by the United Nations Organization on the Peaceful Uses of Atomic Energy, Held at Geneva, Switzerland, in 1971

KhTGZ - Khrakov Turbine-Generator Plant

LMZ - Leningrad Metal Plant

SEV - Union of Economic Mutual Aid (the economic cooperation organization consisting of the U.S.S.R. and other East-European countries)

GSSR - Georgian Soviet Socialist Republic

ARMSSR - Armenian Soviet Socialist Republic

RSFSR - Russian Soviet Federated Socialist Republic (note: In general, "SSR" or "SR" following geographic or political area name refers to this sort of acronymic designation)

NAL - U. S. National Accelerator Laboratory at Batavia, Illinois

IRD - International Relations Department

JPRS - Joint Publication Research Service (an agency of the Department of Commerce)

SUMMARY

Within the Soviet Union, the American delegation was provided with a special TU-134 aircraft and crew that whisked the delegation to nine cities over a period of ten days. In the Moscow area, the delegation traveled by bus and auto to the Institute of High Energy Physics, near Serpukhov, and to the Institute of Physics and Power Engineering at Obninsk. The Delegation visited the Kurchatov Institute of Atomic Energy in Moscow.

Dr. Cool visited the Joint Institute for Nuclear Research at Dubna while Dr. Seaborg and Mr. Lewin visited the Institute of Physical Chemistry in Moscow.

On August 16, Dr. Seaborg presented a paper at the International Conference on Organo-metallic Compounds at Moscow State University, while on August 18 he was the opening speaker at the International Conference on the History of Science at that university. In the course of his visit to the Institute of Physical Chemistry, Dr. Seaborg held a seminar on recent developments in transplutonium element research.

Discussions were held with the State Committee on Atomic Energy on the possibilities for further expansion of collaboration in high-energy particle physics research and on possible exchanges of information and visits in the area of fast breeder reactor development.

Dr. Seaborg, Dr. Cool, and Mr. Lewin visited the presidium of the Academy of Sciences of the U.S.S.R. where the possibilities of expanded scientific contacts, as well as joint kilo-BeV accelerator studies were discussed with Dr. M. V. Keldysh, the President of the Academy.

Dr. Seaborg and Mr. Lewin visited the headquarters of the Znanie (Knowledge) Society where Academician Artobolevskii gave a presentation on the purposes and mode of operation of the Society. The possibility of exchange visits with the AAAS was discussed.

The tour thus included elements of many areas of nuclear science -- from stable isotope separation to power reactor construction -- and provided a broad view of the scope, direction, and intensity of nuclear science and technology in the Soviet Union. Although the individual site visits were somewhat hurried a number of salient impressions regarding the Soviet Atomic Energy Program were obtained:

1. Power reactor construction is now in full swing with reactor designs adjusted to Soviet conditions for an interim period of some 25 years while fast breeders are developed and come on-line.
2. The Sosnovyi Bor atomic power station will be the first nuclear two-thousand megawatt (gross) station in Russia. It will use two reactors of the fuel rod bundle in pressure-tube, graphite-moderated type and should start producing power in 1973. The maximum credible accident for this station is the loss of primary coolant due to a rupture of primary piping. However, the entire core does not depend on only one coolant supply and the simultaneous failure of engineered safety devices, and emergency afterheat removal in particular, is considered incredible.
3. The fast reactor program, as exemplified by the BOR-60 operation and the construction of the BN-350 and BN-600, seems to be progressing vigorously. Shevchenko town is an imaginative and impressive concommitant of that program.

4. The radioactive waste disposal problem is judged to be tractable in the Soviet Union to the extent that deep-well disposal of low and intermediate level wastes is advocated on the basis of test operations, and confidence is expressed in dry-strata burial of immobilized high-level wastes after extraction of strontium and cesium.
5. The test reactors exemplified by the MR, the MIR, the SM-2, and the BOR-60 seem to be operating to capacity in irradiation tests of materials and fuels. The BR-5 reactor is undergoing reconstruction to permit operation at 10 MW.
6. The programs devoted to pure research in the physical sciences seem to be expanding steadily with the accommodation of an influx of new, young scientists. This promises to keep the Soviet programs strong and vigorous in years to come.

The schedule of the visit also included a broad spectrum of cultural and sociological programs. In addition, the extensive trips by auto and bus through cities and countryside provided the American delegation with a rich background to the specific site tours so that a kaleidoscopic set of images of a huge and dynamic country was gleaned from the trip. The differences between American and Soviet outlooks also were seen in a better focus.

The generally warm and cooperative atmosphere of the entire visit augurs well for the continuing mutual relaxation of fears and tensions in the peaceful scientific-technical areas of interest that are shared by our two countries.

ARRIVAL

We flew to Moscow's Sheremet'evo Airport from London's Heathrow aboard a Japan Airlines DC-8 that went on to Tokyo after discharging and taking passengers.

Andronik Melkonovich Petrosyants, Chairman of the State Committee on Atomic Energy (SCAE) met us at the plane. With him were people from the State Committee:

I. D. Morokhov -Deputy Chairman of the SCAE, who just two weeks earlier had been the head of a Soviet delegation to bilateral talks in Washington on the peaceful uses of nuclear explosives (Plowshare)

A. G. Meshkov - Deputy Chairman, SCAE

N. A. Prozorov - Assistant to the Chairman, SCAE

S. V. Patrakeev - Deputy Director of the International Relations Department (IRD), SCAE

B. A. Semenov - Deputy Director of the IRD, SCAE

D. P. Philippov - Group Leader of the IRD, SCAE

E. V. Piskarev - Staff Member of the KIAE and formerly IAEA representative at the United Nations Organization in New York

In addition, there was the group that would travel with us during our tour of the Soviet Nuclear sites:

I. G. Timerbulatov - Group Leader, protocol section of the IRD, SCAE

M. V. Naidionov - Interpreter, IRD, SCAE

V. F. Menshikov - Interpreter, IRD, SCAE, who was a familiar figure to most of us from his several trips to the United States

K. D. Biriukova - Interpreter, IRD, SCAE, who accompanied the ladies and arranged their special program of visits

Yu. A. Tumanov - Staff photographer, JINR, who in addition to recording the trip on film did everything he could to make the trip go well

We were also met by Mr. William N. Harben, Scientific Attache at the American Embassy in Moscow.

We drove south toward the city, past the tank barrier monument to the defense of 1941, past the quaint unpainted wooden houses, past the new conglomerations of five- and nine-story houses that over the years have steadily advanced out into the country. To those of us who had not been in Moscow since the early 1960's the most striking first impression was the vastly increased volume of construction.

We stopped at the Sovetskaya Hotel, that elegant 19th century merchants' hostel, reconstructed in 1952, with 12-ft ceilings and carpeted, marble-lined staircase, that at one time served high-level diplomatic visitors exclusively, and now still caters largely to that sort of clientele.

The proposed itinerary turned out to be the following:

Wednesday, August 4, 1971

7:00 p.m.	Arrival at "Sheremet'evo" Airport
8:00 p.m.	Arrival at "Sovetskaya" Hotel
8:15-9:30 p.m.	Dinner at the hotel

Thursday, August 5, 1971

8:00-9:00 a.m.	Breakfast
9:30-10:30 a.m.	Sightseeing - Kremlin grounds, "Armory," and "Diamond Fund"
10:45 a.m.-12:45 p.m.	Travel to Protvino
1:00-7:00 p.m.	Visit to the High Energy Physics Institute and town of Protvino
7:00 p.m.	Depart for Moscow
9:00 p.m.	Arrival at the hotel

Friday, August 6, 1971

8:00 a.m.	Depart for Minsk
10:00 a.m.- 1:40 p.m.	Visit to the Institute of Nuclear Power of the Academy of Sciences of the BSSR
2:50- 6:00 p.m.	Tour of Khatyn' and Victory Hill (Kurgan Slavy)
7:00 p.m.	Dinner at Hotel Jubilee

Saturday, August 7, 1971

7:30 a.m.	Depart for Leningrad
9:00 a.m.	Arrival at the airport of Leningrad and departure for Sosnovyi Bor
10:30 a.m.- 2:30 p.m.	Visit to Leningrad Atomic Power Station at Sosnovyi Bor
2:30- 4:30 p.m.	Travel to and tour of Petrodvorets
4:30- 5:45 p.m.	Lunch break
5:45 p.m.	Depart for Leningrad
7:30 p.m.	Theatre
10:00 p.m.	Dinner at the Hotel Astoria
11:00- 11:30 p.m.	Tour of Leningrad at night

Sunday, August 8, 1971

10:00 a.m.	Sightseeing - museums and Piskarev Cemetery
2:00 p.m.	Lunch at Hotel Astoria
5:00- 6:00 p.m.	Depart for Ulyanovsk
8:00 p.m.	Arrival at the airport of Ulyanovsk
9:00 p.m.	Arrive at the Hotel "Venets" in Ulyanovsk

Monday, August 9, 1971

9:00 a.m.	Depart for Melekess
10:30 a.m.- 2:00 p.m.	Visit to Scientific and Research Institute of Atomic Reactors
2:00- 3:30 p.m.	Lunch break
3:45 p.m.	Depart for Ulyanovsk
5:30 p.m.	Depart for Novosibirsk
11:30 p.m.	Arrive Novosibirsk airport "Tolmachiovo"

Tuesday, August 10, 1971

00:30 a.m.	Arrival at the Hotel "Golden Valley"
10:00 a.m.- 4:00 p.m.	Tour of the Siberian Branch of the Academy of Sciences of the USSR
4:00- 6:00 p.m.	Motorship Excursion on the Ob' Sea
7:00 p.m.	Dinner

Wednesday, August 11, 1971

8:30 a.m.	Depart for Tashkent
10:30 a.m.	Arrive Tashkent airport
11:00 a.m.	Arrival at the Hotel Durmen
12:15- 6:00 p.m.	Visit to the Institute of Nuclear Physics of the Academy of Sciences of the Uz.SSR
6:00- 8:00 p.m.	Sightseeing in Tashkent
8:00 p.m.	Dinner at the Hotel
9:30 p.m.	Motion pictures of Uzbek dance and art at hotel

Thursday, August 12, 1971

9:00 a.m.	Depart for Samarkand
10:00 a.m.	Arrive Samarkand
11:00 a.m.- 1:00 p.m.	Sightseeing
1:00 p.m.	Depart for Erevan
5:00 p.m.	Arrival at Erevan airport
6:00 p.m.	Arrival at Hotel Ani
7:00- 11:30 p.m.	Trip to Gegard, sightseeing in Erevan

Friday, August 13, 1971

10:00 a.m.- 1:00 p.m.	Tour of Erevan Institute of Physics
1:30- 3:30 p.m.	Lunch
3:30- 6:00 p.m.	Sightseeing - trip to Echmiadzin
7:00 p.m.	Depart for Tbilisi
9:00 p.m.	Arrive at Hotel Iveria

Saturday, August 14, 1971

8:30- 10:00 a.m.	Visit to the Institute of Stable Isotopes of the SCAE
10:00 a.m.- 1:30 p.m.	Visit to the Institute of Physics of the Academy of Sciences of the GSSR
1:30- 3:00 p.m.	Lunch break
3:30- 5:30 p.m.	Sightseeing to Georgian historic and cultural sites
7:00- 11:00 p.m.	Dinner. Host - Institute of Physics of the Academy of Sciences of the GSSR

Sunday, August 15, 1971

8:00 a.m.	Depart for Shevchenko
10:00 a.m.	Arrive Shevchenko
10:30 a.m.	Arrive at hotel
11:30 a.m.- 3:15 p.m.	Visit to the Mangyshlakenergozavod and BN-350 reactor
3:30- 4:30 p.m.	Lunch break - tour of city
5:00 p.m.	Depart for Moscow
7:00 p.m.	Arrive Moscow and proceed to Hotel Sovetskaya

Monday, August 16, 1971

9:00 a.m.	Dr. R. Cool only, to JINR in Dubna
9:00 a.m.	Dr. and Mrs. Seaborg and J. Rubin only, to Moscow State University for Vth International Conference on Organometallic Chemistry sponsored by Academy of Sciences, USSR, and the IUPAC
12:00 noon	Dr. and Mrs. Seaborg and J. Rubin to PPI at Obninsk
9:00 a.m.- 7:00 p.m.	Tour of the Institute of Physics and Power (Obninsk)
7:00- 8:00 p.m.	Dinner at restaurant
8:00 p.m.	Depart for Moscow

Tuesday, August 17, 1971

8:00 a.m.- 1:30 p.m.	"Kurchatov" Institute of Atomic Energy
2:00- 4:00 p.m.	Meeting at Headquarters of the SCAE
4:00- 4:30 p.m.	Seaborg interview with representatives of "Moscow News" and "Literary Gazette"
8:00 p.m.	Farewell dinner at Sovetskaya Hotel

Wednesday, August 18, 1971

Departure for some members of the delegation

9:00 a.m.- 2:00 p.m.	To Moscow State University for opening of XIIIth International Conference on the History of Science. Address by Dr. Seaborg on "The History of the Transuranium Elements and an Outlook for Their Future."
3:00- 4:30 p.m.	Dr. Seaborg and Lewin to the offices of the Znanie (Knowledge) Society

Thursday, August 19, 1971

9:30 a.m.	Dr. and Mrs. Seaborg and Lewin to Institute of Physical Chemistry
3:00- 4:00 p.m.	Dr. Seaborg, Dr. Cool, Mr. Lewin - meeting with Drs. M. V. Keldysh, M. D. Millionshchikov, S. G. Korneev at the Presidium Building of the Academy of Sciences
4:30 p.m.	Dr. Seaborg - press conference with representatives of American and European newspapers
7:30 p.m.	Mrs. Seaborg, Dr. Cool, Mr. Lewin to Ostankino Tower - TV transmission tower with observation platform and restaurants
	Dr. Seaborg to dinner of the Academy of Sciences

Not listed here, as it turned out, was the ladies' program that encompassed visits to museums, churches, stores, and schools. Nor could the itinerary reflect the walks, bus, and subway rides at cities on the itinerary and particularly in Moscow that various members of the delegation undertook during the visit.

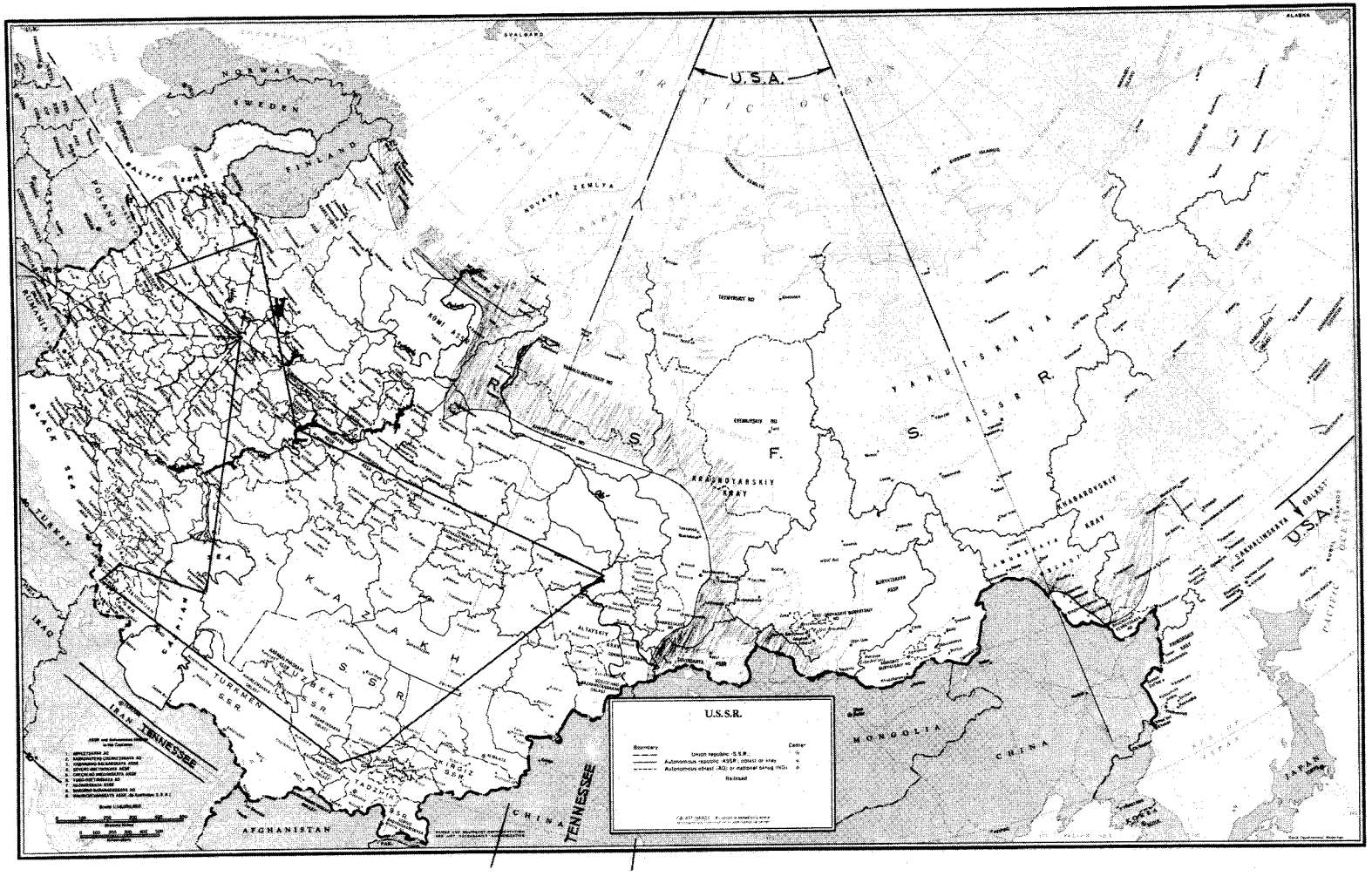
On the morning of the 5th of August, we rode down to the Kremlin and toured the Armory-museum as well as the "Diamond Fund" in the basement. An attractive girl-machine that turned out words as precisely and rapidly as a punch press shears out metal shapes showed us diamonds, gold, silver, and other precious stones, in all forms, stages, and shapes.

Among these were some of the originals of honorary orders of the Czars and of the Stalin period.

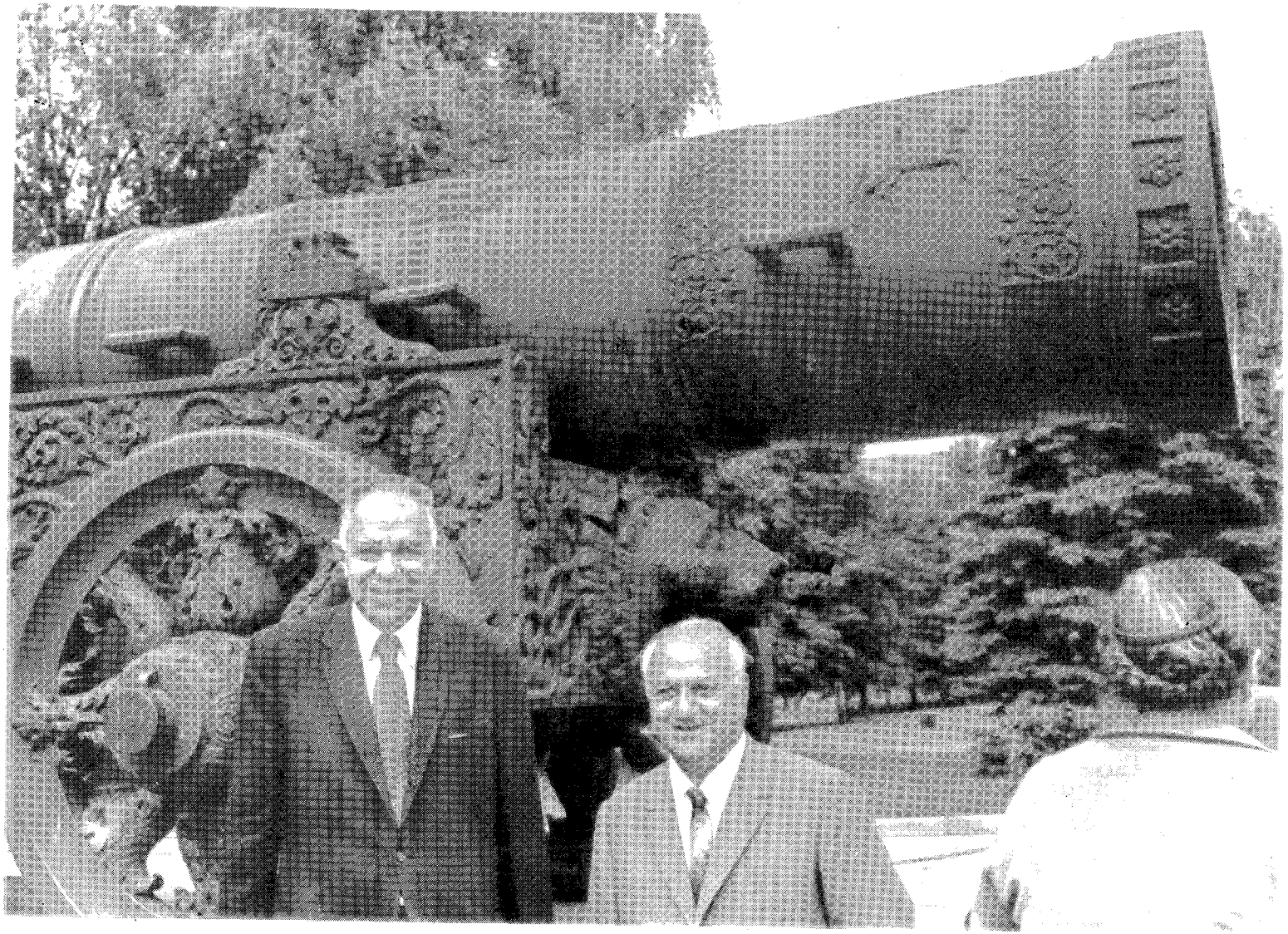
An English-speaking girl named Larissa Aivasova led us through the Kremlin grounds which were thronged with visitors and through the complex of old churches that in the expanding city setting of modern buildings seem to grow more exotic and colorful.

On the morning of August 6, after the previous afternoon's visit to Protvino, we drove out to Vnukovo-I airport. The TU-134 that was to take us around the country was waiting for us. We moved out past IL-18's, TU-104's, IL-62's, and a TU-114 and took off for Minsk.

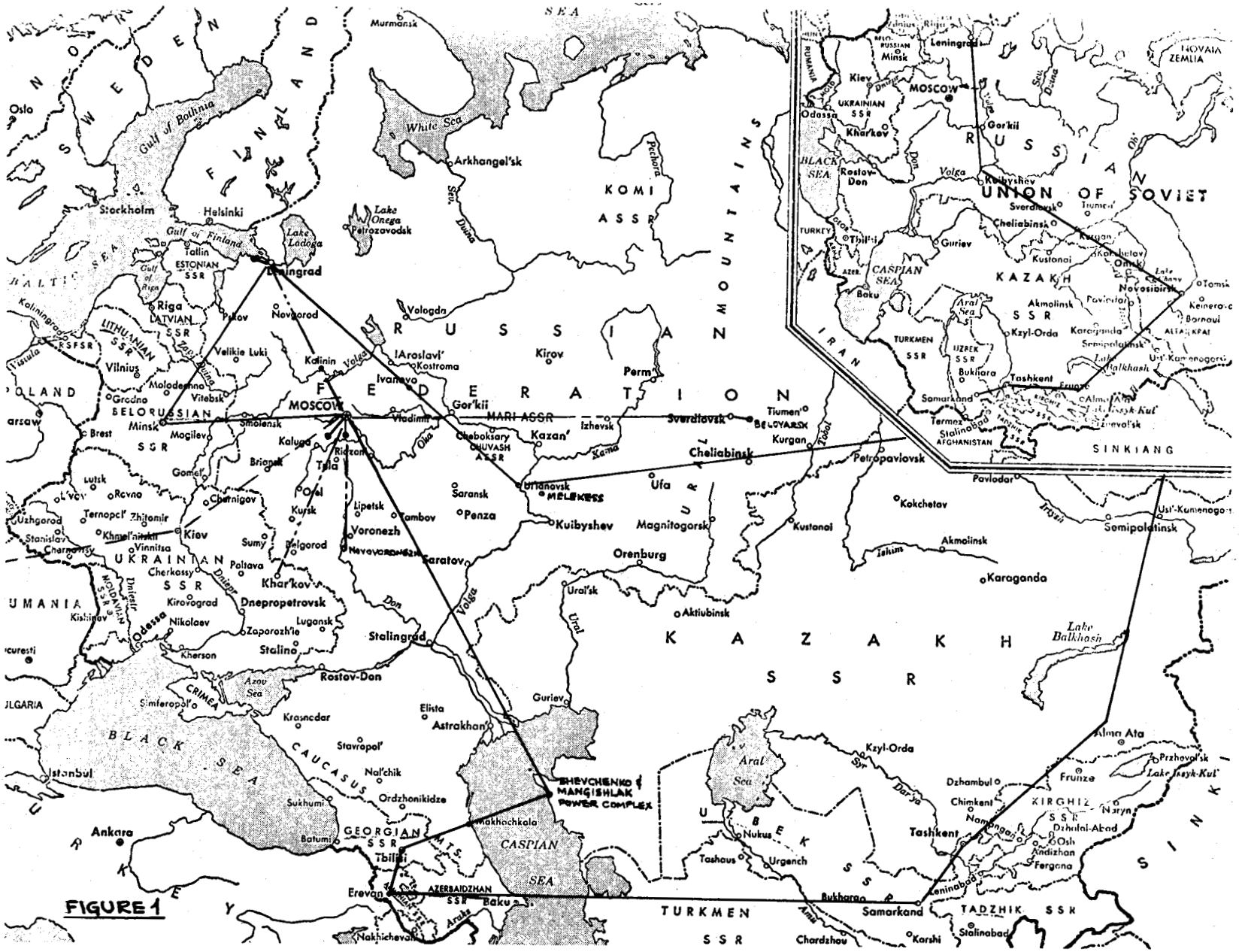
ORNL DWG. 72-6993



Map of U.S.S.R. Showing Locations Visited And Geographic Limits of U.S. and Tennessee in Opposite Hemisphere.



Dr. Seaborg and Mr. Petrosyants at Kremlin's "Czar" Cannon, August 5, 1971.



Map of Trip of 1971 and Some Other Nuclear Locations.

1. Protvino - The "Serpukhov" Accelerator and the Institute of High Energy Physics

This accelerator and the new town in which it is located have been amply described in the literature,[52-54] and at a number of international accelerator meetings. Construction of the accelerator was begun in 1961, and in 1963 the Institute of High Energy Physics was established to operate the machine and to administer the many experiments that would be conducted by various groups. The first beam was circulated in the main ring in October 1967, and in 1970 seven persons were awarded the Lenin Premiums for development and start-up of the 70-GeV machine. These were V. V. Vladimirskii, D. G. Koshkarev, A. A. Kuz'min, A. A. Logunov, R. M. Sulyaev, and I. F. Malyshev. The employment level at the Institute is now about 2,000.

The basic parameters of the accelerator, which will continue to be the highest energy machine in the world until the NAL accelerator begins operation, were published in refs. 54 and 55 as follows:

maximum energy	76 GeV has been reached (70 GeV is nominal)
injection energy	100 MeV
injection current	50 mA
number of protons/pulse	10^{12} (2×10^{12} have been obtained)
number of pulses/minute	8
number of accelerating intervals	54 (RF potential per resonator at each accelerating interval 7 keV)
energy increment per turn	190 keV
average orbit radius	236.14 m
number of magnetic blocks (focusing and defocusing)	120

maximum magnetic field strength	12 kG
magnetic field at injection	76 G
rise time of magnetic field (cycle)	2.6 sec
maximum flat top of magnetic field	1.5 sec
maximum decay time of magnetic field	2.15 sec
maximum rest time	∿1.50 sec
magnetic field tilt control effected to	1/10 milliradian
accelerating electric field frequency	2.6 → 6.1 MHz
power loss in resonators	7 MW
peak power in magnet supply system	90 MW
installed power of synchronous generator drive motors	28 MW

The design beam pulsed intensity of 10^{12} protons at 70 GeV was reached in October, 1968.[54]

We were shown around the accelerator building by Dr. A. A. Naumov. The design intensity has been doubled and 2×10^{12} particles per pulse are now obtained. It is hoped to obtain 5×10^{13} per pulse with the present system. A longer injection pulse system, including drift tube stabilization, now under development, will increase this by a factor of 100. In addition, the vacuum in the ring will be improved from its present value of 10^{-6} mm Hg.

The accelerator has been operating with two internal targets, and a slow beam-on-target deflection system has been in use, as reported in ref. 6.

In March, 1970, a group headed by Dr. Yu. D. Prokoshkin announced identification of an anti-helium-3 nucleus in a secondary beam from the aluminum target.[5]

Attempts to extract a primary beam will be made in the future, but for the present the machine is busy producing secondary beams for experiments. Seven experiments can operate simultaneously on the secondary beams.

Personnel at Protvino (IHEP)

Sulyaev, Roman Matveevich - Deputy Director of IHEP

Naumov, A. A. - Deputy Director of 70-GeV accelerator

Prokoshkin, Yu. D. - Physicist, head of experimental physics of IHEP

Tsyganov, ___ - Physicist

Nurshev, ___ - Physicist

Antipova, Ada - interpreter

Personnel From Other Facilities

Chuvilo, I. B. - Director, ITEP

Baldin, Alexander - Physicist, group leader from JINR

Tatishchev, T. - Physicist of Saclay Laboratory, France

Piskarev, E. V. - Senior Scientist, KIAE

Personnel From SCAE

Petrosyants, A. M. - Chairman

Meshcheryakov, K. N. - Director of department of accelerators

In addition, our traveling SCAE contingent was with us.

The American Delegation and Hosts in the Town of Protvino.

The Town of Protvino

Protvino is south of Moscow, beyond the towns of Podolsk and Serpukhov. In contrast to the latter two, which are old Russian towns with long histories, Protvino was built for the Institute of High Energy Physics and is just ten years old. However, it is a town of about 10,000 persons and is still growing with much construction in evidence, both in the Institute and in the residential areas. An interesting feature of this construction, as well as others that we saw later, is the participation of the Corps of Engineers.

As in other similar cases, the design and construction of the accelerator and Institute, as well as the town in its entirety, was the administrative responsibility of the SCAE. Dr. Meshcheryakov told us that the total cost so far is 150×10^6 rubles. It is, of course, really impossible to translate this to an American scale, but by American standards and the official exchange rate this would seem to be a very low investment for a considerable return.

The town is laid out with broad, straight streets that are lined with trees. It has green-belt and park areas, and the housing seems to be almost exclusively five- and nine-story apartment dwellings. We visited the town's civic center, located in a central shopping area. Since it was late in the day, many people were about and gathered to see Dr. Seaborg and Mr. Petrosyants.

On the way back to Moscow, past huge fields of cabbage and potatoes, we saw nine parachutes emerge from a venerable AN-2 biplane and come floating down to the right of the road where our hosts told us was a large air-sports club. The AN-2 biplane, which we saw at all airports that we visited, is a remarkably ubiquitous and versatile airplane that evoked feelings of nostalgia in some of us.

2. The Institute of Nuclear Power at Minsk

The program of our visit to Belorussia, Minsk, and the Institute of Nuclear Power was outlined by our hosts in a written schedule that was presented to us upon arrival at Minsk Airport. It is reproduced here to serve as a frame of reference, and because it is fairly representative of the scope and pace of our visits to most of the facilities that followed.

Program

Friday, August 6, 1971

9:20-9:50	Arrival at airport and transfer to hotels
9:50-10:25	Check in at hotels
10:25-11:15	Breakfast at the restaurant of the "Jubilee" Hotel
11:15-11:55	Travel from hotel to the Institute of Nuclear Power of the Academy of Sciences of the Belorussian SSR
12:00-12:30	Introductory discussion by the director of the Institute of Nuclear Power, Academician Krasin, Andrei Kapitonovich
12:35-1:05	Visit to experimental installations for research on thermophysical properties of dissociating gases. Presentation by Candidate of Engineering Sciences, Timofeev, Boris Dmitrievich
1:05-1:15	Visit to experimental installations for heat transfer studies. Presentation by Candidate of Engineering Sciences, Kolykhan, Leonid Ivanovich
1:15-1:25	Visit to the experimental installation "Vulkan" for investigation of stability of thermodynamic cycles using a dissociating gas. Presentation by Doctor of Engineering Sciences, Nesterenko, Vasilii Borisovich.

1:25-1:35 - Visit to experimental installation for investigation of heat transfer in bundles of tubes.
Presentation by Candidate of Engineering Sciences, Kolykhan, Leonid Ivanovich.

1:35-1:45 - Visit to the installation "Vikhr'" (The Vortex) for investigation of gas dynamics of dissociating gases.
Presentation by Candidate of Engineering Sciences, Lomashev, Boris Ivanovich.

1:50-2:40 - Brief presentations on power production and radiation chemistry:

1. On the experimental power plant using dissociating gases, BRG-30. Reported by Doctor of Engineering Sciences, Nesterenko, Vasilii Borisovich.
2. On the features of calculations and experiments on heat transfer in chemically reacting nitrogen tetroxide. Reported by Candidate of Engineering Sciences, Tverkovkin, Boris Evgen'evich.
3. On the theoretical and experimental investigations in the field of radiation chemistry.
Reported by Candidate of Chemical Sciences, Nichipor, Genrietta Vladimirovna,and Candidate of Chemical Sciences, Petryaev, Evgenii Petrovich.

2:45-2:55 - Visit to the universal gamma installation UGU-200.
Presentation by Candidate of Engineering Sciences, Borisevich, Valentin Alekseevich.

2:55-3:05 - Visit to the operations and demonstration facilities on the radiation modification of wood products. Presentation by Candidate of Biological Sciences, Vaninskaya, Yuliya Mikhailovna.

3:05-3:35 - Travel from the Institute of Nuclear Power to the "Jubilee" Hotel.

3:35-4:35 - Dinner at the "Jubilee" Hotel restaurant.

4:35-7:30 - Visit to the memorial complex "Khatyn'" and "Kurgan Slavy" (Glory Hill).

7:30-8:00 - Rest

8:00-10:00 - Supper at the Hotel "Jubilee" restaurant

Saturday, August 7, 1971

7:45-8:30 - Breakfast at the restaurant of the Hotel "Jubilee"

8:30 - Depart for airport

9:00 - Take off for Leningrad.

The director of The Institute of Nuclear Power at Minsk is Dr. A. K. Krasin who was one of the co-developers of the AM-1, 5-MW(e) pressure-tube reactor plant at Obninsk. He was director of the PPI at Obninsk from 1956 to 1960[7] when he was made a member of the Academy of Sciences of the Belorussian SSR and moved to Minsk to become head of the Department of Atomic Power of the Heat-Power Institute of the Academy. In 1965 this Department became a separate Institute of Nuclear Power.

The Institute has conducted work in two principal areas: the use of chemically dissociating coolants in reactors, and the use of radiation to achieve chemical modifications in materials. Some reactor physics studies with the use of critical assemblies have also been conducted.[7,38]

The Institute has an IRT-2000 research reactor, a 500,000-gram-equivalent Ra gamma-ray source, a radiochemical laboratory, a complete dissociating coolant laboratory, and the critical assembly laboratory.

The Institute is located southeast of Minsk, a few miles beyond the city limits. Approximately 1000 people work there. The average age of the scientific personnel is in the remarkably low range of 31-32 years.

Dr. Krasin gave the introductory remarks upon our arrival at the Institute to the following effect: The Institute has, from its inception, been interested in the possibilities of gas-cooled reactors. However, this has taken the direction of developing a gas-cooling system that would be superior to helium-cooled ones. (Helium cooling apparently is still under study in an MR reactor experimental loop, as we found out at the Kurchatov Institute.) Chemically dissociating-associating gas processes offer the possibility of obtaining highly increased effective specific heats of the coolant. After an extensive screening study of gases with this property, the chemical compound N_2O_4 was chosen for concentrated study.

After much experimental investigation of the physical and chemical properties of N_2O_4 and its dissociation products NO_2, NO, and O_2 when used as coolant gas mixtures, the Institute has recently made major design studies of experimental and industrial extrapolations of this work.

The BRG-30, a gas-cooled fast-reactor pilot plant of 30 MW(th) and 11 MW(e), has been proposed for construction. (Details were published in ref. 39.) The design calls for turbine inlet parameters of 150-atm. pressure at 510 to 540°C. The power density is 500 to 600 kW/ℓ and the

fuel element cladding temperature is $\leq$ 720° C.

Design studies have been done of a "BRG-1000" to show how a favorable experience with BRG-30 would be extrapolated. A separate design study has been done on chemical industry uses of gamma rays, neutron-alpha particle reactions, and fission products, and an "atomic power-chemical complex" has been defined. Finally, a study was made of the optimum combination of a BRG-1000 and a chemical complex into a "chemo-nuclear" industrial complex.

Institute of Nuclear Power Personnel

Krasin, Andrei Kapitonovich - director of the Institute

Nesterenko, Vasilii Borisovich - deputy director for power producing systems

Salamatov, Il'ya Ilich - deputy director for radiation chemistry

Timofeev, Boris Dmitrievich - scientist, group leader investigating physical properties of dissociating coolants

Kolykhan, Leonid Ivanovich - scientist, group leader investigating heat transfer

Lomashev, Boris Ivanovich - scientist, group leader for gas dynamics studies

Tverkovkin, Boris Evgen'evich - scientist, investigator of heat transfer in systems utilizing N_2O_4

Nichipor, Genrietta Vladimirovna - scientist, chemist in radiation chemistry research

Petryaev, Evgenii Petrovich - scientist, chemist in radiation chemistry research

Borisevich, Valentin Alekseevich - scientist, group leader on UGU-200 gamma facility

Vaninskaya, Yuliya Mikhailovna - scientist, biologist, group leader in wood products irradiation studies

Devoino, Aleksei Nikolaevich - scientific secretary of the Institute

Bilyk, Arkadii Andreevich - administrative assistant of Institute

Sverkov, _____ - scientist in study of chemical reaction kinetics

Belorussian Academy of Science Personnel

Borisevich, N. A. - President of the Academy

Gusev, K. V. - Vice-President of the Academy

Makhach, A. S. - Chief Scientific Secretary of the Academy

Belorussian SSR Government Personnel

Kiselev, Typhon - Chairman, Council of Ministers of the BSSR (by phone only)

Artushevakii, Gennadii - Chairman of the Sciences, Department of the Council of Ministers of the BSSR

Other Personnel

Krasin, Mrs. A. K. - surgeon

Devoino, Mrs. A. N. - biologist

Khrinevich, Evgenia - Deputy Mayor of Minsk

Petrosyants, A. M. - Chairman, SCAE

Patrakeev, S. V. - Deputy Director, IRD-SCAE

Briefing on Work Conducted at the Institute at Minsk.
(l. to r.) Robert Hollingsworth, Glenn T. Seaborg, A. M. Petrosyants, B. D. Timofeev, A. K. Krasin, V. F. Menshikov (back of head in foreground is Mr. E. E. Kintner, person in front of him is one of the hosts)

Members of the Delegation and Hosts at Kurgan Slavy - Memorial to a Battle of World Warr II That Took Place in the Area. (l. to r.) Glenn T. Seaborg, Mrs. Robert Hollingsworth, A. K. Krasin, Mrs. A. K. Krasin, Mrs. J. Rubin, A. M. Petrosyants, Ms. Regina Kristoforova, Robert Hirsch, Mrs. I. I. Salamatov, Mrs. G. T. Seaborg (partly hidden from view), lady host (name unknown), John Taylor, Robert Hollingsworth, lady host at Khantyn', I. I. Salamatov, A. A. Bilyk.

Departure From Minsk.

3. Sosnovyi Bor Atomic Power Station

A 2000-MW(e) nuclear power station is under construction on the shores of the Gulf of Finland in the new town of Sosnovyi Bor. There will be two fuel-rod-in-pressure-tube reactors that utilize a slightly enriched uranium-dioxide fuel, graphite moderator, and light water coolant. This reactor type, plus a series of 440-MW(e) PWR's represent the Soviet large APS commercial construction program for the next five years. The total installed Soviet nuclear generating capacity will be between 8,000 and 10,000 MW at the end of 1975.* Construction of such reactors will continue in European Russia and the trans-Caucasus through 1980 and possibly beyond. Further development will be a 1,000-MW PWR to be built at Novovorovezh and Beloyarsk-type pressure-tube reactors with nuclear superheat of 2,000-MW capacity if suitable materials are developed for the fuel element cladding.

In August, 1971, the Seaborg Delegation found the structures of the principal buildings to be essentially complete and the installations of the reactor and steam-handling equipment in its early stages. Finishing work on the buildings had apparently just begun, so that a considerable intensity of work will be required to meet the power start-up dates of 1973 for the first reactor and 1974 for the second.

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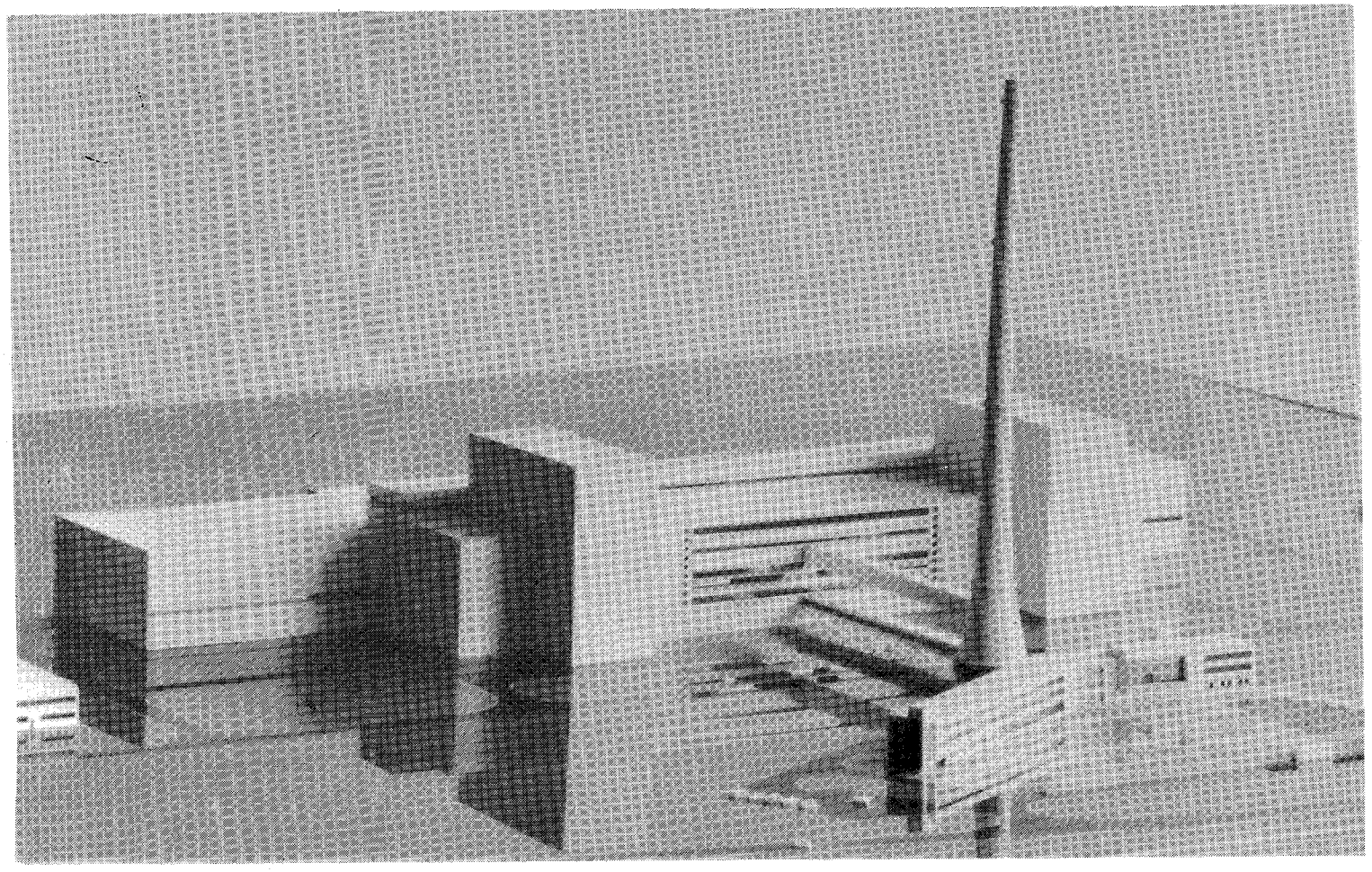
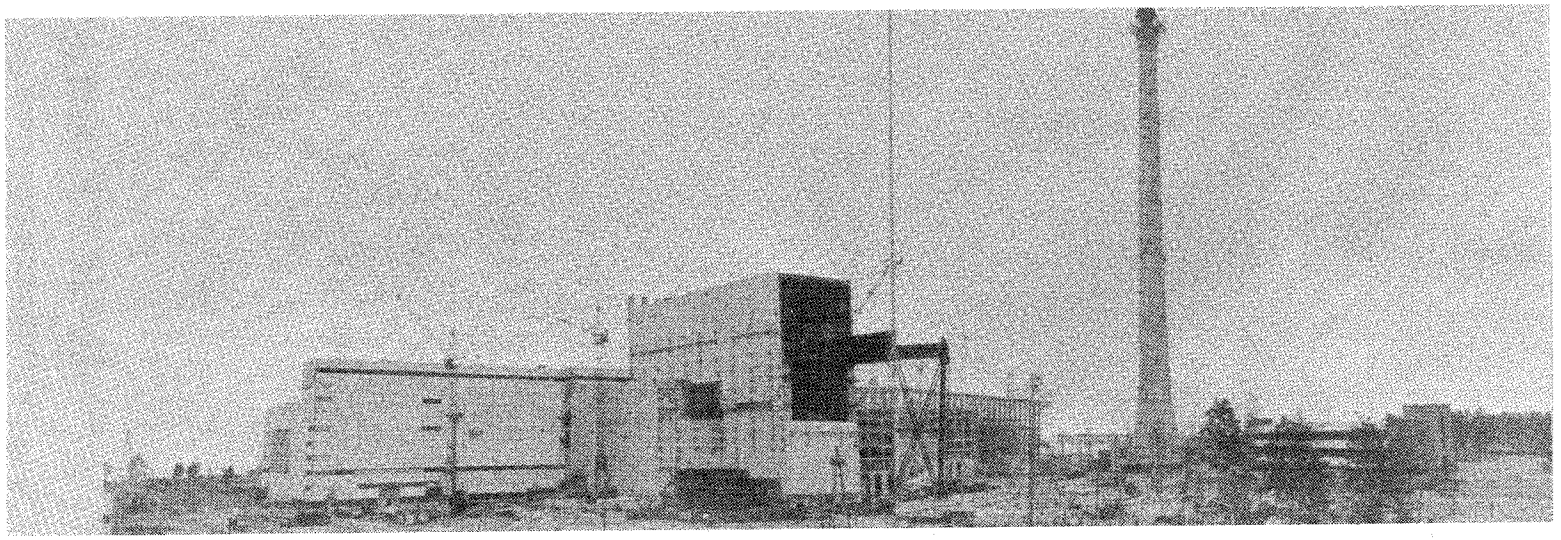
*Annual growth of installed capacity at that time should be $14\text{-}15 \times 10^3$ MW per year.[35]



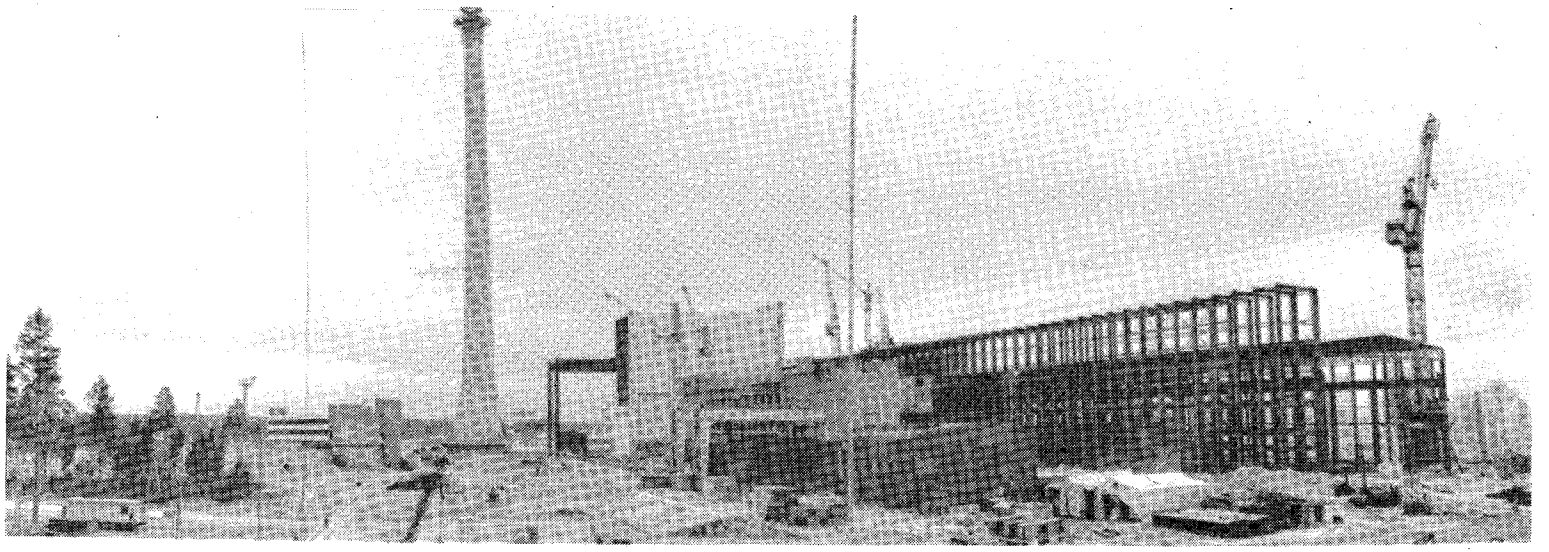
Model of the Sosnovyi-Bor Atomic Power Station

Briefing by Mr. Latii, Chief of Construction, on the Sosnovyi-Bor APS

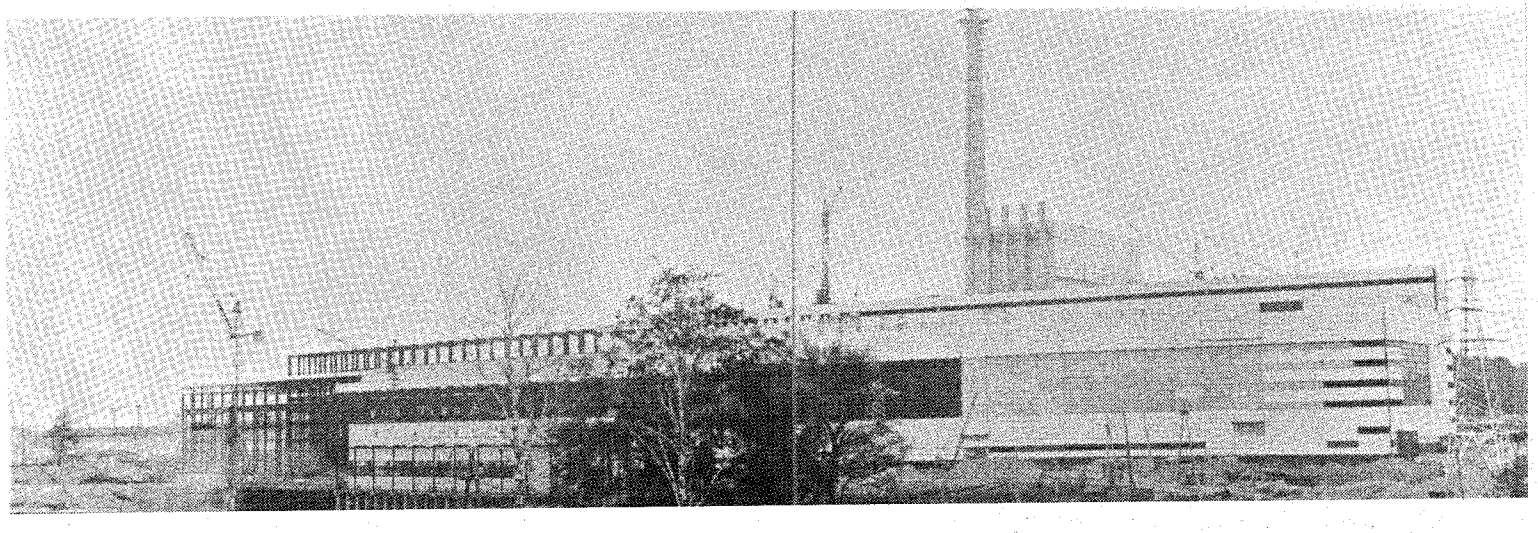
L. to R.: Joseph Lewin; V. P. Murav'ev, director of the station; Julius Rubin; Robert Hollingsworth; A. M. Petrosyants, Chairman of the SCAE; V. F. Menshikov, interpreter of the SCAE; Glenn T. Seaborg; and V. N. Latii



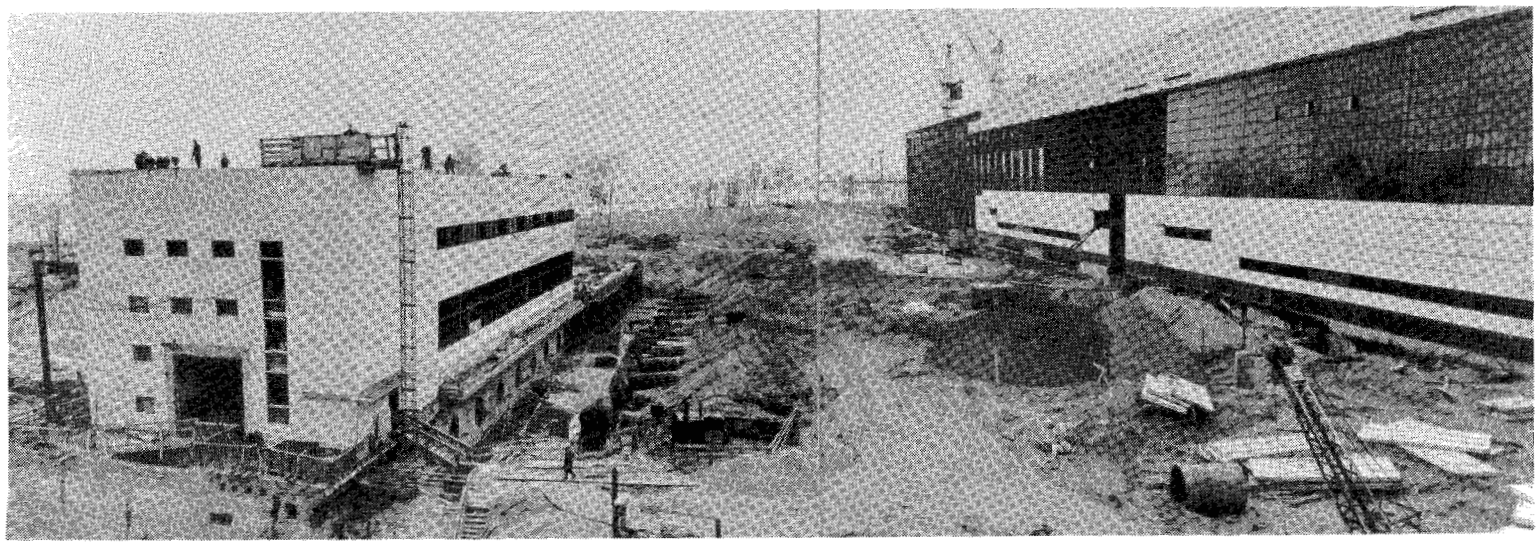
General View of the Construction Site as of Spring 1971.
(The illustration is made up of three prints joined along vertical lines.



General View of Construction Site From Opposite Side as in previous figure.



Rear View of Construction



The Pump House and Water-Treatment Plant For Supply of Water to the Station. A bay of the Gulf of Finland is in the background. (The illustration is made up of two prints joined along vertical line.)

Water-Cooled Power Reactor Construction in the USSR and the Soviet Bloc Countries and Finland

"2 × 440"-type stations, consisting of two 440-MW(e) pressurized water reactors.

Location	Year of Startup	Other Published Plans
Armenia	1975	
Kola Peninsula	by 1975	
Novovoronezh	by 1975	
Ukraine		(see below - may be pressure-tube type)
Bulgaria	1974	2600 MW(e) by 1980
Hungary		
East Germany		3000 MW(e) by 1980
Rumania		1800-2400 MW(e) by 1980
Czechoslovakia		5000 MW(e) by 1985
Finland [one 440-MW(e) only]		

(Note: The total installed capacities given are not necessarily exclusively "2 × 440"-type stations.)

1000-MW(e) PWR - Novovoronezh	Not announced	Construction to begin in 1970[27,28]

Pressure-tube reactors, to be built into Sosnovyi-Bor-type stations of 2000-MW(e) total output.

Sosnovyi Bor	1973 - first block	1974 - second block
Kursk	by 1975	
Smolensk		
Chernobyl'	by 1975	
Unannounced*		probably in Ukraine (may be 2 × 440 type)
Unannounced		probably in Ukraine

*It seems that the decision on the type and size of one APS, to be located in the Ukraine, has not been finalized.

Note: The sources for this table are data obtained on the trip, as well as "Directives of the XXIV Congress of the CPSU" and refs. 1, 3, 16, 17, 27, and 28. The "Directives of the XXIV Congress" call for 6 to 8 million nuclear kW to be added by the end of 1975.

Characteristics of the Sosnovyi Bor Reactors and Proposed Pressure-Tube Reactors With Nuclear Superheating (All Figures, Per Reactor)

	SBAPS[1]	RBM-KP-2000[2]	KP-1000[3]
Power, MW(e)	1000	2000	1000
Power, MW(th)	3200	5620	2220
Steam conditions at turbine inlet			
pressure, Kg/cm^2	70	65	240
temperature, °C	284	450	535
Total number of pressure tubes	1700	1404/354	1270
Number of pressure tubes per cooling loop	850		
Number of pumps per loop	2		
Capacity per pump	7000 m^3/hr		
Ion Exchanger flow, % primary	4%		
Steam separators, 2.3-m dia. by 30-m long			
Steam separator wt, tons	200		
Pressure tube dimensions:			
O.D., mm	88		
thickness, mm	4		
Length of fuel rod	3.5 m		
O.D. of fuel rod clad	13.5 mm		
Thickness of fuel rod clad	0.9 mm		
U loading, Kg(1.8% ^{235}U)	155000		
U loading, Kg(1.1% ^{235}U)	180000	294	52
^{235}U loading, Kg	3240		2500
Average enrichment, wt %	1.8	2.5	5
Design burnup, MW.d/KgU	18500	24000	40000
Specific pwr., MW(th)/ton U	17.8	19.2	51 (44 in.)[28]
Cladding material	Zr-1% Nb	evap.-Zr. alloy superheating-Zr + St.Stl.	St. Stl.
Pressure tube material	Zr-$2\frac{1}{2}$% Nb		
No., rating and speed of turbines	2 x 500 @ 3000 rpm	2 x 1000	

(cont.)

	SBAPS	RBM-KP-2000	KP-1000
No. of fuel rods in each pressure tube	18 in each subassembly	36-37	
Type of fuel	UO_2	UO_2	UC_x
Core dimensions:			
diameter, m	11.8	13.5	
height, m	7	7	
Max. thermal flux 10^6Kcal/m hr	0.7	0.9	2.5
Max. pwr. per tube KW(th)	3000	6350/4500	2200

[1]Designated RBMK-1000 in Geneva-IV paper, 49/P/712 (ref. 28).

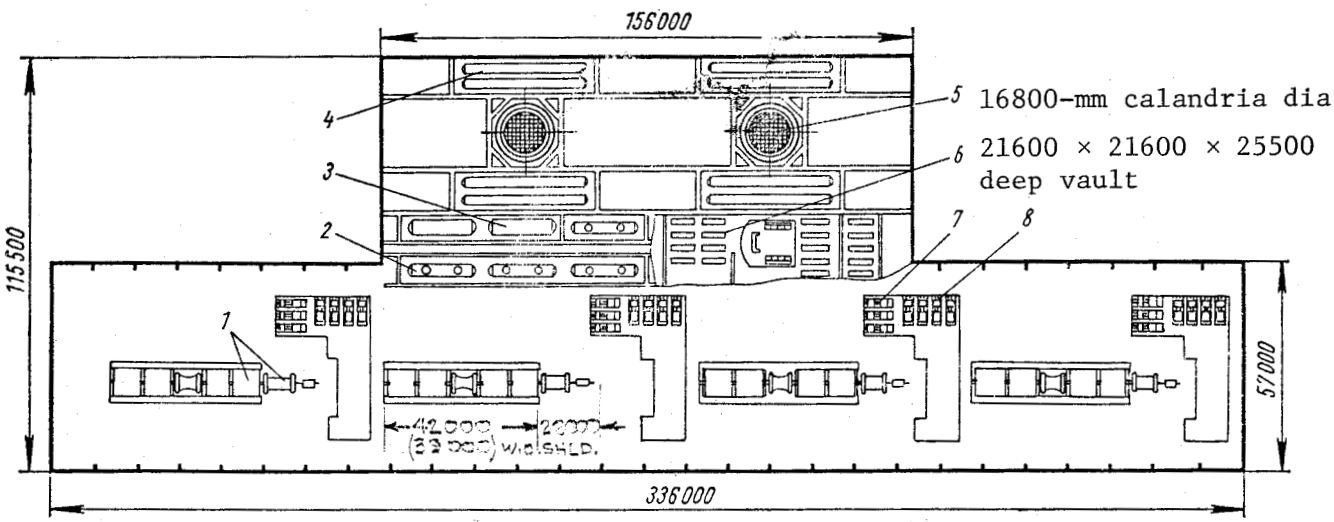
[2]Reported in ref. 28.

[3]Reported in refs. 1 and 33.

The Evolution of Power Reactors of the Pressure-Tube Type With Graphite Moderator and Light Water Coolant

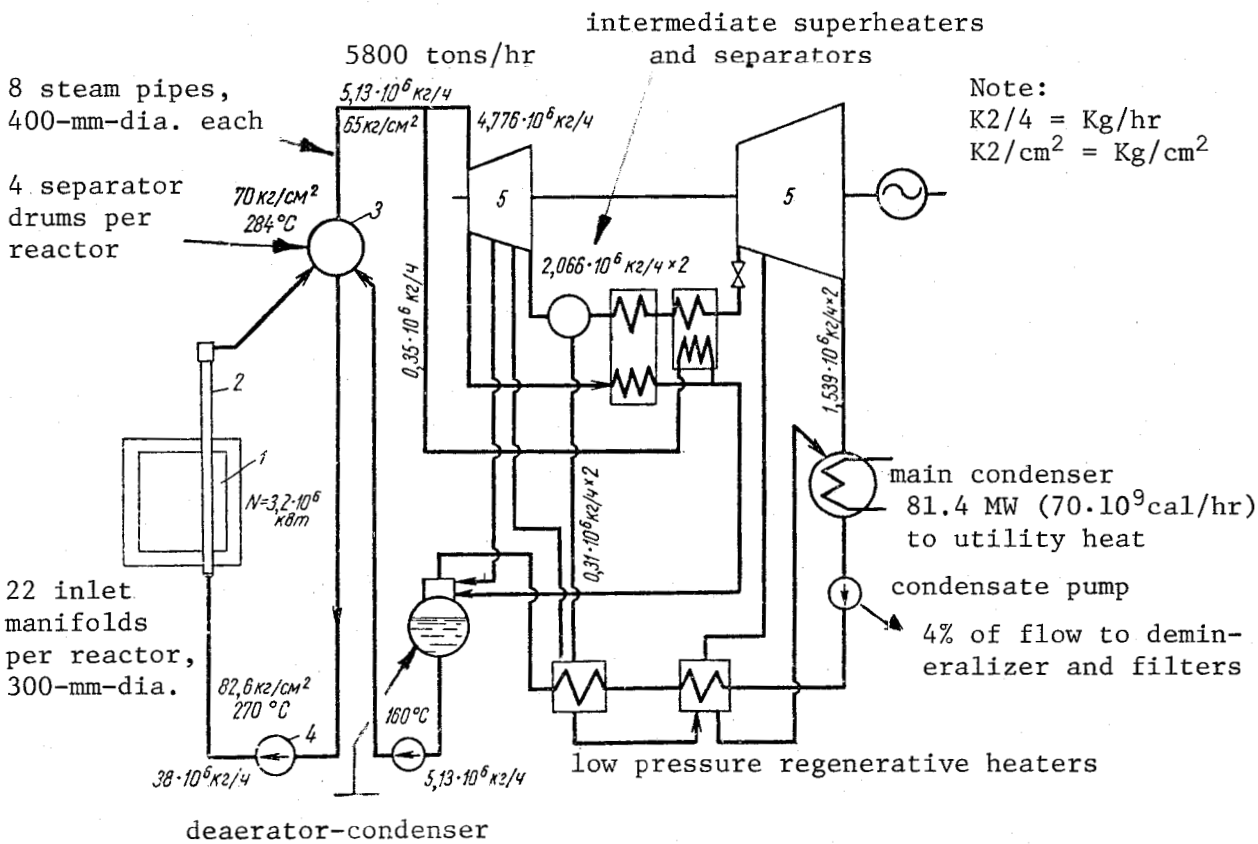
Parameter	First Block	Second Block	Leningrad APS
Year in operation	1964	1967	-
Power, electrical MW	100	200	1000
Power, thermal, MW	286	530	3200
Steam pressure at turbine inlet, kg/cm^2	90	90	70
Steam temperature °C	500	500	284
Total number of power tubes/ number of superheating tubes	998/286	998/266	1725
U-235 loading, kg	1200	1430	3240
Average enrichment weight, %	1.8	3.0	1.8
Uranium burnup, MW-days/kg	4.0	14.6	18.5
Specific power, MW/ton U	4.3	11.3	17.8
Cladding material	St. Stl.	St. Stl.	Zr. Alloy
Specific U-235 loading kg/MW (electric)	12.0	7.15	3.24
MW(e) design/actual	100/108	200/194	
Gross e %	35/36.9	37.7/37.5	
Turbine inlet steam parameters			
pressure, atm.	90/90	80/78	
temperature, °C	500/510	500/520	
Separator steam pressure, atm.	130	134/120	
Number of fuel channels	998	998	
Number of superheating channels (included in above	268	266	
Control material	Boron	Steel	
Number of control rods	100	100	
Average U enrichment, weight %	1.8/2.65	3/3	
Specific heat output MW(th)/TU	4.3/5.5	11.3/11.0	

This table taken from recently published book by A. M. Petrosyants, "From Scientific Search to Atomic Industry," and from ref. 37.



Plan View of Equipment Arrangement of SBAPS

1 - turbine-generator; 2 - deaerators; 3 - scrubbers; 4 - steam separators; 5 - reactors; 6 - control room; 7 - condensate pumps; 8 - feed pumps



Schematic Diagram of SBAPS Steam Circuit

1 - reactor; 2 - evaporating pressure tube; 3 - steam separator; 4 - circulation pump; 5 - turbine

Turbine Type	Nominal Power Output	Year of First Unit	Steam Parameters					Dimensions			Specific Heat Rate** kcal/kW-hr
			Initial		Intermediate Superheat		Condenser Pressure	Length mm	Width mm	Height mm	
			p_o kg/cm	t_o,°C	p kg/cm	t,°C	pk kg/cm				
K-70/75-30	75	1959	30	232.8	-	-	0.04	12,800	15,700*	4,200	3,034
K220-44	220	1969	44	254.9	3	240	0.032-0.052	23,200	8,670	6,250	-
K500-65/3000	500	1970	65.9	280	3.5	265	0.04	4,000	8,670	3,300	-

On the morning of Saturday, August 7, we flew from Minsk to Leningrad. The Leningrad airport is to the south of the city, not far from Pulkovo where the well-known astronomical observatory is located. We drove from the airport directly to the power station, turning onto the road that runs west along the south shore of the Gulf of Finland, near the suburban town of Ligovo.

This shore of the Gulf has been popular as a vacation area for decades. The thick reddish woods of pine (Pinus sylvestris) interspersed with groves of white birch, crowd the road all the way and where allowed, approach the water and the rather narrow beaches. We passed through the towns of Petrodvorets and Lomonosov and then raced through a long succession of villages and vacation colonies. It was Saturday, for about three years no longer a working day in Russia, and the road and shoreline were crowded with people who were obviously going fishing, boating, hiking, and swimming. We passed two childrens' summer camps run by the "Pioneer Organization" for children who are pioneers. The cost in these camps is about 13 rubles for 40 days, per child. (The average wage in the Soviet Union is somewhere in the range of 110 to 120 rubles per month per person. One of the many signs and posters that we saw everywhere on the trip said, "In the course of ninth five-year plan, the average wage of workers in our country will rise to 144 rubles per month." The ninth five-year plan runs through 1975.)

The villages had picturesque names such as Bol'shaya Izhora (Big Izhora), Lebyazh'e (Swan Place), Krasnaya Gorka (Red Hill), Chernaya Lakhta (Black Lakhta), Gora Valdai (Valdai Hill), Lipovo (Linden Place), Ruch'i (Brooks), and finally Sosnovyi-Bor (Pine Woods).

The town has a population of about 18,000, about half of whom are connected with the nuclear power station. The other 9,000 people came there in connection with other industry that preceded the power station. The town was said to have begun its existence in 1967.

It is a town of apartment houses, including some of the standard five-story houses, and several newer ones of nine floors and one "high-rise" of fourteen floors. This greater variety of architecture as compared to the early sixties, plus the more imaginative town layout utilizing small parks and childrens' playgrounds as centers for the grouping of houses, gave the town a pleasing appearance. A favorable contributing factor to the town's appearance was the practice of leaving trees standing wherever possible and of heavy planting of trees along all the streets. This practice, plus the flower gardens in the roughly twelve-foot-wide strips left between the houses and sidewalks, were fairly standard features of all the new towns that we visited.

Another standard feature of most Soviet towns, cities, and villages is the posters and signs that exort to greater achievements or advocate some special attitude through slogans. There are no counter-slogans. Such a practice is of course unfamiliar to Americans and aside from purely political exortations are interesting for their variety. In addition to the poster regarding the average wage mentioned earlier, we saw on the visit to Sosnovyi Bor and Leningrad:

"The road to profits is clear - discipline and economy."

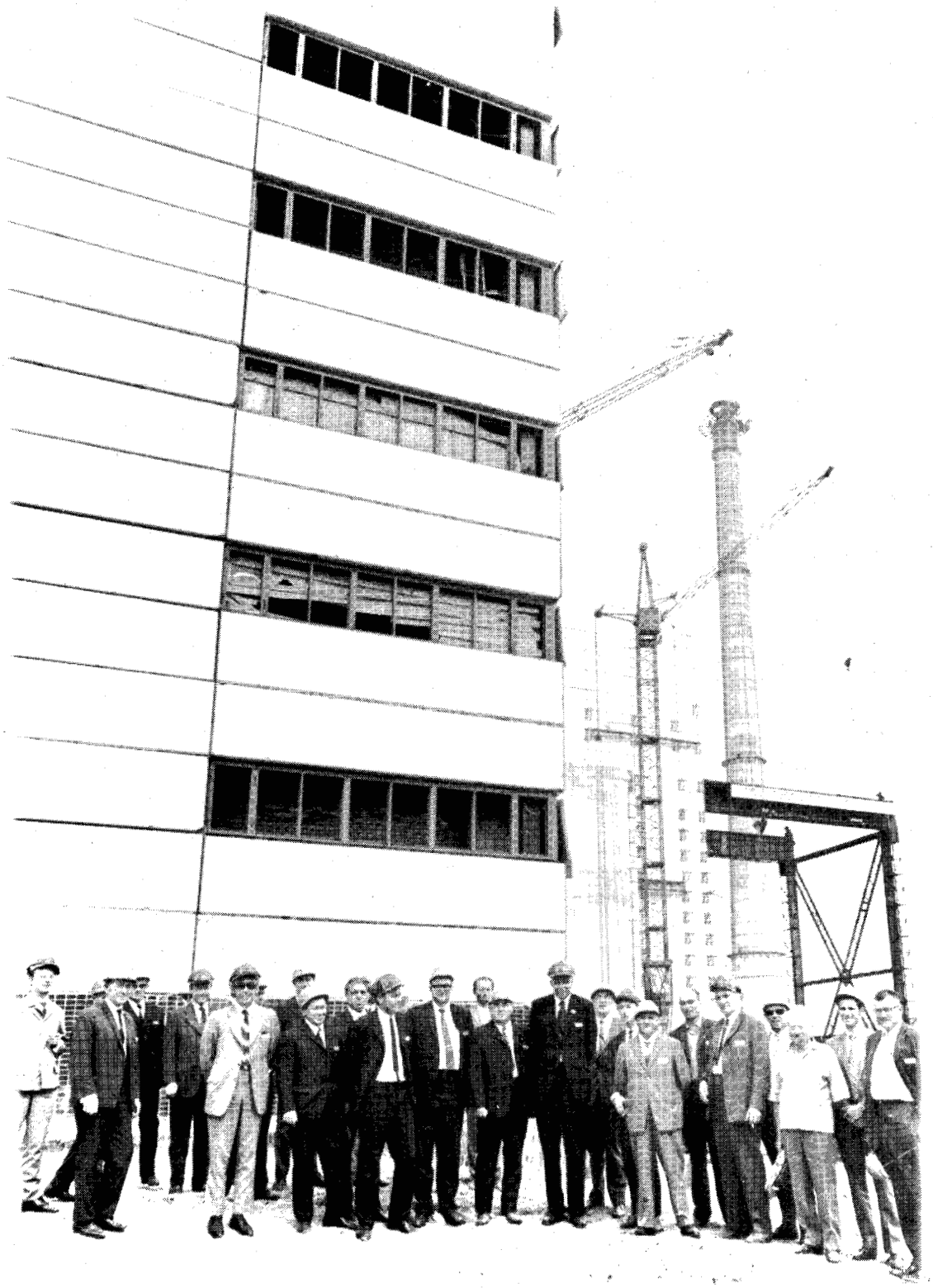
"Mr. Builder - you are the host here, not a guest - save then every nail."

"Glory to work."

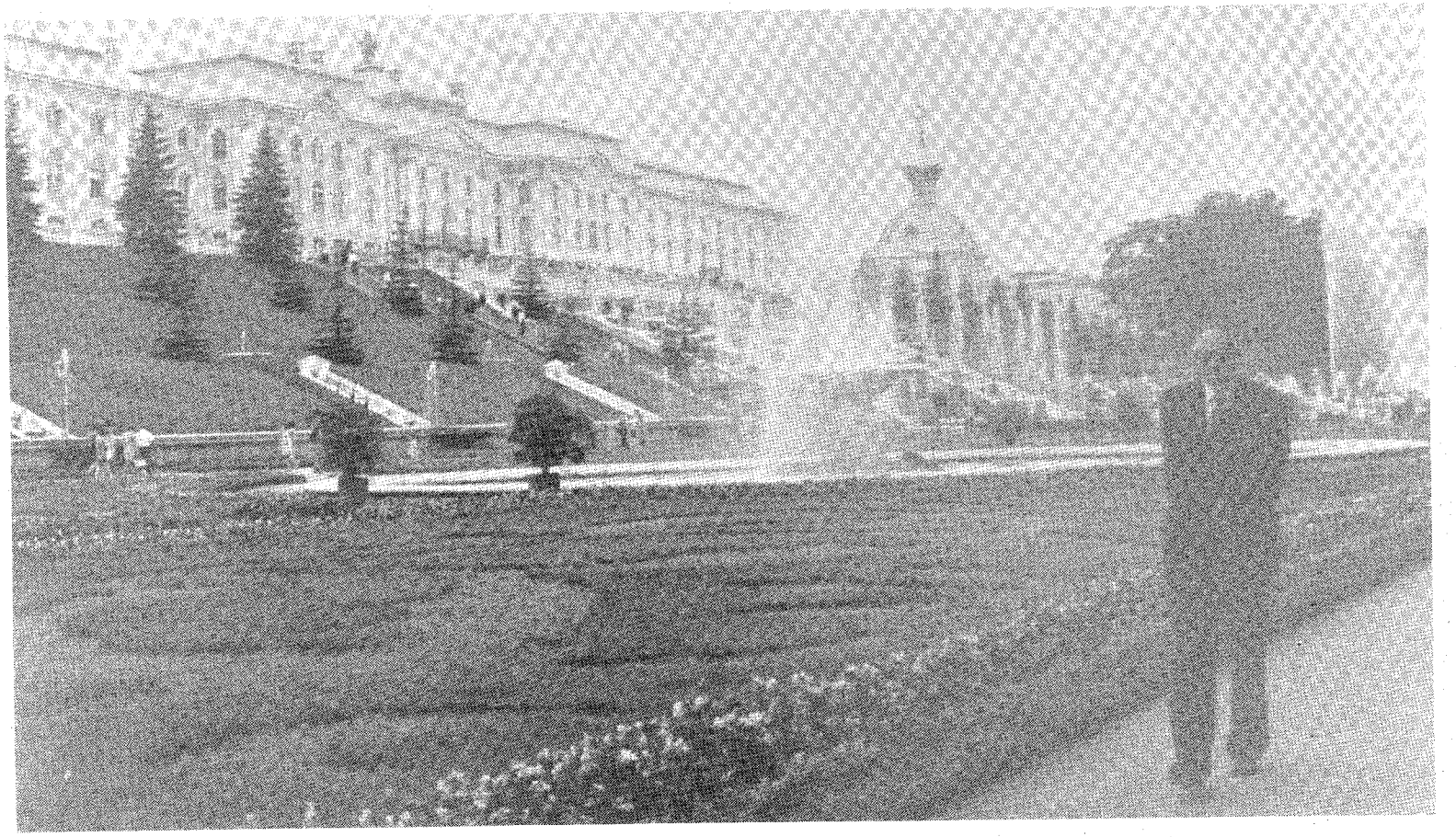
"We must build: - accurately, securely, rapidly, and economically."

There were also, of course, many slogans and posters of a political nature.

It is not easy to find a scale that will span all of life in the Soviet Union and be translatable into meaningful American terms. Some aspects, such as food and clothing prices - are subject to evaluation. However, the so-called "public component of total wages" is not so tractable. Professor N. V. Pukhovskii in a lecture on economics on the radio said that in 1965 take-home pay was 75% of the "total wages" in the Soviet Union. Twenty-five percent of "total wages" was distributed through the "public component" as schooling, medical care, public transportation, and so on. According to Professor Pukhovskii, the "public component" will be about 50% of "total wages" by 1981.



The Delegation and Hosts at the Sosnovyi Bor APS.



At the Petrodvorets Park and Museum.

4. The Scientific Research Institute of Atomic Reactors at Melekess

The Scientific Research Institute of Atomic Reactors at Melekess was founded in 1959 and has been visited by several groups of Americans, including the reactor delegations of 1964[58] and 1970,[14] as well as the USAEC Chairman's delegation of 1963.[62]

Dr. Oleg Dmitrevich Kazachkovskii, who was for many years an associate of A. I. Leipunskii in the fast reactor program at the PPI at Obninsk, is the director of the Institute. He replaced Dr. D. S. Yurchenko in 1964, who went on to become director of the BN-350 project at Shevchenko.

The facilities at the Institute and their start-up dates are as follows:

Name of Facility	Principal Purpose	Power	Date of Start-Up
SM-2	high flux reactor	50 MW(th) 68 MW(th) 75 MW(th) 100 MW(th)	1961 1964 1965 1970
Arbus	organic cooled and moderated test reactor	5 MW(th) 0.75 MW(e)	1963
VK-50	boiling water test reactor	150 MW(th) 35 MW(e)	1965
MIR	materials and fuel element test facility reactor	100 MW(th)	1966-1967
BOR-60	fast breeder test reactor	60 MW(th) 12 MW(e)	1968 dry crit. 1969 wet crit.
Hot Cells	material testing		
Hot Cells	radiochemical work - transuranium elements	can process batches of up to 1 kg irradiated targets	
Liquid Metal Laboratory	sodium component tests		

In addition, there are computer facilities including a BESM-3M machine, radioactive waste handling facilities, and the usual fabrication shops and support facilities.

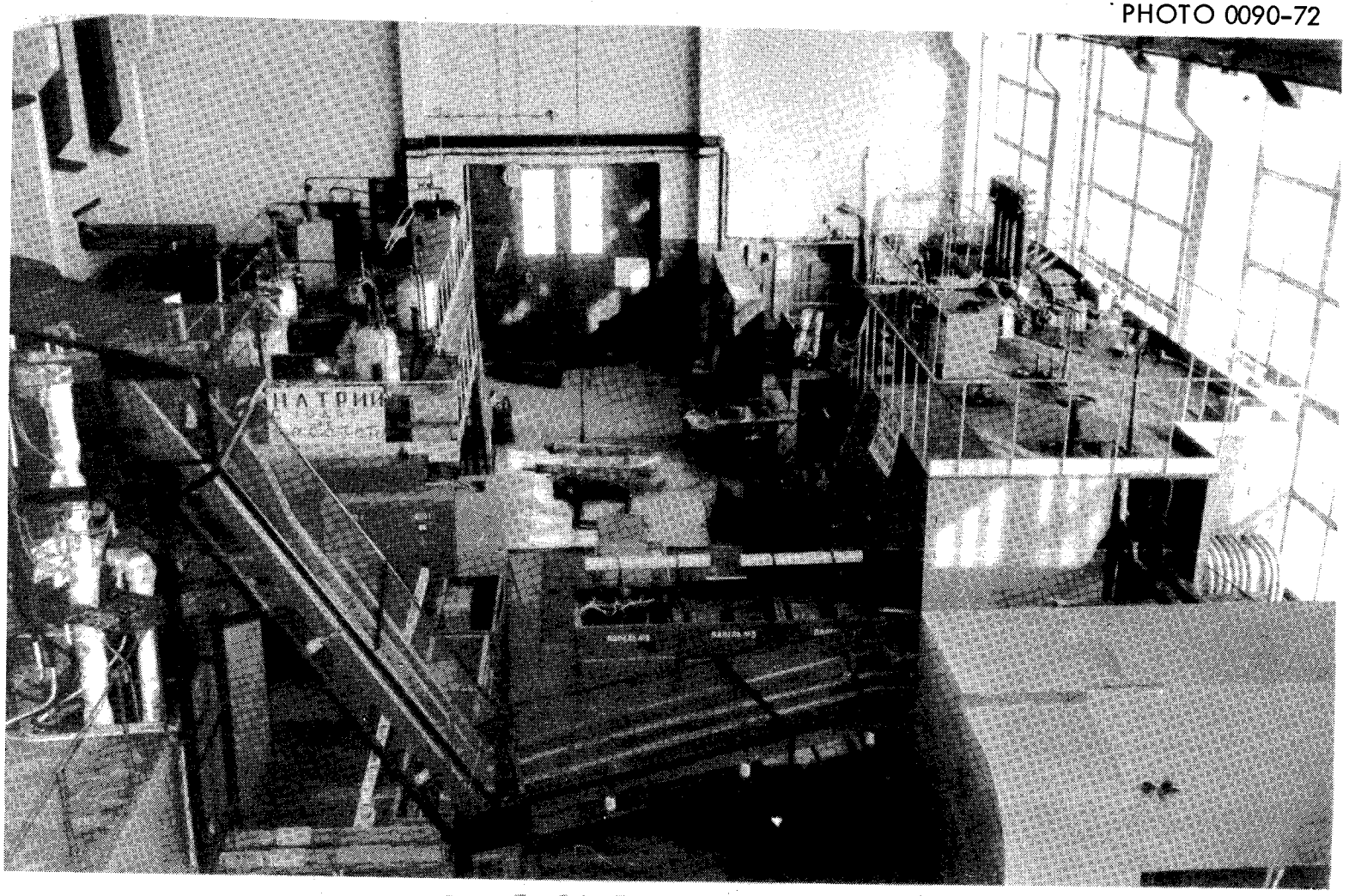
SM-2 and MIR Experiment Loops

Parameter	SM-2 Reactor		MIR Reactor		
	NVP	VVP	PVK	PV	Sodium
Power, KW	3000	250	2000	2000	2000
No. Channels	7	2	2	2	2
Power in each channel, KW	150-1000	120	1000	1000	1000
Volume for experiment in channel, liters	0.9-2.0	0.35	3.1	3.1	1.25
Unperturbed fast-neutron flux, nV	$(0.2-20) \times 10^{13}$	5×10^{12}	-	-	-
Unperturbed thermal-neutron flux, nV	$(0.8-33) \times 10^{14}$	$(0.5-1.1) \times 10^{14}$	-	-	-
Maximum specific power, KW/g ^{235}U	-	-	6.65* 3.40**	6.65* 3.40**	6.65* 3.40**
Coolant pressure, atmospheres	50	200	200	200	15
Coolant temperature at inlet °C, at outlet °C	50 100	300 330	300 350	300 350	200-300 550

*For second row channels.

**For fourth row channels.

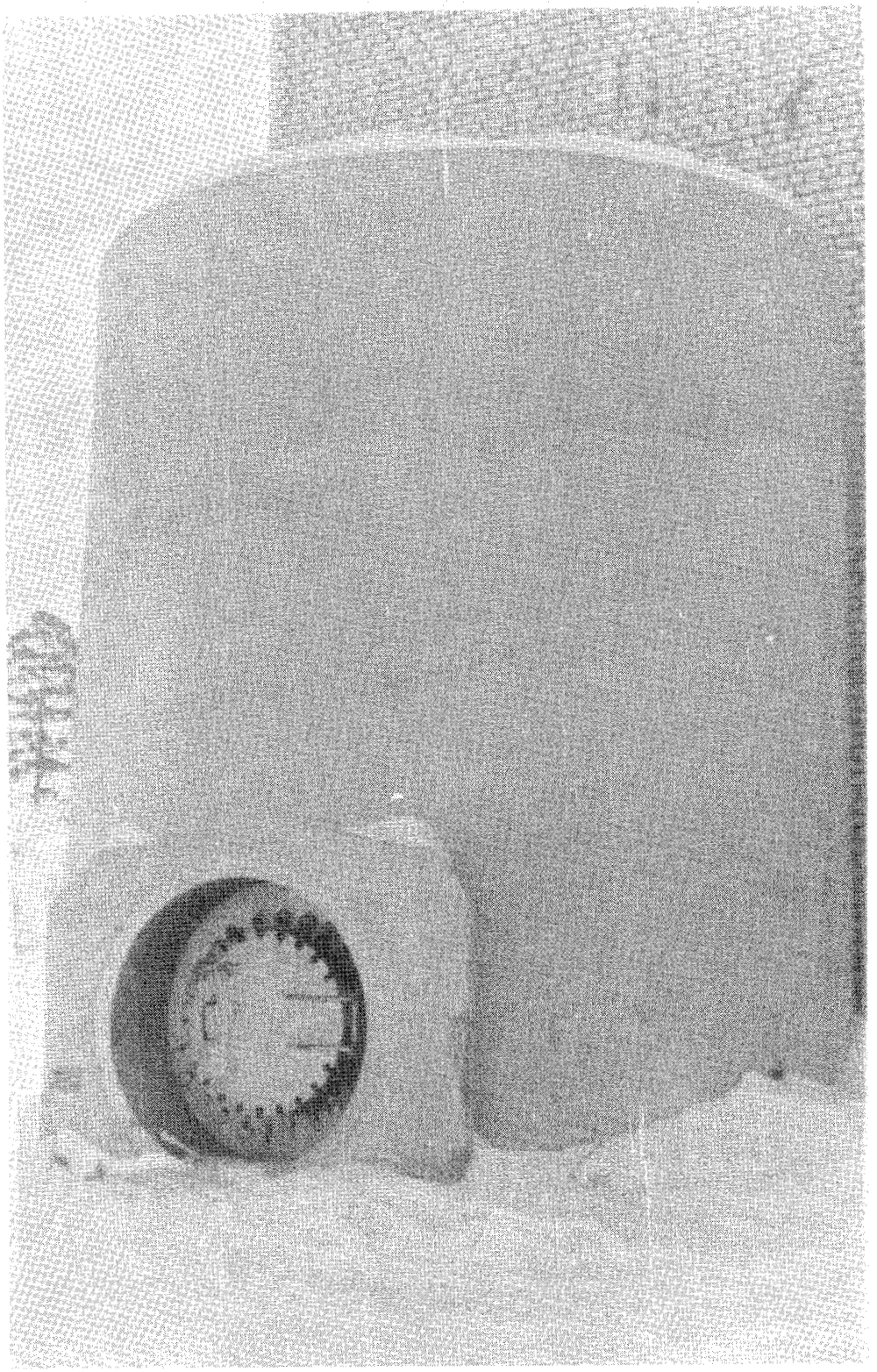
PHOTO 0090-72



Фиг. I. Общий вид стенда по испытанию парогенераторов

General View of the Steam Generator Test Installation. The sodium section is to the left, the water section to the right. The steam generator proper is located outside the building in a box shown on the next figure.

PHOTO 0091-72



Steam Generator Box - Outside the Building

Personnel at Scientific Research Institute of Atomic Reactors

Kazachkovskii, Oleg Dmitrevich - director of the Institute

Demyanovich, M. A. - chief engineer of the Institute

Krasnoyarov, N. V. - deputy director of the Institute for BOR-60 physics

Tsykanov, V. A. - deputy director of the Institute for materials science

Zamyatnin, Yu. S. - deputy director of the Institute for trans-uranium elements

Shkuro, N. L. - deputy director

Bolyatko, A. V. - literature researcher for the director

Barkova, P. A. - staff member of the protocol office

Aver'yanov, P. G. - chief of experimental research reactor division

Zverev, V. A. - chief engineer of experimental research reactor division

Kormushkin, Yu. P. - chief of a section of experimental research reactor division

Bazhenov, M. A. - chief engineer of the radiochemical division

Nikolaev, V. M. - chief of a section of radiochemical division

Gabeskiriya, V. Ya. - chief of a section of radiochemical division

Gordeev, Ya. N. - engineer of the radiochemical division

Barkov, V. A. - engineer of the radiochemical division

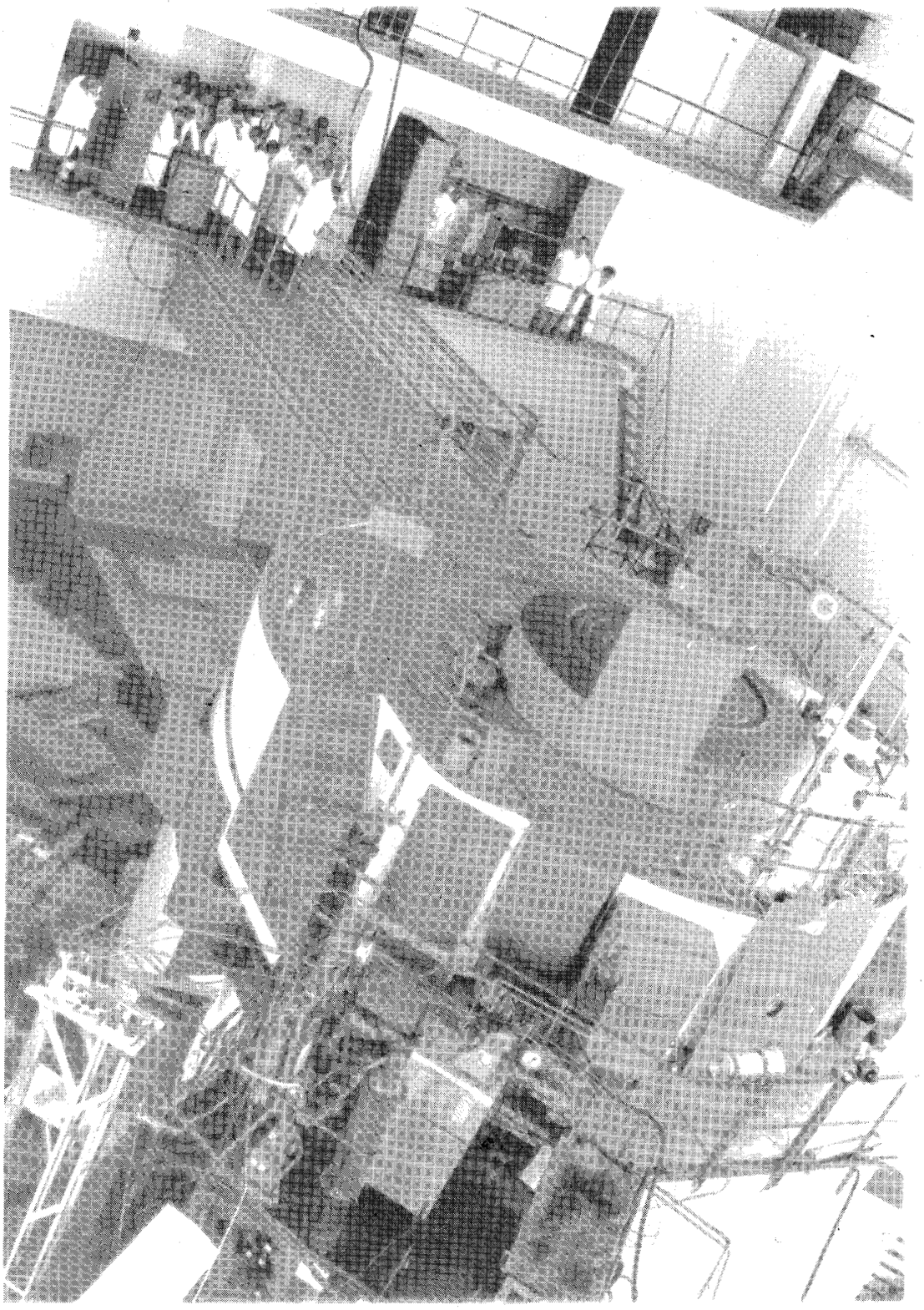
Smirnov, A. M. - chief of BOR-60 installation

Borisyuk, E. V. - chief engineer of the BOR-60

Timchenko, V. L. - engineer of the BOR-60

Medovshchikov, S. F. - engineer of the BOR-60

Belanova, Mrs. Tamara - neutron physicist



At the MIR Testing Reactor.

Ulyanovsk-Melekess and the Volga Region

"That's why it cannot now be doubted,
As one admires the water's reach
That shore to shore are met and routed
The East - the West, a line for each.

That they are joined by the great river
Into one everlasting whole,
That Volga is the spinal center,
The dear land's constant aureol."

From "Beyond Horizon to Horizon"
by Alexander T. Tvardovskii (1910-1971)

In his epic portrait-of-Russia-in-verse, Alexander Tvardovskii stressed the centrality of the Volga, both geographically and emotionally in Russian awareness. At Ulyanovsk we first met the famous river, now really a cascade of lakes impounded behind dams, much as the Tennessee River in the U.S. At Ulyanovsk the west bank on which the city is situated is considerably higher than the east bank and our first view, as we arrived on the evening of the 8th of August, was of an expanse of blue-gray water reflecting the moon in ripples of red and orange. Beyond the water was "the line of the East" which was, around the time of Columbus' voyage westward, the frontier of Russian expansion eastward.

On the morning of August 9, we drove by bus and car across the long continuous truss bridge and headed east through flat farm country that reminded some of us of the Dakotas back home. Our hosts mentioned the low summer rainfall that tends to limit farm production. Still, we were impressed by the huge fields of sunflowers, perhaps twenty acres in one stand, and other crops that we saw. Grain crops appeared to have been gathered.

We passed through a Tartar village called Chardakly, a vestige of the centuries prior to the sixteenth century when the Volga basin was the

territory of these Turkic people with a capital city at Kazan'. The village consisted of wooden log houses with corrugated iron and a few thatched roofs. There were decoratively carved gable cornices and window frames here, as well as at other villages that we passed. Most seemed to have a fairly central pond that served as an assembly point for ducks and geese.

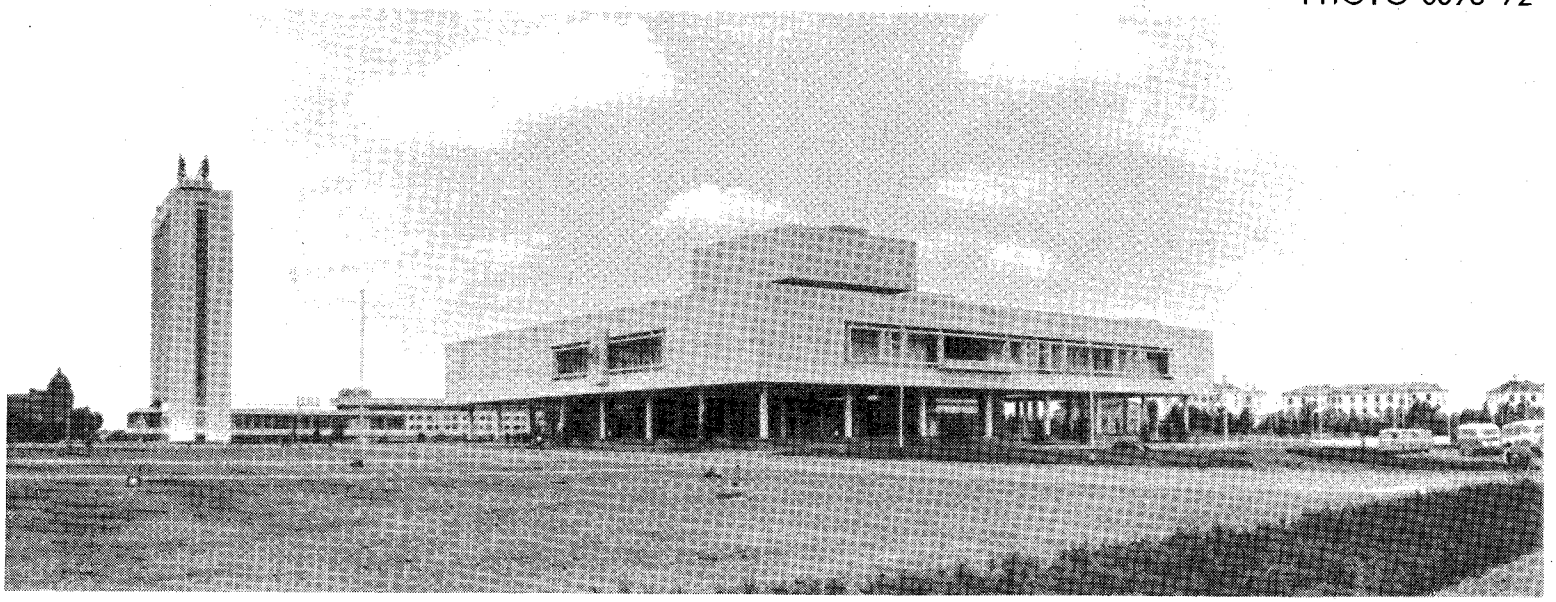
As we approached Melekess, we left the open grain fields and plains area with its rich-looking soil and entered forest areas of birch and linden trees, just beyond the village of Mullovka. The town around the Institute is composed of characteristic five- and nine-story apartment houses with characteristic heavy plantings of trees and flowers around them.

We drove from the Institute back directly to the Ulyanovsk Airport and passed through the city in the daylight. It had been renovated considerably in 1969, in preparation for the 100th anniversary of Lenin's birth here in April of 1970. The ladies of our party had been given a tour of the city and of several houses in which the Ulyanov family had lived.

The ladies also visited, at the town of Melekess, a boarding school for children with special problems ranging from speech defects to physical weaknesses. The age range here was from 2-7 years. The school operates on a six-day week with the children returned home for the seventh day.

They also visited a day-care center that operates for children from 10 months to 2 years on a 12-hour per day basis - 7:00 a.m. to 7:00 p.m.

PHOTO 0098-72



Ulyanovsk at the West Bank of the Volga. The Venets Hotel is in the left background. The building in the fore-center is a memorial complex to Vladimir Ulyanov-Lenin.

PHOTO 2437-71

Residential Area of IAR - at Melekess.
More recent housing units that seem to dominate new construction.

PHOTO 2476-71

Residential Area of IAR - at Melekess. The five-story houses were typical of housing in the early sixties.

PHOTO 3011-71

The American Delegation at the Administration Building of the IAR. To the left of Dr. Seaborg, in the picture, is Mr. Meshkov of the SCAE, and to the right is Dr. O. D. Kazachkovskii. Mr. Patrakeev of the SCAE is between Mr.Hollingsworth and Dr. Duffield at the right.

5. The Institute of Nuclear Physics at Akademgorodok

This Institute and the unusual "science city" in which it is located have been visited by many Americans. Under the leadership of Gersh I. Budker a series of colliding beam machines have been built and in 1967 some of the leading people were awarded "Lenin" prizes for this development. The prizes were awarded "For development of the colliding beams method of research in the physics of elementary particles" to G. I. Budker, A. A. Naumov (who later went to Protvino), A. N. Skrinskii, V. A. Sidorov, and V. S. Panasyuk.

Dr. Budker outlined the development of the colliding beam machines. Twelve years ago, in 1959, 140 people came to Novosibirsk to found the Institute of Nuclear Physics. Most of these people, including Dr. Budker, had worked at the Kurchatov Institute in Moscow. The initial scientific interest of these people was the development of colliding beam methods for high-energy physics research. The method was thought to be good for research on any interactions and particles except neutrinos.

The machines all carry the letter designation VEP - "colliding energetic beams." The first one built was VEP-1, an electron-electron machine, that accelerated such particles to 160 MeV in two storage ring orbits opposed to each other in direction. Elastic scattering of electrons and double bremsstrahlung emanation were studied.

The VEP-2 electron-electron machine was begun but was not completed in its original design because a machine with identical parameters was operated at the Stanford Linear Accelerator in California.

The VEPP-2 was an electron-positron machine that accelerated particles to a maximum of 700 MeV. The first experiments were done at an energy

of each type of particle of 380 MeV, the energy at which the cross section for intermediate ρ-meson formation is maximum. These mesons decay into two π-mesons, that are observable by laboratory methods.

The VEPP-2M machine is a reconstructed VEPP-2. The object of the reconstruction was increased beam luminosity, larger solid angle for detection of interactions, and improved vacuum. ϕ-meson resonance experiments were conducted in 1969 at particle energies of 510 MeV, and some results were reported at the VIIth International Conference of High Energy Accelerators.[90]

The VEPP-3 machine is an electron-positron machine that can achieve particle energies of 3.5 GeV. The installation consists of a storage ring, a synchrotron injector that yields 500-MeV particles, and the electron acceleration passages with a system of electron to positron conversion.

We visited the tunnel in which the machine is located and saw the unusual suspension system of the electron storage ring which is located 2.3 meters above the floor of the tunnel. The machine had already achieved particles of 2 GeV in the colliding beams, but additional tuning of the various complex parts was required before the full design energy in colliding beams would be achieved. The various spark chambers required to obtain data on the results of the electron-positron collisions were under assembly. Colliding beam experiments at full energy are scheduled to begin during the winter of 1971-1972.

The VEPP-4 machine is under construction and is scheduled to begin operations in 1972. This installation will receive 3.5 GeV particles from VEPP-3 and will then accelerate them further to 7 GeV per particle.

The design of this machine calls for magnetic fields of 100 kiloGauss at some points of the particle paths. Some idea of the losses of energy that occur when energies and intensities of these magnitudes are attempted was conveyed to us by Dr. Budker's prediction that five to ten thousand kilowatts would be radiated in 200- to 400-keV x-rays, continuously, during full power operation.

Dr. Budker mentioned that as early as 1958, scientists at various places around the world had postulated the possibility of building machines that could produce observable $e^+ + e^-$ interactions, and beyond that $\gamma+\gamma$ (photon-photon), $\pi+\pi$, K+K, and $\mu+\mu$ (meson-meson) interactions. "Such ideas," said Dr. Budker, "have advanced from 'impossibility' to 'banality' in the intervening short period."

A project that is, so far, only under study at the Institute of Nuclear Physics is the colliding beam proton-antiproton machine called VAPP-NAP, which would accelerate such particles to 23 GeV. This would be equivalent to near 1000-GeV particle energy in an accelerator having one beam impinging on a stationary target.

At the Institute of Nuclear Physics at Akademgorodok.

6. The Institute of Nuclear Physics of the Academy of Sciences of Uzbekistan at Tashkent

This Institute was founded in the early 1950's, and construction of the present complex of buildings was begun in what was a cotton field on the outskirts of Tashkent in 1956. The latest physical addition to the Institute buildings was made in 1970. The grounds are fenced in, with a large gatehouse, and include a beautiful rose garden around a central cascade of water basins.

At the administration building, Dr. Muminov, Vice President of the Academy, addressed us first with a brief outline of the Academy's history and present status. He reminded us of the fact that in 1917 only one person in what is now Uzbekistan had a college education, a man named Turabek or Turabekov. Today there are about 400,000 people with college-level degrees, of whom about 26,000 are in the sciences. The Uzbek "ethnic origin" has a Turko-Iranic base, and one of the Academy's leading institutions is the Oriental Institute which, among other things, has a collection of 16,000 manuscripts, the oldest dating from the ninth century.

The Academy was formally organized in 1943 with an initial inclusion of ten scientific establishments and 210 people. At present, the Academy employs a total of 10,000 people, of whom 4,000 are scientifically trained. The Academy has seven branches, including physics-mathematics, technical (engineering) sciences, chemistry, biology, earth sciences, history and humanities, and law-economics-philosophy.

In Uzbekistan there are 40 higher educational institutions and 130 technical institutes which are closely allied with departments of the Academy. The Ministries of Agriculture, Health, Geology, and others, each have their own institutes.

The Academy at present has 40 full-time members (academicians) and 56 corresponding members. It publishes about 200 books and 12 journals per year; both popular science and scientific-level writings are published under its sponsorship. Among the most successful of these are "Science and Life," a monthly journal whose volume is 400,000 copies per issue, "The Chemistry of Natural Compounds," and "Paleotechniques," a subject title that appears in periodical form only in the U. S. and Uzbekistan.

Dr. Ulug Gulyamov, the Director of the Institute, then described the Institute of Nuclear Physics. It employs 350 physicists and chemists. (If the proportions of the Academy's employment figures hold true, the total employment should be 900-1,000 people.) Associated with the Institute is a "science town" - a suburban development called Ulugbek, in honor of a ruler and astronomer of the early fifteenth century. The population of the town is about 5,000.

The principal installations at the Institute are:

A 150-cm cyclotron giving 20-MeV protons (U-150-2 type).

A 2-MW research reactor (VVR-S-type).

A gamma-ray source installation with one source of 400,000 Ci of ^{60}Co and eight smaller sources that are a total of about another 100,000 Ci.

Radiochemical laboratory.

In addition, there is a cosmic-ray laboratory at another location in the mountains.

Some divisions of the Institute carry on services for agriculture and industry. Thus, a division of activation analysis runs six labs at which small neutron sources are available for activation of minerals, ores, soils, plants, and tissues, and can be irradiated and products of experiments analyzed.

The Division of Applied Physics does radiation logging work for geological explorations.

Biogeological chemistry with activation analysis methods is being developed to allow analysis of deep soil formations on the basis of biological compositions of surface layers. This is due to deep roots (20 to 30 ft) of some plants and to exchange processes between layers that occur.

The radiochemistry of platinum is an important field because of explorations for platinum deposits.

The Training Division at the Institute helps to improve qualifications and insight of teachers at all levels of the educational system.

Institute of Nuclear Physics of the Academy of Sciences of the Uz.SSR
Personnel

Gulyamov, Ulug Gafurovich - director of the Institute

Mazitov, Burkhan Salakhitdinovich - scientist, engineering

Muminov, Vafo Arabovich - scientist, physics-mathematics

Losskii, Oleg Klement'evich - senior scientist

Usmanova, Manzura Muminova - scientist, physics-mathematics

Niyazova, Ozod Rakhimovna - scientist, physics-mathematics

Vakhidov, Shavkat Akhadovich - scientist, physics-mathematics

Khodzhaev, Latif Sharipovich - scientist, physics-mathematics

Ismatov, Erik Ismatovich - scientist, physics-mathematics

Islamov, Akmal' Anvarovich - scientist, physics-mathematics

Talipov, Tulyagan Talipovich - senior scientist

Irisbaev, Kabul Narmukhamedovich - scientist, engineering

Maksudov, Erkin Khamidovich - senior scientist

Mirzaev, Mirdzhalil Razykovich - senior scientist

Kist, Aleksander Alekseevich - doctor of engineering sciences

Abrarov Omon Abrarovich - scientist, chemistry

Khaidarov, Viktor Aleksandrovich - scientist, physics-mathematics

Talanin, Yurii Nikolaevich - scientist, physics-mathematics

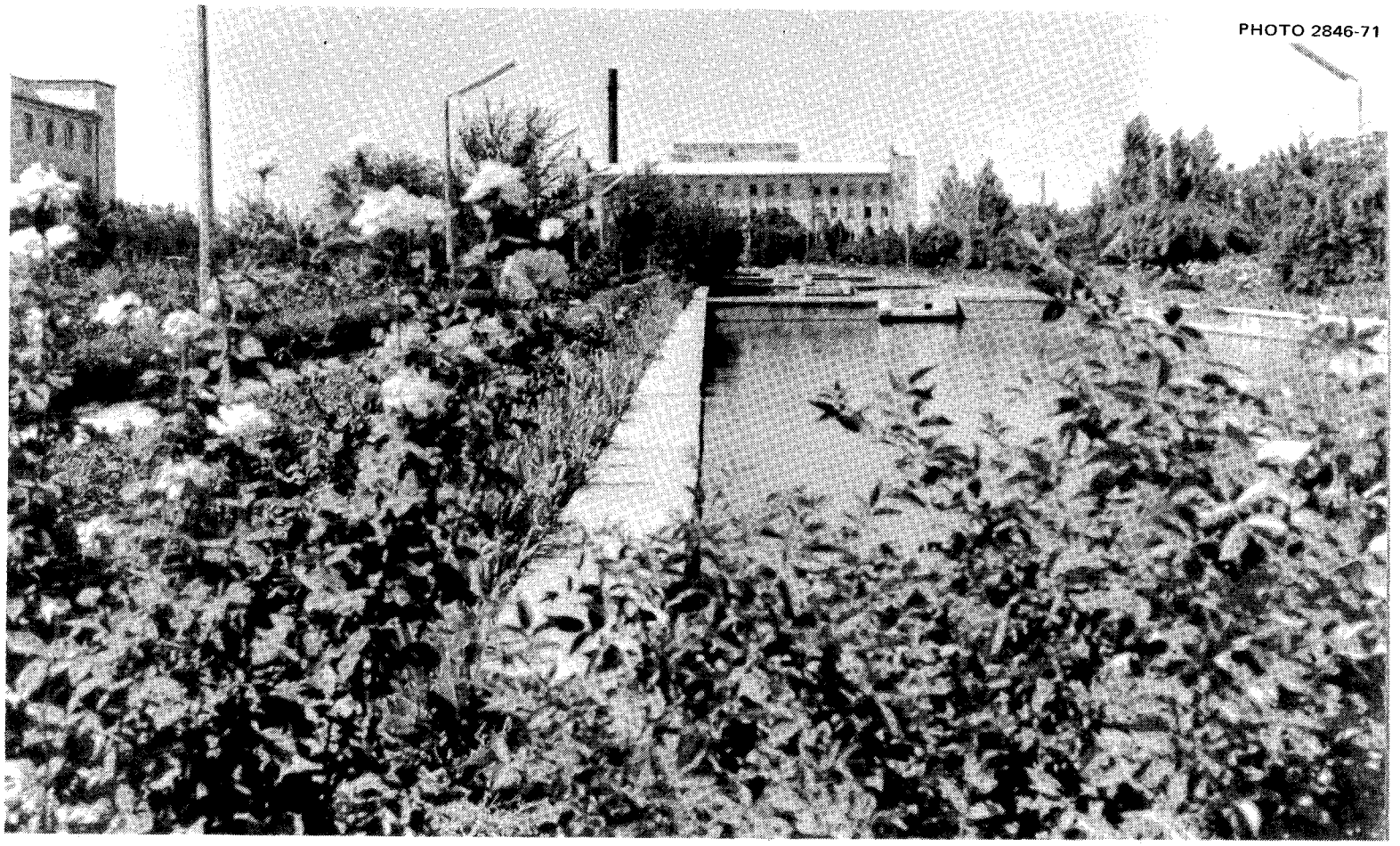
Arifov, Ubai Arifovich - professor, doctor of physics-mathematics

Azimov, Sadyk Azimovich - professor, doctor of physics-mathematics

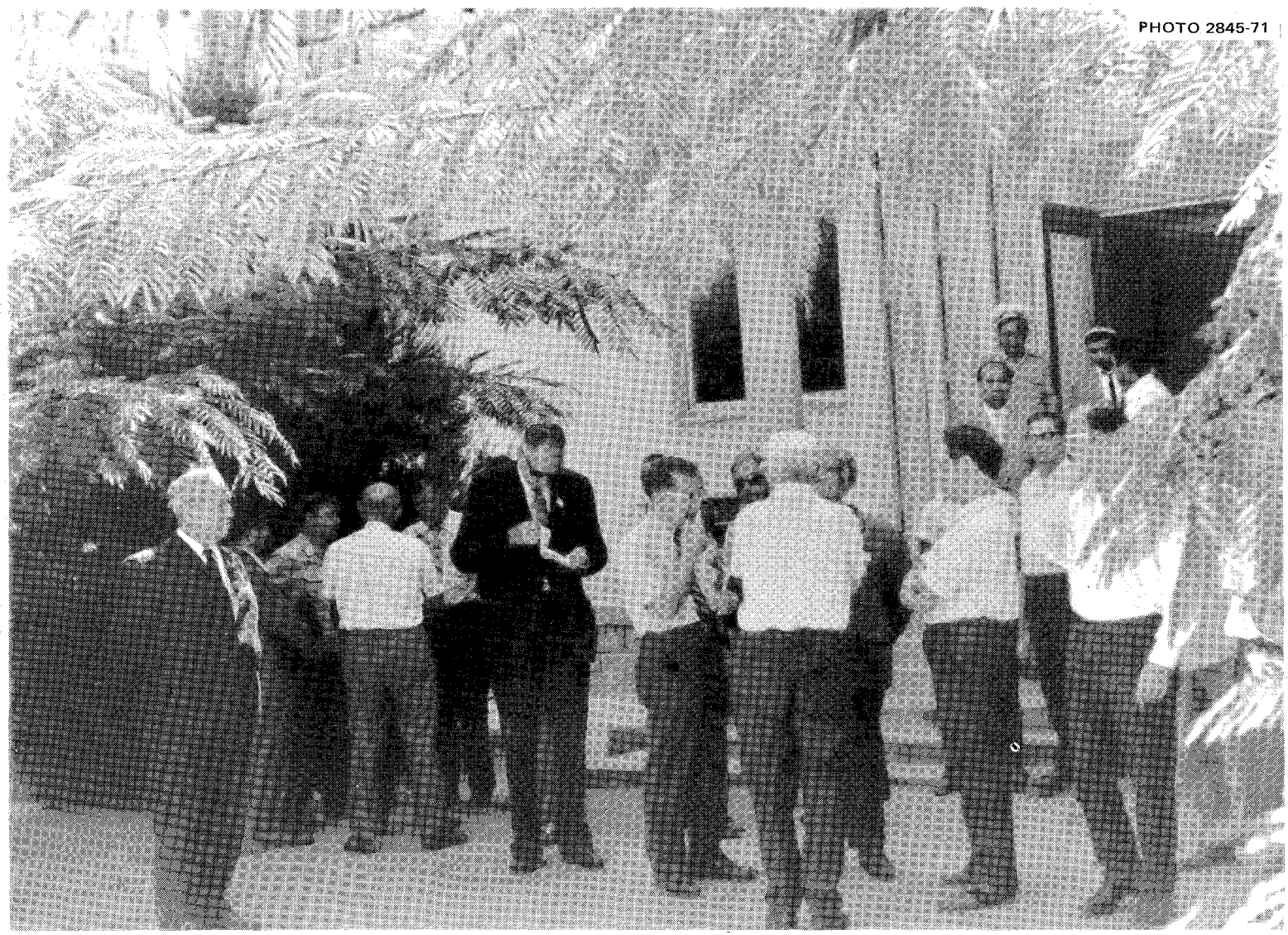
Ganiev, Abduali Ganievich - scientist, chemistry

Iminov, Mustaf - supervisor, gamma-ray irradiation facility

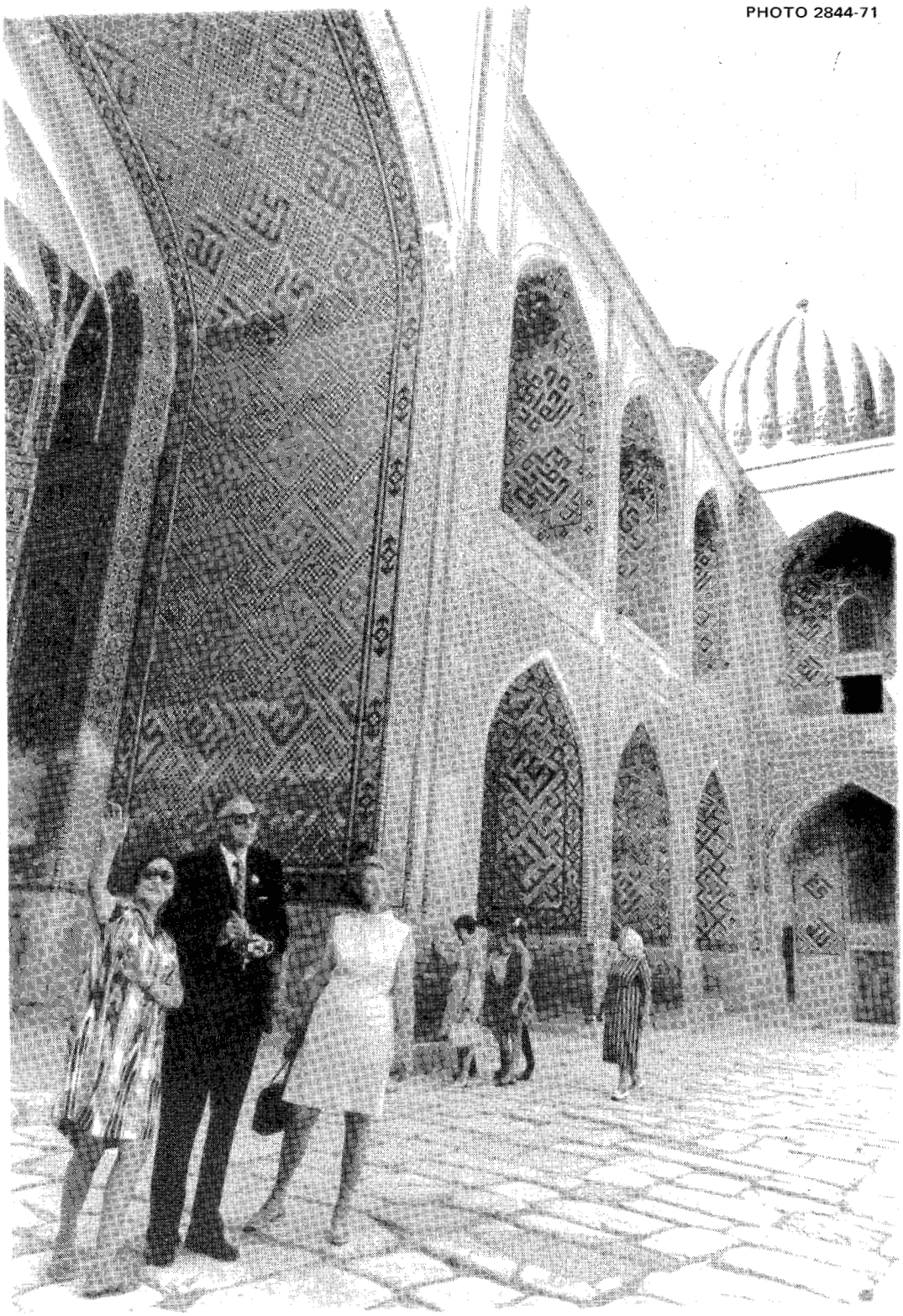
Bashinskii, _____ - supervisor, gamma-ray irradiation facility



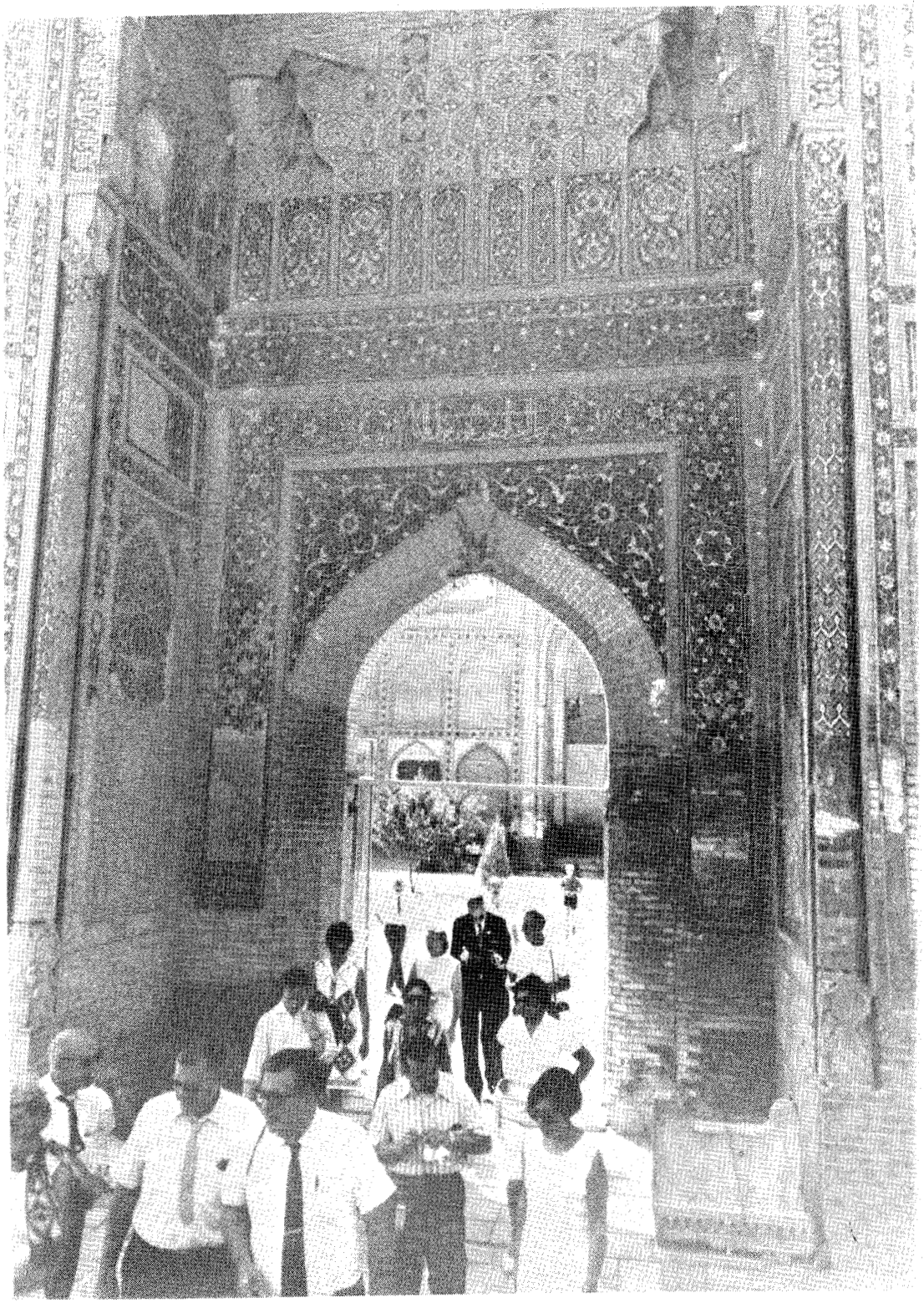
A View Down the Quadrangle of the Institute of Nuclear Physics at Tashkent. The building in the center-background houses the VVR-S reactor and associated laboratories.



At the Reactor Building (l to r) Dr. Ibragim Muminov, Vice President Uz. Academy of Sciences; Mr. Ilgiz Timerbulatov, SCAE; Capt Martin Kzavchenko; E. E. Kintner; Lombard Squires; G. T. Seaborg; J. Lewin; Rodney Cool; Dr. Ryzhov (back to camera); N. M. Sinev (barely visible); R. Duffield (barely visible); M. R. Mirzaev (in foreground); M. Z. Namudkhanov; policeman; B. Mazitov, Deputy Director; S. A. Azimov (on steps); U. G. Gulyamov (in foreground).



Dr. and Mrs. Seaborg with Maya in one of the courtyards of the Registan.



At One of the Portals of
the Registan.

7. The Erevan Physical Institute

The Erevan Institute of Physics of the SCAE, in Armenia, has a 6-GeV electron synchrotron in operation since 1968. Twenty percent of the primary beam has just been extracted, whereas most work has so far been done with secondary beams from internal targets. The interests of the Institute seem to be predominantly in the area of high-energy photon-nuclear interactions and in the physics of elementary particles derived therefrom. The Institute has developed particle track-spark chambers, and has a complement of other particle-analysis chambers. A theoretical group and wide collaboration with IHEP, as well as contacts with foreign physics establishments, seem to provide the Institute with a broad base. A CDC-6400 computer is about to be purchased from the United States.

Artem Isaakovich Alikhanyan has been the Director of this Institute almost since its inception in 1942 when seven physicists formed a working group at Erevan during the most difficult period of the war. Among these seven were Pomeranchuk, Asasiani, and Alikhanov. Abram Isaakovich Alikhanov, who, subsequent to the war, was Director of the Institute of Theoretical and Experimental Physics in Moscow until his death in December of 1970, was the brother of A. I. Alikhanyan.

Personnel at Erevan Institute of Physics

Alikhan'yan, Artem Isaakovich - Director (for the past 28 years)

Esin, Sergei K. - Director of accelerator installation

Garibyan, Grigorii Markarovich - theoretician

Matinyan, S. G. - Deputy Director

Vartapotyan, G. A. - Division Director

Asatiani, Tina Levanovna - Division Director

Badalyan, G. V. - Division Director

Ispiryan, K. - senior scientist

Personnel at Armenian Academy of Sciences

Mergelyan, Sergei Nikitovich - Vice President

Bakunz, Sevada Aleksandrovich - Scientific Secretary

Stepanyan, G. I. - Director of Laboratory of Geomechanics

Garibyan, G. M. - academician

Alikhanyan, A. I. - academician

Merzoyan, L. V. - Deputy Director, Buzakan astronomical observatory

Vartapetyan, G. A. - corresponding member

Akopov, A. M. - Director of foreign relations department

Personnel of Armenian SSR Government

Karapetyan, _____ - Council of Ministers, Office of Scientific Affairs

Safarov, _____ - Council of Ministers, Chairman of Scientific Affairs

Neli Akopova - guide to the historical sites

Others

Shakhnazaryan, ____ - reporter of the Armenian Press Bureau (Telegraph Agency)

At the Model of the Electron Synchrotron.

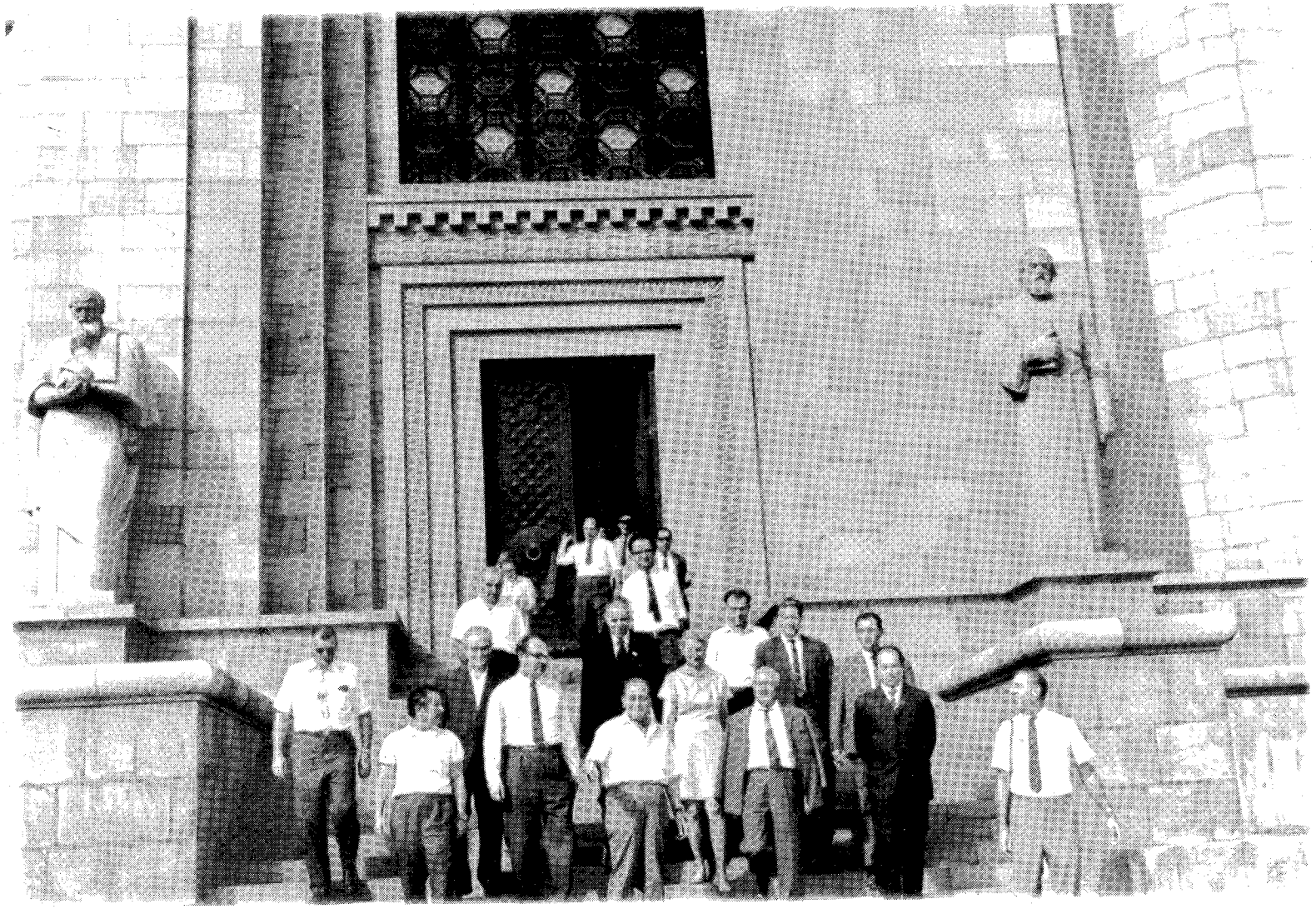
Personnel at the Matenadaran (Historical Library)

Chookasyan, Babken - Deputy Director

Lalafasyan, Sanson - Curator of Exhibitions

Koshkeryan, Armine - researcher, philologist,who specializes in 12 to 15th century canticles

Dr. Sergei Esin Briefs the Delegation in the Tunnel of the Synchrotron.



At the Matenadaran.

8. The Institute For Stable Isotopes of the State Committee on Atomic Energy

This institute is located in a new section of Tbilisi, which is separated from the older part of the city by a mountain ridge. A four-lane road was cut through the ridge about twelve years ago.

Buran Nikolaevich Muskhelishvili, the Director of the Institute, gave us the introductory briefing. There are six divisions in the Institute:

1. isotope separation
2. chemistry
3. metallurgy
4. thermo-physics
5. instruments
6. engineering

The latter division designs full-scale production facilities as extrapolations of the lab-scale and pilot-scale work done at the Institute.

The Institute was established by the SCAE in 1961 for the small-scale production of stable isotopes of low mass number. The Institute also conducts research and development on separation techniques for stable isotopes such as distillation, mass diffusion, and chemical exchange methods (but not electromagnetic methods), and develops equipment for "commercial" (layer scale) application of these methods. The separated isotopes are made up into a limited number of chemical compounds for shipment to other sites in the Soviet Union. No labeled organic compounds or biological materials are made at the Institute.

Currently the following isotopes are produced:

a) ^{10}B, 30 kg/yr, by low temperature distillation of BF_3. Elemental ^{10}B is prepared by electrolysis of molten salts.

b) ^{15}N, 4.5 kg/yr by chemical exchange between gaseous NO and aqueous HNO_3. $^{15}NH_3$ is the final product for shipment.

c) ^{13}C, 0.5 kg/yr by low-temperature distillation of CO. $Ba(^{13}CO_3)_2$ is the final product for shipment.

d) ^{22}Ne, 0.5 kg/yr by mass diffusion of neon gas through mercury vapor.

In addition to the above, a new facility for the production of ^{18}O by the low-temperature distillation of NO is in an advanced state of construction for operation within a few months.

Personnel at Institute of Stable Isotopes, Tbilisi

Muskhelishvili, Buran Nikolaevich - Director

Dziashvili, _____ - Deputy Director

Tevsadze, _____ - Chief Engineer

Kekelidze, _____ -

Gagna, _____ - Deputy Chief Engineer

Osiashvili, Elena - Scientist

9. Institute of Physics of Academy of Sciences, GSSR

Dr. E. L. Andronikashvili, Director of the Institute, gave us an initial overall view of the history and organization of the Institute. It is just twenty years old, the initial organization having been made in 1950. For a time it was the only scientific research institute in Georgia. At present, there are 800-900 people employed there.

The initial organization of Soviet science was said to have differed from the organization of American science in that a large gap was allowed to develop between the academies of science and their institutes on the one hand, and the universities on the other. This gap is now being closed, one method being the participation of university students in research work at the institutes. In this respect, the Soviet academies' institutes are becoming more like U. S. national laboratories.

Dr. Andronikashvili paid tribute to former members of the Institute staff: Professor Chikovani who died unexpectedly in 1970 and Professor Kachicheladze who had been a deputy director of the Institute. By working with the universities, they had improved the collaboration between the two types of institutions.

The briefing continued in the Institute's lecture auditorium. The major programs were listed as follows:

I. Nuclear Physics

II. Solid State Physics

III. Low Temperature Physics

IV. Biophysics

V. Automation of Research

Each of these would, presumably, correspond to a division in an American national laboratory. Each program has groups that concentrate on narrower areas of the general fields.

These groups, the major equipment that they have used, and some of the salient work that has been done were listed as follows:

I. Nuclear Physics

A. High Energy Nuclear Physics

1. Cosmic Rays

a. High mountain TSKHRA-TSKARO Station (work by Kotliarevskii)

b. Underground station - μ-meson research

2. Accelerators at Dubna, Serpukhov, CERN (4 new elementary particles)

3. Streamer Chamber, Discharge - Cloud Chambers (Chikovani, Roinsshvili)

B. Low Energy Nuclear Physics (cluster model of light nuclei)

C. Applied Nuclear Physics

1. Physics of Reactors (heat transfer and neutronics)

2. Radiation Loops (at IRT reactor, indium-gallium loops)

3. Isotopes and Accelerators in Industry

II. Solid State Physics

A. Magnetic Resonance Phenomena (Khutsishvili)

B. Radiation Physics of Ionic Crystals

C. Radiation Physics of Metals and Alloys; Low Temperature Reactor Loops, Reactor Intrachannel Installations

D. Radiation Physics of Surfaces

III. Low Temperature Physics

A. Superfluidity (Tsakadge)

B. Superconductivity (Shuchman)

C. Effect of Radiation on Superconductivity

IV. Biophysics (Andronikashvili, Mrevlishvili, Mosulishvili)

A. Cryobiophysics (including physics of cancer)

B. Intramolecular Phase Transitions (including physics of cancer)

C. Microelements in Normal and "Cancer" Macromolecules

V. Automation of Scientific Investigations

Personnel at Institute of Physics of Academy of Sciences, GSSR

Andronikashvili, Elevter Luarsabovich - Director

Kiknadze, Genadii Iraklievich - Deputy Director

Naskidashvili, _____ - Division Director, Metals & Alloys - Effects of Radiation

Mosulishvili, _____ - Scientist, Biophysics

Zhsetladze, Thea (Mrs.) - Head of Division of Applied Nuclear Physics

Potashnikov, _____ - Director of Public Relations

Mandjavidze, _____ - Scientist, Discharge Cloud Chamber

Beritashvili, _____ - Scientist, Department of Physiology

Gvachazia, _____ - Division Director of Isotopes and Accelerators

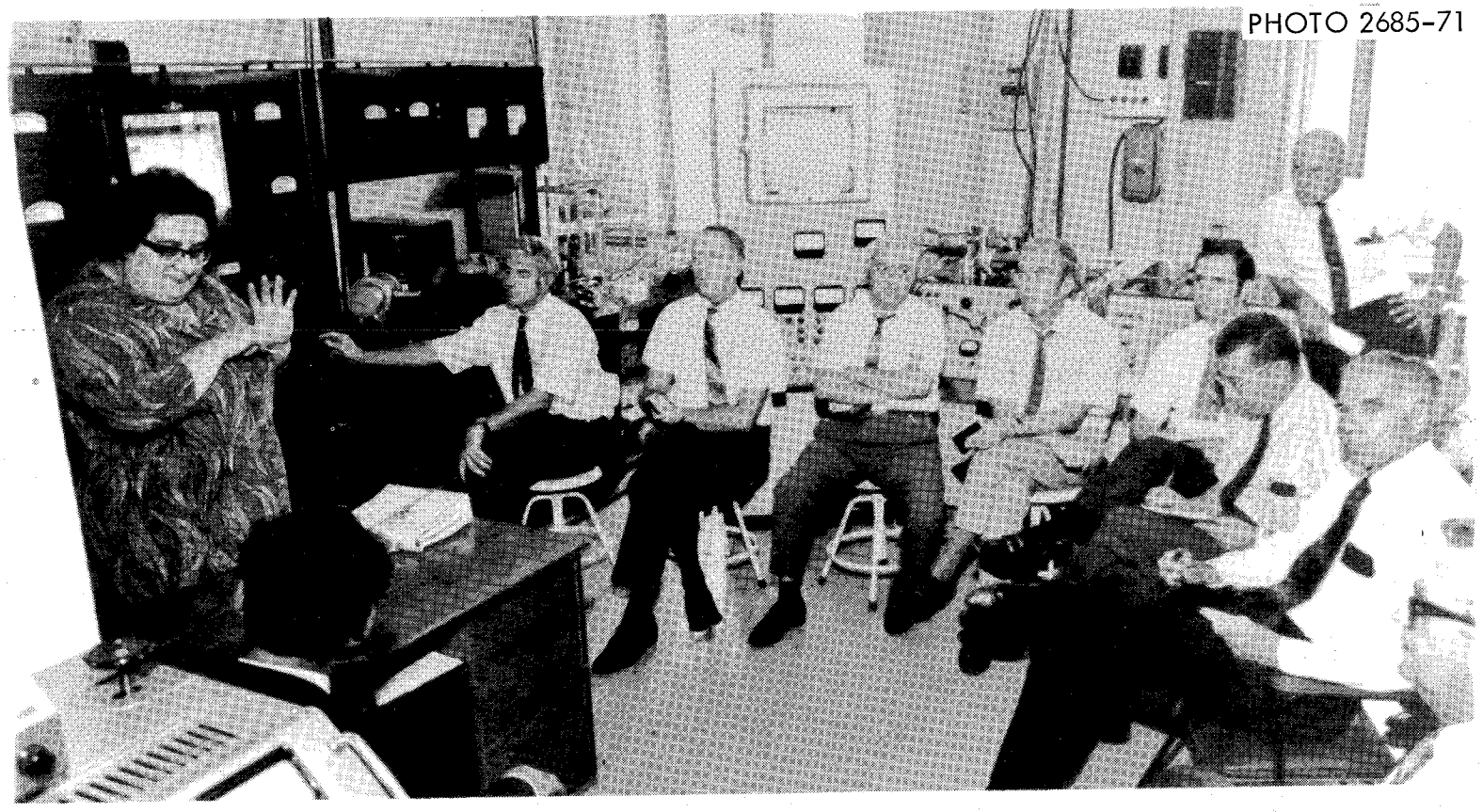
Mrevlishvili, _____ - Scientist, Biophysics

Politov, N. G. - Scientist, Group Leader, Ion Crystals

Roinishvili, _____

Bibilashvili, _____ - Scientist, Department of Nuclear Physics

Tsakadze, _____ - Scientist, Low Temperature Physics



Mrs. Zhsetladze, Director of Division of Applied Nuclear Physics, Briefs the Delegation on her Work.

Personnel at Georgian Academy of Sciences

Muskhelishvili, Nikolai Ivanovich - President (met briefly only during tour of city)

Dvali, Rafail Rafailovich - Vice President

Personnel in Government of Georgian SSR

Siradze, Victoria Moiseevna - Deputy Premier

Khundadze, G. L. - Assistant to the Prime Minister

Dolidze, Gizo Fedorovich - Deputy Chairman of Science and Technology Committee

Other Personnel

Gomelavri, Vakhtang Ivanovich - Professor of the Tbilisi Polytechnic Institute

The following ladies entertained the American ladies:

Mrs. Tina Gomelavri (teacher of English)

Mrs. Lamra Margelashvili (director of school)

Mrs. Isa Turvanadze (president of Women's Federation of Communist Party of Georgia)

Mrs. Otari Tkeshelashvili (director of Museum of Ethnology)

Koba Guruli - artist of Tbilisi

Mrs. Irene Uznadze - curator of Institute of Fine Arts

At the Institute of Stable Isotopes
in Tbilisi.

PHOTO 2689-71

(left to right) Mrs. Helen Seaborg, Mr. Dolidze, Mrs. Eva Rubin, Dr. Seaborg, Mr. Petrosyants, followed by the delegation and hosts climbing up the hill to the Dzhvari Church and monastery. In the valley, to the left, is the reactor installation of the Institute of Physics, called Mukhatgverdi - Oak Side.

(l. to r.) Dr. E. L. Andronikashvili, A. M. Petrosyants, Mrs. V. M. Siradze, G. T. Seaborg, M. Naidionov, R. R. Dvali, R. E. Hollingsworth.

10. The Town of Shevchenko and the Mangyshlak Power Complex

The Seaborg Delegation visited the town of Shevchenko and the site of the BN-350 reactor in one day, flying in from Tbilisi early in the morning and departing from Shevchenko for Moscow in the early evening. The BN-350 reactor was in the final stages of construction and the first critical assembly of the core was anticipated in the first quarter of 1972 and first power production late in that year.

The BN-350 Reactor

This reactor has been amply described over the years as its design evolved with the growth of fast neutron system experience and understanding based largely, in the Soviet Union, on the BR-5 reactor at Obninsk.* In 1964 an American group interested in desalination of sea water visited Shevchenko[13] which was already the site of an operating, fossil-fueled, desalination plant. In the early summer of that year a Soviet desalination group, including N. M. Sinev and A. I. Leipunskii, visited the United States and described plans for the BN-350. The American reactor group of 1964 was given current plans for this reactor[58] while the reactor group of June 1970 visited the reactor site and described it in considerable detail in its report.[14] In addition, of course, there have been many articles published and papers presented by the designers of the plant.

*See chapter on visit to PPI at Obninsk for more general account of fast breeder reactor development.

D. S. Yurchenko, who was director at IAR until 1964 and is now director of the BN-350 power-desalting complex, began the briefing of our group:

The fossil-fired desalination plant began construction in 1960, and operation began in 1963. The Caspian Sea water contains 13 to 15 g/liter minerals, mostly in salts. For drinking water, this must be reduced to less than 1 g/liter and the actual concentration maintained at Shevchenko is 0.4 to 0.8 g/liter. For process water, the salt concentration is maintained at or below 4 g/liter. In August, the production rate was over 40,000 m^3/d for both process and drinking water.

This output comes from two banks of five evaporators each that are located at the BN-350 site and seems to represent operation at 33% above rated capacity. In one month, i.e., in September, a new bank of ten evaporators is to go into service. At the time of our visit, all ten evaporators were in place. The two units that were built at the fossil-fired plant site are apparently not in operation at present.

We toured the entire building that houses the BN-350. It is nine stories high and was depicted in an article by Leipunskii, Afrikantov, Orlov, Pinkhasik, and others in 1967.[71]

The present schedule for the BN-350 is: Oct.-Dec., 1971 - "run-in" of equipment and controls; first quarter 1972 - first critical assembly; late 1972 - first power output. Dr. Yurchenko said that the construction was 95% complete.

Mangyshlakenergozavod Personnel

Yurchenko, Dmitrii Sergeevich - director of nuclear project

Timofeev, Anatolii Efimovich - chief of BN-350 reactor

Vasilenko, Konstantin Timofeevich - chief engineer of the BN-350

Baklushin, Rudol'f Petrovich - deputy chief engineer for production

Pomerantsev, Gleb Borisovich - professor, doctor of engineering, deputy chief engineer for scientific problems

Kiselev, Gennadii Vladimirovich - deputy director of "Glavatomenergo" department

Epikhin, Mikhail Frolovich - chief electrician

Tverdovokii, Ninel' Dmitrievich - chief of H.P.

Vakhnin, Ivan Grigor'evich - chief of the industrial water supply installation

Pavozkov, Vyacheslav Alekseevich - chief of technical information

Akel'kin, Viktor Alekseevich - senior engineer of the Division of Technical Information

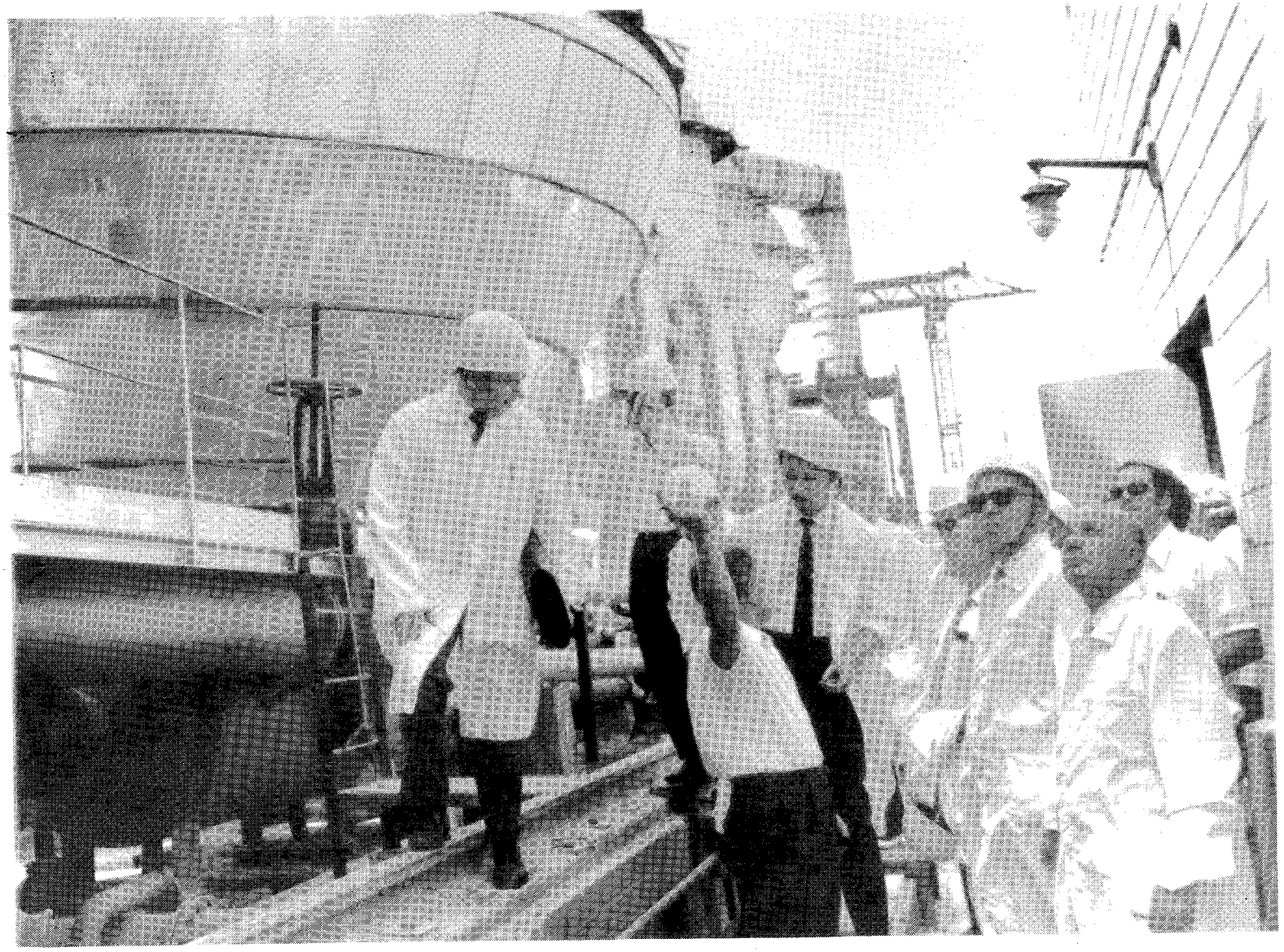
Martyushev, Fedor Grigor'evich - literature researcher for the director

Other Personnel

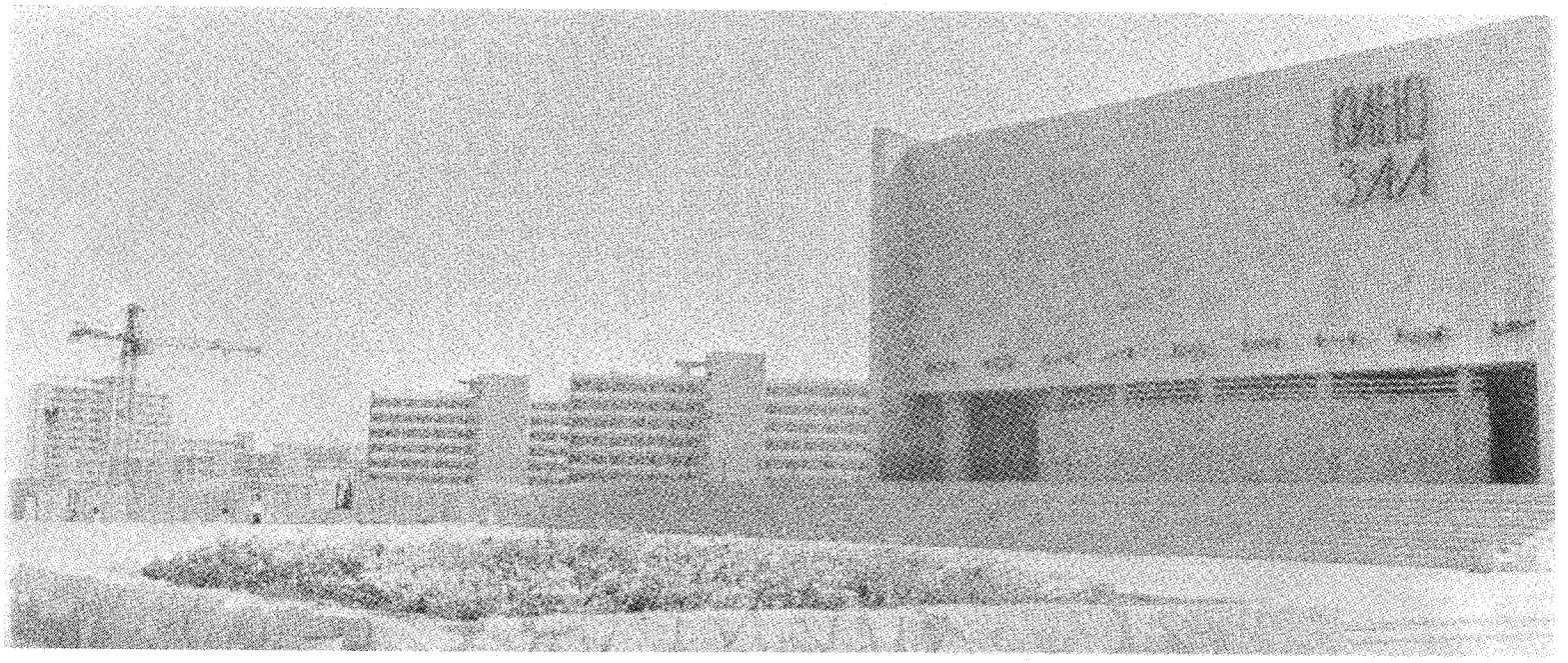
Tyulenev, A. A. - supervisor of all construction at Shevchenko

At the BN-350 Reactor. The top shielding is not yet installed.

At the Fuel Handling Control Panel
of the BN-350.



At the Vertical Tube Evaporators of the Desalination Plant.



A General View of Shevchenko Town.

11. Physics and Power Engineering Institute at Obninsk

The Physics and Power Engineering Institute at Obninsk is one of the two leading nuclear reactor theory and design establishments in the Soviet Union. After the Kurchatov Institute of Atomic Energy, it is also the oldest.

At Obninsk, under the direction of A. I. Leipunskii, the Soviet LMFBR program has been developed and the first Soviet fast critical assemblies were made. The BR-5 reactor has been in operation with various fuel loadings and test fuel assemblies, since 1959. In addition, sodium technology and component conceptual design have been developed at Obninsk.

Many other reactor design concepts have been conceived and demonstrated at Obninsk, including the AM-1 pressure tube, graphite-moderated, light water-cooled reactor, a whole series of low power APS for remote locations starting with the TES-3 semi-mobile pressurized water reactor APS.

Supporting scientific, metallurgical, and computational work is also conducted at the PPI.

This institute has been visited by many American groups and individual Americans on scientific visits to Russia. In addition to this organization, which is under the administrative cognizance of the SCAE, there are other scientific and medical organizations based at Obninsk. Thus, Obninsk is a "science town" that for size and diversity of efforts is probably matched by few others.

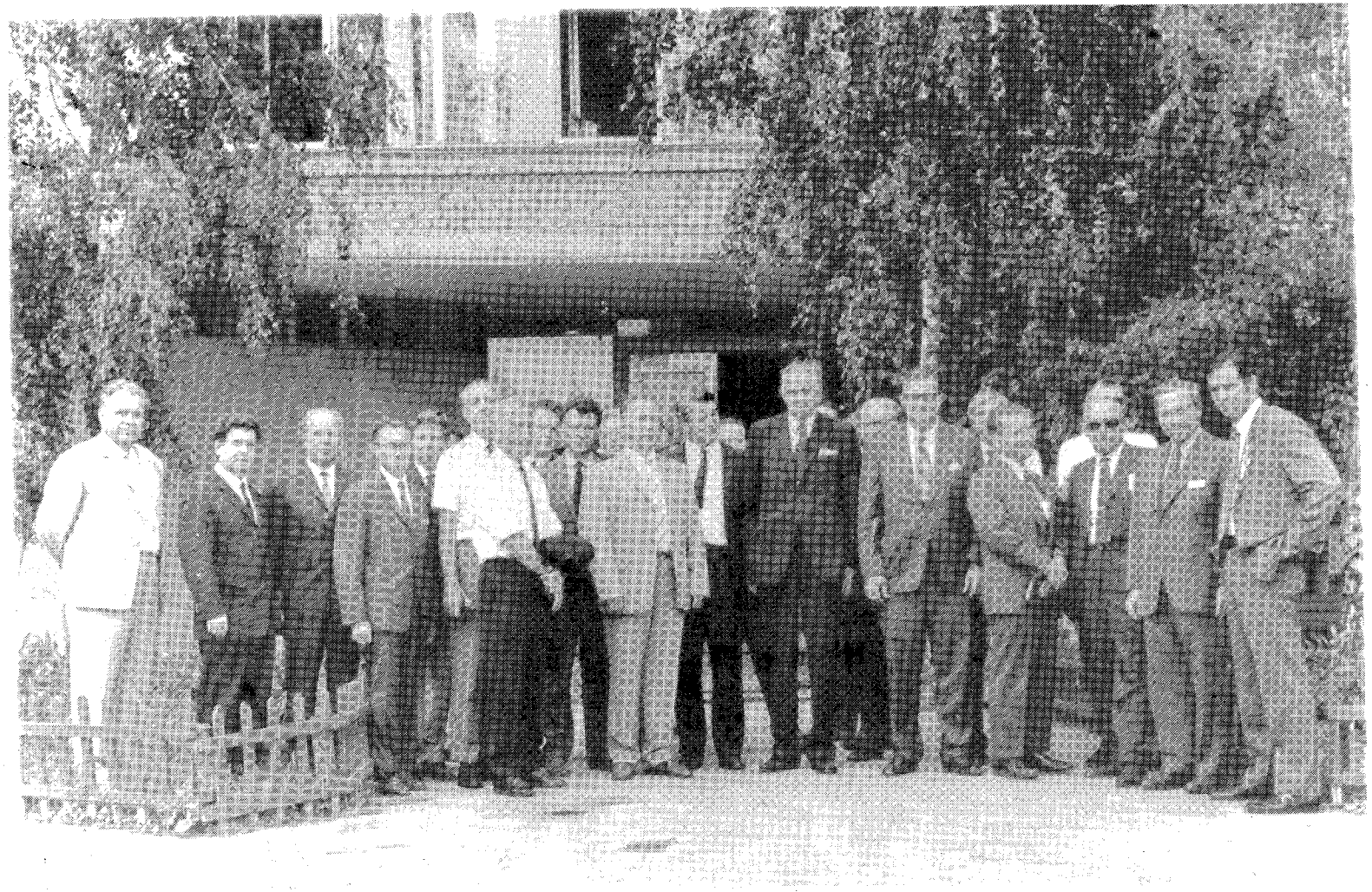
Dr. V. A. Kuznetsov, who became director of the PPI in 1968 or 1969 and whose name has been associated with various types of reactor and conversion equipment for many years, gave us a general briefing about the Institute:

It is basically a reactor development institution. In addition to earlier reactor configurations that are well known, the Bilibino heat-power station and the "Sever" (North) small package power plant were developed during the past few years. (For "Sever" reactors see ref. 24 and for Bilibino station see ref. 3, page 145.)

The principal thrust of the work at PPI, however, has been LMFBR development. Over the years, in addition to analytical work,[50] critical assemblies have been made for fast neutron systems. These were used for physics studies for the IBR-2 at Dubna, the BOR-60, and the BN-350, among others. The neutron spectrum of the BN-600 was modeled here and physics studies for the BN-600 are continuing.

No design work is done at PPI (obviously this means no mechanical or electrical detail design), but specifications for reactor, core, steam, and auxiliary systems are drawn up here. Exchange of opinions is carried on with the design institute, and the final design of parts and systems must be approved by PPI people.

PPI people participate in the formulation of test specifications, in the tests themselves, and in the start-up operations. Observation of operations is also conducted by PPI.



At the Physics and Power Engineering Institute at Obninsk - outside the liquid metal engineering building.

Soviet Fast Reactors*

Parameter	BR-5	BOR-60	BN-350	BN-600
Power, thermal, MW	5	60	1000	1500
Power, electrical, MW	-	12	150 + 120×10^3 tons/day distilled water†	600
No. of coolant circuits	2	2	6	3
Na inlet T, °C	430	360-450	300	37.7
Na outlet T, °C	500	560-620	500	550
Maximum cladding T at hot spot	600	700-750	680	700
Maximum neutron flux, nV	10^{15}	3×10^{15}	8×10^{15}	1×10^{16}
Fuel	UO_2 PuO_2 UC	UO_2	UO_2	UO_2
Burnup actually achieved, in % of heavy nuclei	7% in PuO_2 5% in UC			
Linear heat rates (maximum) watts/cm		400 (so far)	410	520

*Taken from ref. 11, with additions)

†Has generating capacity installed for 250 if information on installed generators is correct.

Other Fast Breeder Reactor Programs

Other countries are, of course, also pursuing breeder reactor development programs. For perspective we include here plants that are in operation or expected to become operational in the 1970's.

Country	Name	Power MW(th)	Power MW(e)	Type	Initial Operation
USA	Enrico Fermi	200	66	Loop	1963-1970 f.p.*
USA	EBR-II	62.5	20	Loop	1964
USA	SEFOR	20	-	Loop	1969
USA	FFTF	400	-	Loop	1974
USA	Demo #1	750-1250	300-500	?	1977
USA	Demo #2	750-1250	300-500	?	1979
Great Britain	Dounreay DFR	72	15	Loop	1959
Great Britain	PFR	600	250	Pool	1972
Great Britain	CFR	3125	1250	?	1979
France	RAPSODIE	40	-	Loop	1967
France	Phenix	600	250	Pool	1973
Germany	KNK-II	58	20	Loop	1973
Germany-Benelux	SNR	730	300	Loop	1976
Japan	JEFR	100	-	Loop	1973
Japan	JPFR	750	300	Loop	1976
Italy	PEC	140	-	Modified Pool	1975

Thus the 1970's should see beginning of nuclear electric power generation from fast reactors with the British PFR and Soviet BN-350 due to start-up within the same year.

The 1980's then may see the exciting realization of fuel (^{239}Pu and/or ^{233}U) breeding.

*f.p. - full power reached in 1970.

A Note on Fuel Cladding Material Tests

In December 1969 an article was published that described tests of high temperature mechanical properties of irradiated stainless steels.[86] The article was published with the unusual note by the editors: "While publishing this article the editorial board notes that both in the U.S.S.R. and abroad there are differing points of view on the phenomena discussed here."

The article compared the high temperature creep and tensile strength of three steels after irradiation in the SM-2 reactor. The essence of the findings was that the presence of boron in small proportions did not lead to high temperature embrittlement and even improved slightly the long-term tensile strength of the steel.

The three steels tested were:

	Chemical Composition w/o									
Designation	e	Si	Mn	S	P	Cr	Ni	Mo	Nb	B
OKh16N15M3B electric arc melt (this is EI847 steel)	0.06	0.44	0.58	0.007	0.013	16.88	14.75	2.84	0.47	-
OKL16N15M3BR electric arc melt	0.07	0.34	0.42	0.009	0.012	15.40	14.65	2.80	0.69	0.005
OOKh16N15 induction melt	0.03	0.39	0.57	0.019	0.007	15.20	15.20	-	-	-

All three batches of samples were held at 1120°C to 1150°C for 30 minutes and air cooled before irradiation. Irradiations were made to $2 \cdot 10^{20}$ nvt fast and $1 \cdot 5 \cdot 10^{20}$ nvt thermal.

The general conclusions were:

1. The austenitic stainless steels OKh16N15M3B and OKL16N15M3BR that differ only by the presence of 0.005 weight % boron in the latter retain good plasticity up to temperatures of 800°C after irradiation in the SM-2. At the same time high temperature embrittlement is noted in OOKh16N15 steel. The embrittlement may however also be connected with unequal contaminants and nonmetallic inclusions, between the steels, that were melted in different furnaces.

2. The grain boundary presence of borides and near-boride zones in OKh16N15M3BR steel, after irradiation, testify to the presence at the grain boundaries of lithium and helium products of the neutron reaction with the ^{10}B isotope.

3. Boron, when present in quantities not exceeding 0.005 weight %, does not detract from the high temperature properties of irradiated austenitic steel. In this the results contradict the hypothesis that ascribes embrittlement to helium bubble formation.

The possibility then, of including boron in EI847 steel, was discussed during our visit to Melekess and to Obninsk.

The paper at Geneva IV by Agapova et al.[87] again asserted that niobium and boron in small quantities in the basic low carbon 16% Cr, 15% Ni, 3% Mo, steel improves the high temperature embrittlement properties of irradiated steel and that investigations are continuing.

12. The Kurchatov Institute of Atomic Energy at Moscow

Dr. M. D. Millionshchikov, who is the Vice President of the Academy of Sciences, Editor-in-Chief of Atomnaya Energiya, and Chairman of the Supreme Soviet of the RSFSR, as well as a researcher in heat and mass transfer processes,[89] gave the welcoming introductory address upon our arrival at the Institute.

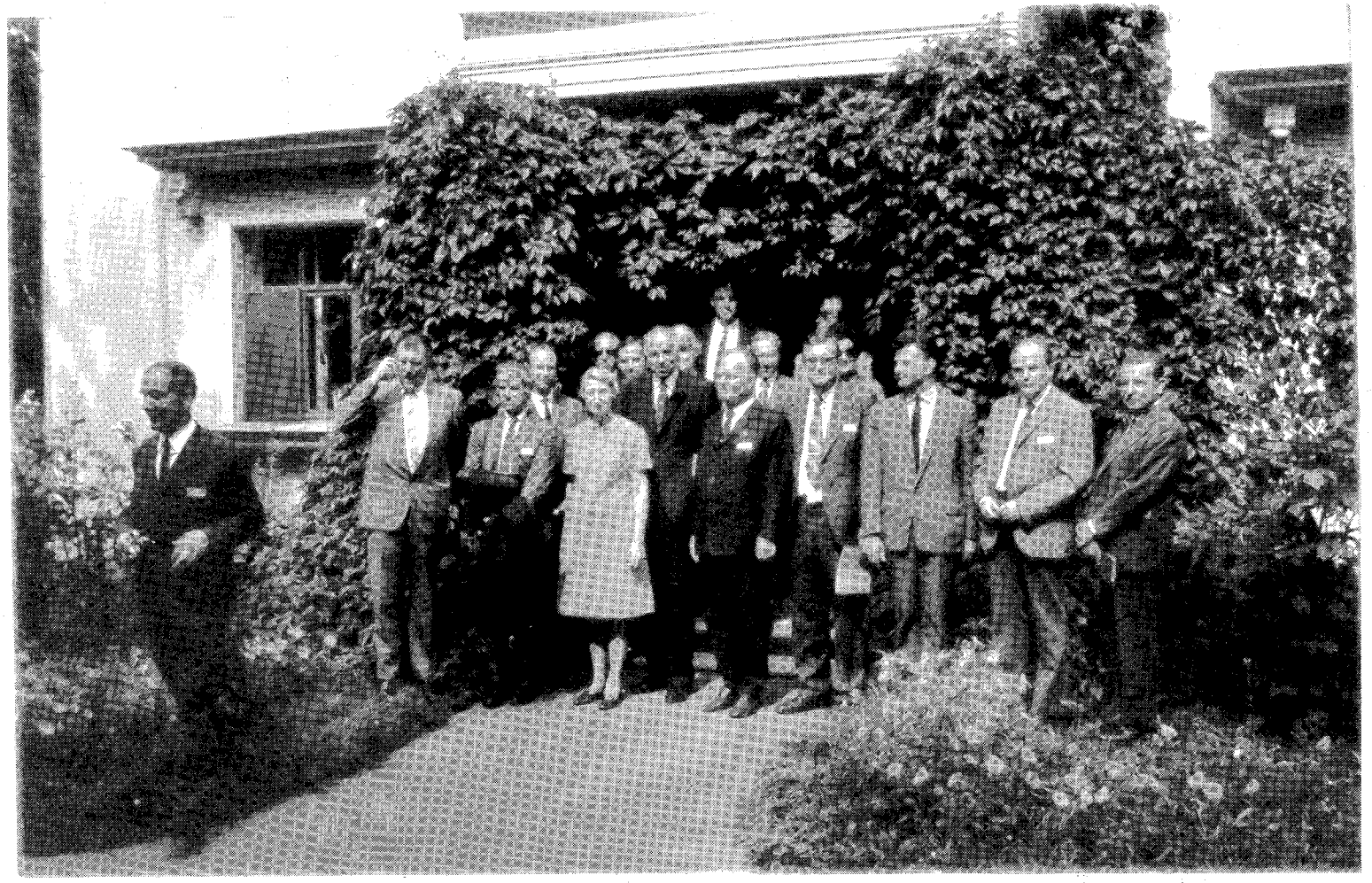
The Institute, as is well known, traces its origins to the initial organization of the Soviet fission program. In this sense, all the fission and fusion programs and institutes originated here. However, the most recent developments at the Institute, outside of CTR research, enumerated by Dr. Millionshchikov are cryogenics labs; the superconductivity laboratory; and the "MR" reactor.

As is well known, the Institute has been the scientific consultant to the Soviet PWR development and is now the scientific consultant to the zirconium-clad pressure-tube power reactor program.

The Kurchatov Institute has been the scientific "home" of all pressurized water-cooled, central station power reactors in the USSR, the first of which was the Novovoronezh power reactor of 210 MW(e).

Division of Solid State Physics

This division is only two years old at the Kurchatov Institute, although it is clear that the areas of research have been active to various degrees for many years. The director of the new division is N. A. Chernoplekhov and his deputy appears to be B. N. Samoilov. Both of these gentlemen visited the United States in February, 1964, as members of the Solid States Physics Delegation. Samoilov was one of the winners of a government bonus in 1969 for the development of a new method of polarizing atomic nuclei and for research on magnetic effects in nuclear interactions.



At the Kurchatov Institute of Atomic Energy. Dr. M. D. Millionshchikov is between Dr. Seaborg and Mr. Hollingsworth.

Basic Performance Parameters of PWR-APS in the USSR†

Parameter	Novovoronezh APS 1st Block	Novovoronezh APS 2nd Block	Novovoronezh APS 3rd and 4th Blocks, Each	New APS 1st and 2nd Blocks, Each
Start construction	1957	1963	1967	1970
Power, MW	210	365	440	1000
Turbine, MW	70	73	220	500
Steam pressure atmos.	29	30	44	60
Net station efficiency %	25.5	25.7	29.7	32.5
PWR per loop, MW	35	46	73	250
Specific volume of principal buildings M^3/kW	1.14	0.92	0.86	0.7
Cost of installed capacity rubles/kW	326	186*	127*	130
Unit PWR cost kopeks/kW·hr	0.95**	0.7	0.5	0.4

†Taken from ref. 27.

*Cost of expanding station.

**Actual - for the year 1968.

Kurchatov Institute

"MR" - Reactor

Presentation by
Ryazantsev, Evgenii Petrovich

Experimental Loops in "MR" Reactor

Designation	No. of Channels	Fluids	Pwr. MW.	Flow Rate Tons/Hr	P kg/cm^2	Max. T °C	Clad Max. T
1. PVTs	7	H_2O - Steam	3	30	100	450	525
2. PVK	5	H_2O - Steam	3	>150	100	310	350
3. PVO	3	H_2O	2	30	200	350	365
4. PVU - Carbon-Steel	3	H_2O - Steam	3	30	100	310	350
5. PO	2	Liquid Organic Coolant	1	30	20	400	450
6. PG	1	He	1	2	100	800	1500
7. PVTs-M	2	H_2O	0.2	5	100	300	320
8. PPG	1	Inert Gas	0.05	-	50	-	1700
9. PND	1	H_2O	0.02	-	50	-	2000

Since 1964, when it first began operating, the total power output of the reactor has more than doubled to 40 MW from the fuel elements and over 10 MW from the in-core loops, for a total of about 50 MW. At the present time, the core configuration has been modified to the point where the number of test loop positions in the core is equal to the number of driver fuel positions.

The areas of interest of the new division were enumerated by Chernoplekhov as follows:

1. neutron scattering (diffraction)
2. Mossbauer effect in gamma-ray emissions
3. superconductivity
4. low-temperature techniques and physics
5. derivation of neutron interaction constants.

Superconductivity Work

In 1967, the first superconductive system operated at the Kurchatov Institute. It had a stored energy of 1/2-megajoule and created a field of 53 kiloOersteds peak in a volume of 10 liters.

One of the purposes of the superconducting system work was said to be the development of capacity to provide the CTR program with such systems when they become necessary.

We were shown a model of a new magnet installation that is presently under construction. This is the same magnet that will be turned over to Zavoiskii's CTR group. The volume of the magnet will be 1-1/2 m long and 1 m in diameter. 30-35 kiloOersteds will be produced in this volume by superconducting coils of Nb-Ti alloy conducting 6000 A. The conductor will be forced-convection cooled by liquid helium at a pressure of 10-12 atmospheres. Maximum field generated will be 40 kOe at the bus.

It was stated that there is a comparable magnetic volume at CERN, and that the Kurchatov unit will be the second in the world. However, this was said to not be an end product, but only a stepping stone. Although the current density will be high, the magnetic field achieved is relatively low. The next magnet will try for a higher field.

A gentleman named V. E. Keilin was said to have prime responsibility for design and construction of superconducting magnets.

The Electron Linear Accelerator

We visited the IAE's linear electron accelerator, which seemed to be in Chernoplekhov's division. There was what appeared to be extensive mechanical work going on at the target room. The targets are apparently all uranium, clad in stainless steel, as at the BFS-1 facility at the PPS. However, there are five targets, each with their own "chamber," which probably means "chamber for retraction out of the electron beam." Two targets are for reactor physics constants studies and three are for solid states physics experiments.

The average electron energy will be 60 MeV and the current, in pulses, will be over 1 A. The pulses will be from 5 μsec down to 0.01 μsec duration, and the maximum power in the beam will be over 50 kW.

This accelerator was designed at the Radiotechnical Institute of the Academy of Sciences in Moscow and a description was published in Atomnaya Energiya in 1969.[88] We include here a plan view of the accelerator installation and a table of linear electron accelerators included in the article with the addition of the recent large linear accelerator installed at Oak Ridge.

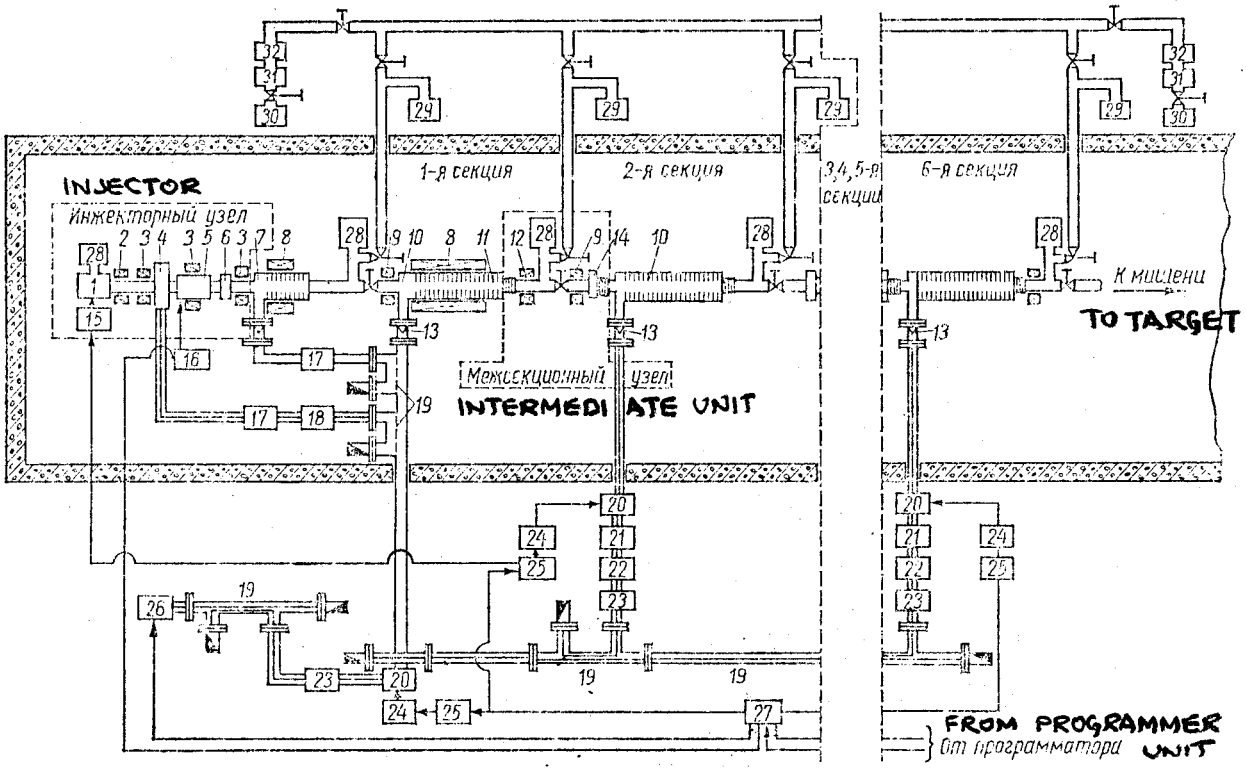


Diagram of 60-MeV Electron Accelerator

1. electron gun
2. trimming coils
3. lens
4. chopper
5. inflector
6. deflection magnet
7. buncher
8. focusing coil
9. current and beam location sensors
10. diaphragm waveguide
11. waveguide load
12. quadrupole lens
13. waveguide window
14. Lamellar beam dump indicator
15. gun pulsed transformer
16. inflector modulator
17. phase shifter
18. attenuator
19. directed deflector
20. klystron tube
21. phase shifter
22. ferrite valve
23. attenuator
24. pulsed transformer
25. klystron modulator
26. exciter
27. timer
28. high vacuum pump "Nord 10"
29. vacuum unit TsVA-1-2
30. vacuum unit AVM-50
31. zeolite filter
32. nitrogen trap

PARAMETERS OF SOME LINEAR ELECTRON ACCELERATORS

	Country	City	Organization	Electron Energy	Pulsed Current Amperes	Pulse Duration μsec	Charge per Pulse in μCoulombs
1	USSR	Moscow	Radiotechnical Institute, KIAE	60	1	5.5	5.5
2	USA	Gaithersburg,Md.	NBS	100	0.5	6	3
3	USA	Troy, N. Y.	Rensselaer Univ.	35	0.82	4.6	3.8
4	USA	Stanford, Cal.	Stanford Univ.	16,000	0.025	1.5	0.037
5	USA	Seattle, Wash.	Boeing Co.	6	2.7	8	21.6
6	USSR	Khar'kov	PTI-AS-UKSSR	1,800	0.01	1	0.01
7	USA	California	California Univ.	35	0.5	30	15
8	France	Orsay	Ecole	1,300	0.08	1	0.08
9	Italy	Frascati	National Lab.	400	0.1	3.2	0.32
10	USSR	Moscow	KIAE	25	0.25	0.6	0.15
11	USSR	Moscow	-	5	1	5	5
12	Belgium	Mol	Euratom	80	0.2	1.5	0.3
13	France	Sacle	KEA	46	0.085	2	0.17
14	France	Sacle	KEA	500	0.05	10	0.5
15	England	-	-	4	1	2	2
16	USSR	Moscow	MIFI	3	0.18	3	0.54
17	USSR	Khar'kov	PTI-AS-UKSSR	400	0.05	1	0.05
18	USA	Stanford, Cal.	Stanford Univ.	630	0.05	1	0.05
19	Canada	Saskatoon	Saskatchewan Univ.	98	0.158	1	0.158
20	USA	Livermore, Cal.	Univ. of California	22	0.25	2	0.5

PARAMETERS OF SOME LINEAR ELECTRON ACCELERATORS

	Country	City	Organization	Electron Energy	Pulsed Current Amperes	Pulse Duration μsec	Charge per Pulse in μCoulombs
21	Germany	Hamburg	-	46	0.25	1.6	0.4
22	USA	San Diego,Cal.	Gulf General Atomic	25	0.5	4.5	2.25
23	USA	Ithaca, N.Y.	Cornell Univ.	10	0.2	1	0.2
24	Japan	Tokyo	Tokyo Univ.	10	0.15	2	0.3
25	USA	Oak Ridge,Tn.	ORNL	140	16	2.3×10^{-3} to 1	0.24

People We Met at the Kurchatov Institute

M. D. Millionshchikov - academician

E. P. Velikhov - Deputy Director

V. N. Kosyakov - transuranium chemistry group leader

S. M. Feinberg - reactor analyst and designer

N. A. Chernoplekhov - Solid States Division Director

E. P. Ryazantsev - M.R. Reactor Director

K. A. Razumova - CTR Program group leader

G. M. Dzhubailov -

B. N. Samoilov - physicist

N. G. Koval'skii - CTR Program physicist

S. A. Trofimov -

E. V. Novikov -

E. N. Babulevich - M.R. Reactor Operations Chief

M. A. Andrianov - CTR Program physicst

V. F. Gerasimov - Solid States Division physicist

V. E. Keilin - superconductivity laboratory leader

13. Final Meeting at the Offices of the SCAE and Farewell Dinner at the Sovetskaya Hotel

On August 17, immediately following our visit to the KIAE, a final formal meeting was held at the offices of the State Committee on Atomic Energy. The entire American delegation and Mr. William Harben of the U. S. Embassy were present.

From the Soviet Union, present were Messrs. Petrosyants, Meshkov, Patrakeev, Velikhov, Leipunskii, Kuznetsov, Chuvilo, Meshcheryakov, Prozorov, Semenov, Filippov, Menshikov, and Timerbulatov, all of whom we had met in the course of our visit. In addition, there were Mr. I. I. Smolin and Mrs. D. F. Khokhlova of the SCAE-IRD.

Both Dr. Seaborg and Mr. Petrosyants expressed satisfaction with the visit and with the physical and mental endurance displayed by both hosts and visitors.

A number of topics regarding the exchange program were discussed, among them the following:

1. A visit by Soviet high-energy physicists to the National Accelerator Laboratory at Batavia, Illinois.
2. A possible exchange of information on LMFBR startups and, in particular, the forthcoming startup of BN-350.
3. An extended working visit by scientists from Protvino to UCLA for collaboration with Dr. Darrell Drickey's group in the analysis of experiments done on the Serpukhov accelerator.
4. An invitation to Soviet scientists to attend a Symposium on Transplutonium Elements at Argonne National Laboratory in October 1971.

5. An invitation to Mr. Petrosyants and his colleagues to attend the International Meeting of the Atomic Industrial Forum and American Nuclear Society in Washington, D. C., in November 1972.
6. A possible exchange of data and visits between Stanford University and Brookhaven National Laboratory and Soviet high-energy nuclear physicists.
7. A tentative invitation to Dr. Ghiorso of Lawrence Radiation Laboratory to visit JINR at Dubna and attempt to resolve some differences in interpretation of experimental results that seem to have arisen.

That evening the SCAE was host at a farewell dinner for the American delegation. Chairman Petrosyants wished us well and in particular offered a toast to Dr. and Mrs. Seaborg upon their impending departure from Washington.

In referring to our extensive tour, he affirmed that we had seen some of his country's achievements - the material as exemplified by the buildings, plants, and institutes - and the human achievements as exemplified principally by the outlying republics. He reminded us that the older generation of Soviet people, in particular, remembers well the sacrifice out of which the achievements were born.

With this dinner was concluded our formal visit as guests of the SCAE.

14. Interview with Dr. Glenn T. Seaborg As Reported in the Literary Gazette of the 25th of August, 1971, Front Page

(Note: As a result of the translation into Russian, together with some editing by the Literary Gazette in order to shorten and polish the original transcript, and the translation back into English, this is not a verbatim reproduction of the interview.)

Interview "LG"

The Peaceful Atom - A Field For Cooperation

At the invitation of the State Committee for Atomic Energy and of the Academy of Sciences of the U.S.S.R. our country was recently visited by a group of American specialists in the field of atomic science and technology. The group was headed by the well-known scientist, Nobel-Prize Laureate and foreign member of the Academy of Sciences of the U.S.S.R., Glenn Seaborg. This was a return visit for one made to the United States in April 1971 by a group of Soviet scientists headed by the Chairman of the State Committee on Atomic Energy of the U.S.S.R., A. M. Petrosyants.

Today we publish the answers of G. Seaborg to the questions posed by A. Lepikhov, correspondent of the "LG." In the interview granted by the American scientist, not all his statements appear to us to be incontrovertible.

Q.- What is the current place of science in society?

A.- Science plays an important role in the lives of an ever-increasing number of people. People are living much more comfortably than in the past because science and its derivative technologies make it possible.

In my opinion, this contribution of science will grow in the future. And if we shall manage science properly, its growth will have tremendous significance not only for the United States and the Soviet Union, but for developing countries as well.

Q.- What future do you see for science? What discoveries do you expect?

A.- If we speak of the possibilities of atomic energy, for example, by the year 2000 we may perfect nuclear reactors and will obtain most of our energy from them. Radioactive isotopes will be used much more extensively in industry and agriculture. Perhaps we will have learned how to make artificial hearts powered by radioactive isotopes. Through nuclear energy we will dare go much deeper into space and perhaps will have landed on Mars.

However, the most important discoveries I expect in biology. We shall learn more of the mechanism of illness and using biological knowledge shall learn to cure it and even to prevent it.

There is also the probability that we shall learn to control life and to create it. We may reach the stage where we shall be able to exert control over the human organism to an even greater degree than may be desirable. Then we may find in our hands a frightening power - the ability to control personality. Then people may find themselves in the power of a small group of leaders. I speak of this not because I consider such an eventuality inescapable but to call attention to the need for proper coordination of our efforts in science and technology and to the need for extreme caution.

In the future we will completely conquer the moon, will learn how to produce enough food, but we must also remember that population growth could reach for infinity and finally even science may find itself unequal to the task of providing for an endlessly multiplying humanity.

I would also like to note one of the undesirable consequences of the development of science - everything could become so automated that people may lose the freedom of independent individual action and they may themselves become automatons. I do not really fear this, personally, but I do hear such fears expressed.

Q.- What are your impressions from the visit to our country?

A.- My group was assigned a special plane so that in nine days we visited nine cities where we saw the work of nuclear physics institutes. It seems to me that cooperation between Soviet and American scientists will improve as a consequence of our visit and the visits by your scientists to America. We became acquainted with the work of Soviet scientists and will be able to go on in the fields of peaceful uses of atomic energy without duplicating each other's efforts.

I also note with interest that in the Soviet Union there is generous support of the social sciences and literature and art. This is good for it allows all culture to develop uniformly and prevents the disproportionate advance of exact sciences and technology to the disadvantage of the enormous body of other knowledge.

15. Visit to the Znanie (Knowledge) Society

On the afternoon of August 18, Dr. Seaborg, accompanied by J. Lewin, went to the headquarters of the Znanie (Knowledge) Society, located on Serov Street in the building of the Polytechnical Museum.

We were met by the President of the Society, Academician Ivan Ivanovich Artobolevskii; Valerii Ivanovich Popkov, Chairman of the IRD of the Society; Vitalii Iosifovich Gol'danskii, Vice President and Deputy Chairman of the Society's Council on Popularization of Chemistry; Nina Dmitrievna Bakanova, Deputy Chairman of the Executive Committee of the Society and a candidate of historical sciences; and Elizaveta Victorovna Akimova, abstractor of the IRD of the Executive Committee of the Society. The office of the President of the Society is a largely honorary one, involving no salary. The chief executive position, however, is that of First Vice President, or Executive Chairman, and is a full-time job that is at present held by Yurii Fishevskii.

The Society publishes one of the most popular magazines in the Soviet Union, "Nauka i Zhizn'" (Science and Life), which can perhaps best be described as a combination "Scientific American," "Popular Science," and "Saturday Review" from the American scene. In addition, the magazine "Znanie Sila" (Knowledge is Strength) is published by the Society. Both magazines began publication in the early 1930's and as such predate the Society.

Dr. Artobolevskii outlined for us the history of the Society as follows: It was formally founded in 1947 by S. I. Vavilov, who was a former president of the Academy of Sciences and a well known physicist. However, the idea of such a society predates the revolutions when such Russian scientists as Stoletov, Chaplygin and others formed "knowledge" clubs and tried to popularize scientific thought among broader segments of the people.

The purpose of the Society is popularization of science and technology among the general population. In some respects, then, it is a counterpart of the American Association for the Advancement of Science.

The membership of the Society is 2,300,000 people, including 700,000 teachers, many medical doctors, and almost all corresponding members and academicians of the Academy of Sciences. The requirement for membership is a basic higher education or recognized expertise in some field and an interest in explaining and popularizing knowledge. This membership is organized into 126,000 groups or clubs, for an average of about 20 people per club. These clubs are associated in regional sections with their own officers and each of the 15 Soviet Republics has its own branch with officers who serve on the central "Znanie" executive committee. There are no individual membership dues, the Society's income emanating from publications and other sales.

There are also institutional memberships such as the Technological Museum and the Technological Library in Moscow, and some 40 planetariums all over the country.

The total publication volume of the Society is about 100,000,000 copies per year of magazines, books, and pamphlets. The volume of Nauka i Zhizn' (Science and Life) alone is over 3,000,000. The pamphlets included 670 titles in 1970. The Society also operates a plant in Moscow that produces slides and visual aids for lectures. The income of the Society is derived entirely from the sale of its publications and from the small fees (about six rubles) that are paid to the Society when a member gives a lecture at some institution, usually a factory or collective or Soviet farm. The lecturers receive no fees for such lectures.

Up to about eight years ago, the Society received government subsidies but converted to a self-supporting basis. (It is interesting that what has been called The Economic Reform, a greater economic-managerial autonomy, began to be introduced at about this time in Soviet agriculture and industry.)

The Society operates what are called "People's Universities" that, as we understood it, are evening programs of study that encompass one, two, and even three years. Subjects in the social sciences, pedagogical sciences, as well as the exact sciences, are offered. Last year there were 22,500 such "universities" attended by 5 million people, or about 220 people per unit. It was not clear to us whether any of these carry academic credits.

The Society also presents about two hours of television per week.

Over the years, the Society has accumulated some capital from its operations and now plans to build its own centers, or "Houses of Popular Science" all over the country. Two such centers are already in operation - one in Kiev and one in Tashkent. Next year construction will begin on a large center in Moscow. It will feature five lecture halls, one of 1600 seats, two of 800 seats, and two more of 350 seats each.

The Society presents a number of "Vavilov" medals for outstanding work in science popularization. It sponsors annual competitions for the best books in each of several fields.

Dr. Artobolevskii conveyed to Dr. Seaborg the Society's desire to develop some contacts and exchanges of lecturers with the AAAS.

16. The Institute of Physical Chemistry

Dr. V. I. Spitsyn, the Director of the Institute, invited Dr. Seaborg to address the Institute staff on current developments in transuranium element research, and to tour the Institute. Thus, Dr. Seaborg and Mr. Lewin went to the Institute in the southwest part of Moscow, on the morning of August 19.

This institute is an establishment of the Academy of Sciences, but a close working relationship exists with the SCAE in the area of radioactive waste disposal. The old institute building, on Leninskii Prospekt, is now overshadowed and partly hidden from view by a new steel and glass structure of one of the branches of the Academy of Medical Sciences. However, the Institute boasts a new "campus" for its Radiochemical Departments on the southwestern outskirts of the city. This new area was included in the visit, after the address which was made to an enthusiastic audience in a packed auditorium.

Victor Ivanovich Spitsyn gave the introductory briefing:

The total population of the Institute is 1,300 people, and the Radiochemical Department has 300 of this total. Of these 300 persons, 100 are scientists. Another 100 are classed as technicians, and the last 100 are "workers." The Radiochemical Department houses a number of specialized small laboratories, a Van de Graaff Accelerator, and a radiactive waste disposal laboratory, as well as a waste disposal facility from which radioactive material is sent to the Moscow Radiactive Waste Processing Plant. The Institute also has a section that specializes in transuranium element research.

17. Visit to the Headquarters of the Academy of Sciences of the U.S.S.R.

On the afternoon of August 19, Dr. Seaborg was invited to call on Dr. M. V. Keldysh, President of the Academy of Sciences at its headquarters building on Leninskii Prospekt. Dr. Rodney Cool and Joseph Lewin were with Dr. Seaborg on this occasion.

In addition to Dr. Keldysh, Dr. M. D. Millionshchikov, Dr. V. I. Spitsyn, and Dr. S. G. Korneev, as well as Miss Agnes Nabatova,were present at the meeting. Dr. Keldysh, as well as Drs. Millionshchikov and Spitsyn, speak English quite fluently and the conversation ranged smoothly over several topics of mutual interest, particularly the perspectives for a future particle accelerator to achieve at least 5000-GeV proton energies, and projected bilateral or tripartite (including CERN) discussions of instrumental requirements for high-energy physics.

Dr. Keldysh outlined briefly some recent organizational developments in the Soviet Academy, including the creation of a Far Eastern Branch of the Academy at Vladivostok.

The headquarters building of the Academy is the former Niskuchnyi Palace, given to Catherine II in the eighteenth century as a suburban estate. This served as the home of the Czars in Moscow, in contrast to the official residence at the Kremlin, and today still preserves much of the elegance of a palace. The room in which Dr. Keldysh received us was called "The Nicholas-II Room" for it had served that Czar as a study, and models of space vehicles, geological samples and volumes on mathematics, mechanics, astronomy, and physics, many of them in the English language, were enshrined on shelves and tables in regal decor.

18. Some Examples of Areas of Interest of the Academy of Sciences of the U.S.S.R.

As Walt Kelly's American sage Pogo once said, "Words are not immutable - they mute, they shift, they change." Thus the words "sciences" and "academy" taken together or separately do not always mean quite the same thing in Soviet and American contexts. For this reason, as well as for reasons of absolute, non-comparative interest, we include here a few excerpts that illustrate the many fields and the variety of approaches to different topics that are included in the circle of interest of the Academy of Sciences of the U.S.S.R.

All the items are taken from the Bulletin of the Academy of Sciences (Vestnik Akademii Nauk) which is edited by Dr. Millionshchikov and offers a broad overview of activities under the general aegis of the Academy. The table of contents of one issue is reproduced to show the broad scope of subject matter.

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VESTNIK OF THE USSR ACADEMY OF SCIENCES

Vol. 41, No. 9, 1971

Selected articles from the Russian-language periodical Vestnik Akademii Nauk SSSR published by the USSR Academy of Sciences.

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From the Bulletin of the Academy of Sciences No. 6, 1969.

Organization of a Commission on the Problems of Conservation of Natural Water Resources

The pollution of natural water resources by industrial and municipal effluents has so seriously restricted the available water supplies and their utility, that in many high-population-density, economically important areas of the U.S.S.R. there threatens a shortage of water vis-a-vis the current requirements. Thus, the conservation of natural water supplies has has become one of the most pressing current problems, while scientific work on this problem is developing inadequately.

In view of this, the Presidium of the Academy of Sciences of the U.S.S.R. has decided to organize a special Commission on the problems of conservation of natural water resources. This Commission will be affiliated with the Section of Chemical Technology and Biological Sciences, and with the Section of Earth Sciences.

The activities of the Commission will consist of the development of recommendations related to the organization and development of research on the conservation of natural water resources in its limnological, oceanological and chemical aspects, to be conducted at scientific establishments of the Academy and of the Academies of the Union Republics; and will also consist of coordination and cooperation with other agencies conducting complex research programs, in order to produce scientific methods of prognosis of water conditions and changes resulting from contamination of supplies.

The Commission is a scientific-methodological and operative agency and therefore must facilitate the solution of the more serious problems of conservation of water resources.

The Chairman of the Commission is Academician N. N. Semenov, and the Co-Chairman is Academician A. P. Vinogradov.

(Translation by JPRS)

PROBLEMS OF AMERICAN STUDIES

(Conference in Moscow)

[Article by Candidate of Historical Sciences G. S. Khozin; Moscow, Vestnik Akademii Nauk SSSR, Russian, Vol 41, No 9, September 1971, pp 109-110]

The complex study of the politics, economics, ideology, and social problems of the United States in the contemporary stage is of great scientific and practical interest; it gives the key to an understanding of many phenomena in the domestic and foreign policy of the leading power of the imperialist camp. On 27-28 May in Moscow a scientific conference was held on the theme, "The USA in the 1970s". Its organizers were the Institute of the USA and the Institute of World Economy and International Relations of the AS USSR. Participating in the work of the conference were over 300 specialists from Moscow, Leningrad, Kiev, Novosibirsk, Tomsk, and Irkutsk.

Discussed were such major problems as the contemporary state of the economy of the USA and extra-economic expansion, scientific and technical progress and its consequences, the foreign policy and military-political strategy of the USA, problems of administration, domestic-political and social. At the plenary sessions and in the sections 14 reports and over 40 presentations were heard.

Opening the conference, the director of the Institute of the USA G. A. Arbatov noted that an overall result of the development of the USA in the past decade was a sharp aggravation of internal problems on a scale unprecedented since the Civil War. Not only the economy but also the foreign policy of the country are going through a serious crisis.

From the Bulletin of the Academy of Sciences #1, January 1971

(Translation by JPRS)

INTERNATIONAL COLLABORATION OF SCIENTISTS

(General Assembly of the ICSU in Madrid)

Ye. D. Lebedkina [pp 100-103]

The regular, 23rd General Assembly of the International Council of Scientific Unions (ICSU), one of the most important non-governmental scientific organizations, of which the AS USSR has been a member since 1955, was held in the capital of Spain on 19-29 September 1970.

Participating in the work of the Assembly were about 300 persons representing 36 international organizations, including UNESCO, the World Health Organization (WHO), the World Meteorological Organization (WMO), the Pacific Ocean Scientific Association, the World Federation of Engineering Societies, and also national scientific research centers, councils and academies of sciences of over 40 countries of the world.

The AS USSR was represented by a delegation headed by the President of the Academy, Academician M. V. Keldysh. Academician V. A. Ambartsumyan also participated in the work of the Assembly as President of the ICSU.

All the sessions were held in the building of the Supreme Scientific Research Council of Spain.

The Assembly approved the holding of a number of international congresses, including an International Congress on Theoretical and Applied Biophysics, to be held in 1972 in Moscow.

THE IDEOLOGICAL STRUGGLE AND PROBLEMS OF CULTURE

(Conference in Moscow)

[Article by Doctor of Philological Sciences U. A. Gural'nik; Moscow, Vestnik Akademii Nauk SSSR, Russian, Vol 41, No 6, June 1971, pp 123-124]

The Department of Literature and Language, the Institut of World Literature imeni A. M. Gor'kiy of the AS USSR and the Academy of Pedagogical Sciences USSR held in Moscow on 17-19 March a scientific conference devoted to urgent problems of culture in the light of the ideological struggle taking place in our day.

Opening the conference, the Director of the Institute of World Literature imeni A. M. Gor'kiy, V. L. Suchkov, pointed out the need to establish a closer connection between literatur and culture and to determine the character of their interaction Very many factors of the spiritual life of contemporary man which at times appear to be not very well explained, he said, become more understandable thanks to literature as a part of spiritual culture, taken as a whole. The encounter of ideologies is projected on the image of life, on culture, and on literature, which we regard as a reflection of social reality, and therefore it is necessary to clarify the relation of literature and the social environment.

Heard at the conference were over 30 reports and statements of literary specialists, art specialists, philosophers, linguists, and workers of pedagogical science, who shed light on various aspects of the ideological struggle in the area of culture and subjected to argumented criticism contemporary bourgeois, leftist-revisionist and vulgarized theories of culture which abroad exert a strong influence on literature and art. Serious attention was given to analysis of leftist and rightist extremism, which acts on culture.

There were discussions of questions of the national characteristics of socialist culture, the specifics of "mass culture" in the countries of capitalism, and the importance of means of mass communication in the formation of political and esthetic views. The tasks of education of the new man and the contribution of socialist society to world culture were characterized.

19. Interview with Representatives of the American and West European Press on August 19, 1971

This interview with Dr. Seaborg was held at the Sovetskaya Hotel, following the visit to the Academy of Sciences. Mr. William Harben, Scientific Attache at the Embassy of the United States and Mr. Roger Lydon, Press Secretary of the Embassy, were present. The nine men from the press, including one photographer, F. Soloviov, from the Associated Press, included D. Bonaviya of "The Times;" Dieter Basil of the German Press Agency; James Yuenger of the Chicago Tribune; Peter J. Shaw of United Press International; Denis Legras of the AFP, French agency; David Levy of Columbia Broadcasting System; James Peipert of the Associated Press; and Julian Nundy of the Reuters Agency.

20. The XIII International Congress on the History of Science, at Moscow State University

On the morning of August 18, there opened at the Moscow State University the XIII International Conference on the History of Science. Dr. Glenn T. Seaborg was one of the opening speakers at the first session with an address on "The History of the Transuranium Elements and an Outlook for Their Future." Mrs. Seaborg, Mr. Julius Rubin, and Joseph Lewin accompanied Dr. Seaborg to the Conference. Miss Agnes Nabatova, an interpreter for the Academy of Sciences accompanied us on this trip and on subsequent visits to Academy of Sciences establishments.

The importance of this meeting, one of several international meetings going on more or less in rapid sequence in Moscow during the summer of 1971, was underscored by the galaxy of Soviet scientific notables in attendance. Keldysh, Kedrov, Kapitsa, Artobolovskii, Flerov, Spitsyn were some of those at the opening session. In attendance at this meeting were representatives of over 40 countries and a total of over 2,000 people.

The marble-columned, chandeliered and carpeted central auditorium was filled to overflowing and the press-photo and TV coverage seemed to compare favorably with that given a Miss America contest in Atlantic City.

Emblazoned in red and gold on each side of the stage were two interesting quotations:

> "There are no wide open highways in science, and its shining peaks can only be reached by him who unmindful of fatigue struggles up its stony trails."
>
> Lomonosov

and the formidable

> "One can become a Communist only after enriching the memory with knowledge of all the riches that humanity has developed."
>
> V. I. Lenin

The attention that the conference received in the press is to some degree exemplified by one full page of the Literary Gazette for the 25 August 1971 issue. At the top was an article by Academician B. Kedrov, organizer of the Conference, based on his address at the opening session and titled "Science - What is Ahead?"

The article was preceded by the following introduction:

> "On the 18 of August there opened in Moscow the XIII International Conference on the History of Science. How should the history of science be regarded - as a dead fossilized subject of interest only to historians, or as a powerful instrument for understanding the present and predicting the future? To this question was directed the report of the Chairman of the organizing committee of the Conference, B. Kedrov."

The rest of the page was devoted to a sort of polemic in print between Professor Derek Price of Yale University and Dr. S. Mikulinskii, a corresponding member of the Academy of Sciences. The two articles were entitled: "The Unavoidable Decline," by Derek Price, Professor of Yale University, USA, and "The Natural Laws of Progress," C. M. Kulinskii, Corresponding Member of the Academy of Sciences, USSR.

21. Departure

In August of 1971 downtown Moscow seemed saturated with foreigners. A major portion of them, naturally enough, were Europeans but in general they seemed to come from all corners of the world. Only to those over thirty years of age is such an observation remarkable, but since most of our group could remember one and two decades before the Second World War, this seemed a real measure of how much and how quickly mobility and accessibility in our world have changed. Of course our arrival on a Japanese airplane had been such a measure, as had the American and European credit card emblems at a couple of Moscow hotels, as were the new Zhiguli (Fiat) automobiles on Russian streets, and indeed as was the large picture of Sophia Loren taped up in a Moscow taxicab.

A boat ride on the Moscow River also revealed the many facets of this capital, each with its own story: the many small churches under restoration or already restored to gold-topped beauty; the large grey-stone office buildings of the fifties capped with sculptured cornices of wreaths and fanned banners in Napoleonic style; the baroque steepled ochre structures of the University and the Ukraine Hotel and others; the new steel and glass parallelepipeds now bidding to dominate the sky-line; the older metal-roofed four- and five-story stuccoed houses in faded pastel shades that had been silent witnesses to the cataclysms and convulsions of the past.

As the boat approached the Gorkii Park of Culture and Rest, a name on a column stood out boldly - BRUNSWICK - in English. This was part of the American bowling exhibit, called "kegel' ban" in the Russian papers, that spent the summer overlooking the Pushkin Embankment as part of an international exhibit of amusements called "Attractions - 71."

In the restaurant atop the Ostankino Television Tower the waitresses were dressed in light blue stewardess-type uniforms with chic little blue caps on their heads. A small poster on the wall said that because of their good work the employees were a"Komsomol Brigade of Communist Labor," an accolade that in our memory was more logically associated with kerchief-covered heads in a wheat field or at the Dnieper River Dam. The piped music in the revolving restaurant included to our over-thirty amazement "The Green Leaves of Summer" from the American movie "The Alamo." But a measure of the distance to the Alamo were the omnipresent slogans on bunting and banners: "Glory to the Party," "The Party and People are One," "The Party's Policies - We Approve!" and many others.

On August 21 there opened in Moscow the XXIV Congress of the International Association of Surgeons and the X International Conference on Cardio-Vascular Diseases. The morning edition of "Pravda" for the 22 of August, as the last of our group left for home, carried a greeting from the Soviet Council of Ministers to the many participants of these two meetings who in their American business suits crowded the entrance to the "New Intourist" Hotel, next to the old "National." The same paper carried an extensive "Review of the International Scene" which concluded with: "The capitalist world, in these last days of summer, is a picture of chaos and insurmountable social-political contradictions."

These were some of the impressions of the strata of the Soviet Union through which we passed. As our own country, and Europe, the Soviet Union is perhaps now a complex and stratified society. To a significant extent, as perhaps our trip and others like it have demonstrated, these various strata are separable under certain circumstances, for the good of both societies.

APPENDIX

Some Exchange Groups and Itineraries

The American group of July 1959 consisted of:

John A. McCone, Chairman, USAEC

John H. Williams, Commissioner, USAEC

Frank K. Pittman, Director, Division of Reactor Development, USAEC

Kenneth S. Pitzer, Dean, College of Chemistry at the University of California, Berkeley

Lyman Spitzer, Jr., Director, Matterhorn CTR Project, Princeton University

Alvin M. Weinberg, Director, Oak Ridge National Laboratory, Tennessee

Cecil King, Staff Assistant to Mr. McCone

Raymond Garthoff, Interpreter

Following the McCone visit of 1959, Dr. V. S. Emelyanov, Chairman of the SCAE, came to the United States in September of 1959 in the entourage of Chairman of the Council of Ministers Nikita S. Khrushchev. In the course of this visit discussions were held with Mr. McCone. These discussions led directly to the visit to the United States of November, and on the 24th day of that month the first Memorandum of Cooperation in the peaceful uses of nuclear energy was signed in Washington.

The Soviet group of November 1959 consisted of:

Vasilii S. Emelyanov, Chairman, USSR State Committee on Atomic Energy

Anatolii P. Aleksandrov, Director, Kurchatov Institute of Atomic Energy

Vladimir I. Veksler, Director, High Energy Laboratory at JINR

Nikolai A. Dollezhal, Director of Power and Construction Engineering

Aleksander I. Leipunskii, Scientific Director, PPI at Obninsk

Gennadii L. Konstantinov, Engineer, SCAE

Evgenii V. Piskarev, Director of Nuclear Physics, Institute of Nuclear Problems.

Pursuant to this memorandum, the year 1960 saw reciprocal exchange visits by groups of specialists in high energy particle physics and in controlled thermonuclear research. In addition, a group of Soviet scientists who had attended the Gordon Conference in New Hampshire that summer, toured some centers of nuclear chemistry research in the United States.

In June of 1962, two American scientists visited some Soviet corrosion chemistry research centers. In addition, during both 1961 and 1962, there were several visits by American scientists on a private basis or as participants in international scientific meetings, an increasing number of which were beginning to be held in the Soviet Union. An example was the Fifth International Congress of Biochemistry held in Moscow on August 9-16, 1961. The focus here is on scientists in United States Atomic Energy Commission sponsored programs. Obviously, there were other occasions for visits by scientists and engineers.

In 1963, the International Union of Pure and Applied Physics co-sponsored a meeting on high energy particle accelerators held at the JINR, Dubna. This was the first of these biennial meetings to be held in the USSR.

In 1963, with the atmospheric nuclear test ban approaching realization, the Chairman of the USAEC again led a group of Americans on a visit to Soviet nuclear centers. The members of this group were:

Dr. Glenn T. Seaborg, Chairman, USAEC

Dr. Gerald F. Tape, Commissioner, USAEC; and President, Associated Universities, Inc.

Dr.Manson Benedict, Chairman, General Advisory Committee, USAEC; and Professor, MIT

Mr. Alvin R. Luedecke, General Manager, USAEC

Dr. Albert V. Crewe, Director, Argonne National Laboratory

Mr. Albert Ghiorso, Scientist, Lawrence Radiation Laboratory

Dr. Alexander Zucker, Scientist, Oak Ridge National Laboratory

Mr. Algie A. Wells, Director, Division of International Affairs, USAEC

Dr. Arnold R. Fritsch, Technical Assistant to the Chairman, USAEC

Mr. Cecil St. C. King, Staff Assistant to the Chairman, USAEC

The delegation was also accompanied during the visit in the Soviet Union by Mr. Herbert Okun, Second Secretary, U. S. Embassy, Moscow.

They visited the following sites in the USSR:

Moscow State University, "Lebedev" Physics Institute, Institute of Chemical Physics, "Kurchatov" Atomic Energy Institute, Physics and Power Institute at Obninsk, Scientific Research Institute of Atomic Reactors at Melekess, "Khlopin" Radium Institute at Leningrad, "Ioffe" Physico-Technical Institute, "Efremov" Scientific-Technical Institute for Electrophysical Apparatus, Novovoronezh Atomic Power Station, Physico-Technical Institute at Kharkov, Joint Institute for Nuclear Research, Construction site of the 70-BeV proton accelerator.

In November, 1963, Andronik M. Petrosyants, Chairman of the SCAE, led a group of Soviet scientists and engineers to the United States. The members of this group were:

Petrosyants, Andronik Melkonovich - Chairman of the USSR-SCAE

Sinev, Nikolai Mikhailovich - Deputy Chairman of the USSR-SCAE

Artsimovich, Lev Andreevich - Director of CTR Group at "Kurchatov" Institute of Atomic Energy

Bogolyubov, Nikolai Nokolaevich - Director of Theoretical Physics at JINR, Dubna

Kazachkovskii, Oleg Dmitrevich - Director of Fast Reactor Program at IPP, Obninsk

Ponomarev-Stepnoi, Nikolai Nikolaevich - Group leader of reactor core design at KIAE, Moscow

Afrikantov, Igor Ivanovich - Professor of mechanical engineering at Gorki Polytechnical Institute and design consultant to SCAE

Yakovlev, Georgii Nikolaevich - Director of Radiochemical Laboratory and Transuranium Facility at Melekess

Ratnikov, Nikolai Timofeevich - Staff member of USSR-SCAE

Belov, Anatolii Ivanovich - Staff member of Department of Foreign Affairs of USSR-SCAE

The delegation was accompanied on its tour of the United States by Revin, Valentin Alekseevich, Assistant Science Attache at the Soviet Embassy in Washington.

This group visited the following American locations:

Oak Ridge National Laboratory, Lawrence Radiation Laboratory at Berkeley, Yosemite National Park, Reactor Testing Station at Idaho Falls, Dresden I Power Reactor Site, Argonne National Laboratory, the city of Chicago, "Enrico Fermi" fast reactor site, Greenfield Village at Dearborn, Brookhaven National Laboratory, Indian Point I Power Reactor, Battelle Memorial Institute at Ames, Iowa, Hallam Sodium Cooled Demonstration Reactor Station, the USAEC Headquarters, and New York City.

In 1964 five groups under sponsorship by the USAEC visited Russia. These groups were specialized in Controlled Thermonuclear Research, Solid States Physics, Desalination of Sea Water, Radioactive Waste Management and Disposal, and Power Reactors. Soviet groups in the areas of CTR, Solid States Physics and Desalting, visited the United States.

In 1965 Soviet groups on Power Reactors, Radioactive Waste Disposal, and Low Energy Particle Physics visited the United States. The Power Reactor Group was headed by A. P. Aleksandrov, Director of the Kurchatov Institute of Atomic Energy. An American group of Radioneurological Medical experts visited medical facilities in Russia. In addition, one American began a residence of several months at the Lebedev Physics Institute in Moscow and another at the Physico-Technical Institute in Kharkov. Both were researchers in the CTR area.

In 1966 an American group of physicists in the area of low energy particle physics, and a group interested in radioactive tracer techniques in medicine visited Soviet facilities, while a Soviet team of radioneurological medical people came to the United States. In addition, two Soviet physicists began an extended stay at the CTR center at Princeton University.

In 1967 and 1968, as indeed had been the case in 1964 and 1965, there were a number of conferences in both countries that were attended by scientists from each side as well as many other countries of the world.

In late 1969, a group of Soviet reactor specialists came to the United States and in the summer of 1970 American reactor experts went to Russia.

As a result of these visits it is probably true that most of the leading people working in the peaceful uses of nuclear energy have visited each other's countries and have some understanding of the work conducted in their areas of interest as well as of the environment and context in which this work is conducted.

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