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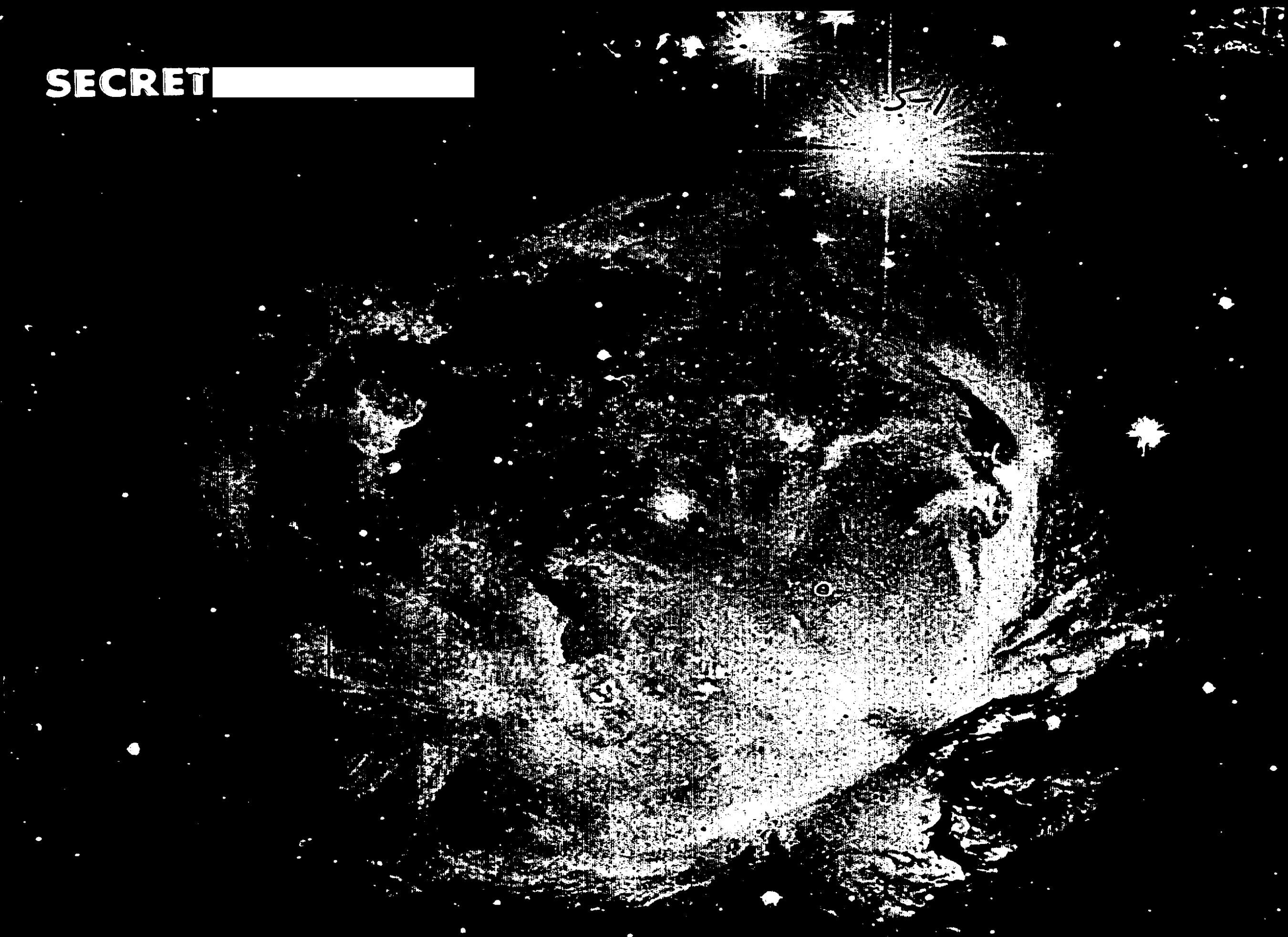

SCIENTIFIC INTELLIGENCE DIGEST

Office of
Scientific
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CENTRAL
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AGENCY

OSI-SD/65-6
June 1965

No 436

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NOTES

GRAPHICS

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SOVIET SPOON REST B RADAR PROBABLY A KNIFE REST B MODIFICATION

25X1A [redacted]
Defensive Systems Division
OSI/CIA

The Spoon Rest B, a Soviet early warning radar, may be more widely deployed [redacted]

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[redacted]

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The ratio of deployed Spoon Rest B to Knife Rest B radars in the USSR and satellites was believed to be about 1 to 30. [redacted] contributed significantly to the Radar Order of Battle. [redacted]

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Figure 1. SPOON REST B

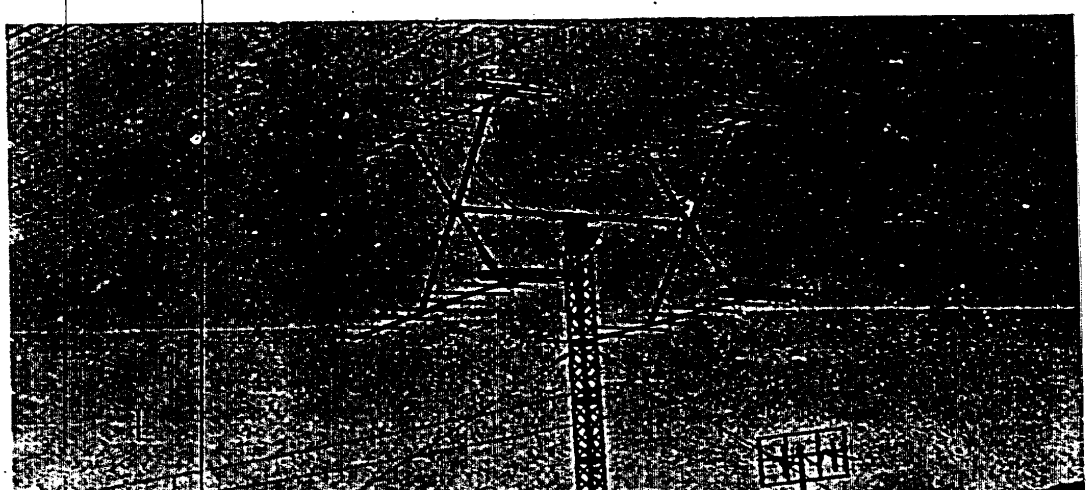

Figure 2. KNIFE REST B

JAPAN PLANS TO DEVELOP A COMMUNICATION SATELLITE SYSTEM

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[redacted]
Ballistic Missiles and Space Division
OSI/CIA

The Japanese Science and Technology Agency (STA) has granted eight Japanese companies approximately $700,000 to initiate a program to develop a communication satellite, the satellite launch vehicle, the guidance system, instrumentation, and necessary ground facilities. The program schedule, i.e., the orbiting of 231-pound communication satellite at an altitude of 620 miles between April 1970 and April 1971 is believed within Japanese capabilities.

The reasons for the Japanese decision to develop a communication satellite are not readily apparent inasmuch as Japan is a signatory of the international communication satellite agreement. One possibility, however, is that Japan sees the satellite as a means of enhancing her scientific reputation in Asia. Japan may also be looking for profits in that they may anticipate the possibility of the international group utilizing the Japanese satellite in its program.

The companies involved in the program are Nippon Electric, Hitachi, Mitsubishi Electric, Tokyo Shibaura Electric, Mitsubishi Heavy Industries, Ishikawajima-Harima Heavy Industries, Matsushita Electric Industrial, and Nippon Oils and Fats. Some of these companies already are involved in the previously announced STA artificial satellite and launch vehicle research and development program. There are, undoubtedly, many areas where an inter- [redacted] 25X1C

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[redacted]

SOVIETS EXPANDING STRONG RESEARCH PROGRAM IN SEISMIC ENGINEERING

25X1A [redacted]
Gener[redacted]vision
OSI/CIA

For the past twelve years, the Soviets have had a vigorous program of research in seismic engineering* and current information indicates this program is expanding. The volume of seismic engineering research conducted by the Soviets exceeds that of any Western country and is only approached by the United States and Japan. Thus far no outstanding discoveries have been made by the Soviets, but such a strong research program may lead to significant discoveries in the future.

A large part of the Soviet program of zoning the seismic areas for expected earthquake intensities has been completed. Maps have been compiled showing these zones and, presumably, construction codes are enforced in them. Some U.S. seismologists question some of the Soviet methods, such as using very minor earthquakes to project to larger destructive earthquakes, but the overall program seems to be fairly effective. Zoning and theoretical wave studies are conducted at the Institute of Physics of the Earth, Moscow.

The Soviets conducted laboratory research on the effect of strong seismic waves on buildings, dams, canals and other structures. For this research, the Earthquake Resistant Building Institute at Ashkhabad has built an experimental three story brick building mounted on springs, but costs were higher than other antiseismic construction. In addition, this institute has two vibration platforms of 4400-pound and 10-ton capacities. Using the large vibration platform, experiments have been made on a scale model (1/20) of the Kara Kum Canal. Two large East German presses of 100- and 200-ton capacities are used as pulsing vibrators for testing structural members of large buildings.

Near Tashkent a "polygon" of shells of buildings of different types of construction, common in central Asia, is being erected. Explosions up to 500 tons of HE will be set off later this year at a depth of 65 meters and about 150 meters from these buildings to determine the seismic effect. Similar experiments currently are being conducted at Dushanbe with 10-ton charges at 5 meters depth and 100-ton charges at 20 meters depth.

According to the Soviets, about one-fifth of the USSR is subject to "noticeable seismic influences." The Soviets spend

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* Seismic engineering is the study of the effect of earthquakes on man-made structures and the determination of measures to prevent damage.

[redacted]

over 60 million rubles every year on special antiseismic measures for preservation of human life and buildings.

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POLISH HUMAN CENTRIFUGE FOR STUDIES OF GRAVITATIONAL FORCES

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[redacted]
Life Sciences Division
OSI/CIA

The first direct involvement of a bloc country in the Soviet bioastronautics program is noted in a report that the Institute of Aeromedicine, Warsaw, is building a human centrifuge which is to be used by the Soviets -- and probably by the Poles -- to study some of the effects of gravitational forces encountered by man in spaceflight. There apparently has already been a limited exchange of personnel between the Institute of Aeromedicine and its counterpart Soviet facilities. Many complaints had been made previously by the bloc countries that they had been left out of the Soviet program.

The centrifuge and an associated computer facility are to be installed in a building attached to the institute and are to become operational in the fall of 1965. The facility probably will be used to conduct experiments relating to the physiological effect of changes in the gravitational forces on the bones, muscles, and reflexes of living subjects, and thus may reduce the work load on the centrifuges such as those in the USSR at Tomilino and the cosmonaut training center.

The Polish centrifuge, which is to have two phases of motion, apparently will have an advanced capability for receiving telemetry signals from subjects inside the centrifuge cabin. The Poles appear to have solved the difficulty of weak telemetry signals in an electromagnetic field which has been a problem with the Soviet centrifuges. The electromyographic signal particularly will be studied to determine muscle tone and effectiveness in a changed gravitation field which is related to the problem of weightlessness. [redacted]

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CENTER FOR THE SOVIET PLOWSHARE-TYPE* PROGRAM

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[redacted]
Nuclear Energy Division
OSI/CIA

25X1C

The first Soviet confirmation of the existence of a Plowshare-type program in the USSR and a specific institute involved in it was made recently by Dr. Sergey I. Drozdov to [redacted] 25X1C [redacted] who attended an international conference at the Siberian Department of the Academy of Sciences, USSR. Dr. Drozdov, of the Institute of Atomic Energy in Moscow, stated that this institute has a program for nuclear explosions for peaceful uses.

The Institute of Atomic Energy (IAE) has had a history of involvement in all aspects of the Soviet atomic energy program, both classified and unclassified. Formerly Laboratory 2 of the Academy of Sciences, it is now subordinate to the State Committee of Atomic Energy which controls unclassified Soviet atomic energy work. Despite this subordination, however, the institute is believed to have close ties with the weapons program, whose scientists would be expected to develop the explosive devices for a Plowshare-type program. Thus the institute appears to be the logical choice for the administrative center for a Soviet program of this type. Because of its subordination, the IAE provides an unclassified installation from which to publish and exchange Plowshare-type information with foreign countries.

Dr. Drozdov further stated that experimentation with explosions also was being conducted at the Siberian institute (sic), but did not go into detail. This is believed to be the Institute of Hydrodynamics of the Siberian Department of the Academy, a center of research in the use of conventional high explosives. The work of which probably has plowshare-type application [redacted]

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* Plowshare is the U.S. designation for the program involving peaceful uses of nuclear explosions.

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JAPANESE DEVELOP ROCKET-BORNE TV SYSTEM FOR METEOROLOGICAL PURPOSES

[redacted]
General Sciences Division
OSI/CIA

In January 1965, Tokyo University's Space and Aeronautics Research Institute successfully ground tested a newly developed TV camera to be used in rocket research of the upper atmosphere. The Japanese reportedly will use this camera to look back at the exhaust trail as the rocket rises through the atmosphere. This information, in turn, will be used to calculate wind velocities in the upper atmosphere. The Japanese expect to flight test this TV system on a Kappa-9M rocket in June 1965.

The use of a TV camera on board a rocket to study upper atmospheric winds is a novel approach, and it probably will be quite useful. At the present time, ground photography provides the most detailed information available on wind velocities and vertical wind shears in the high atmosphere. It is relatively inexpensive but requires generally clear skies. Use of the TV system should largely eliminate the clear sky limitation and allow wind observations to be made under a wider variety of weather conditions.

According to the Japanese announcement, the TV camera which they have developed utilizes a vidicon tube. The TV pictures will be transmitted to the earth on a frequency of 890 megacycles, and a 3-meter parabolic antenna will be used for reception. [redacted]

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SOVIET RESEARCH AND DEVELOPMENT ON THE DESALTING OF WATER*

25X1A

[redacted]

General Sciences Division
OSI/CIA

CONCLUSIONS

The Soviet desalination development program is smaller in size, effort, and capital investment than the program of the United States and appears to be 3 to 5 years behind current US developments. Although the Soviets have competent scientists doing excellent research in desalination, their accomplishments in terms of pilot plants, hardware, and development of economical processes have not been significant. The lack of apparent, significant Soviet accomplishments may be due to their primary concern with the removal of salts from brackish or low-salt-content water. This is a less difficult problem than the removal of salts from sea water, which is the major concern of related US technology.

Pure water requirements for steam-powered electrical generating plants and for the chemical industry provided the original impetus for Soviet desalination research. More recently, there has been a growing demand for industrially usable water in a few rapidly developing areas in the Soviet Union. This has been responsible for increasing Soviet research efforts to develop economically feasible methods for desalting brackish waters.

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The processes of freezing, reverse osmosis, hydration, and biological treatment have been given only limited study in the USSR, but ion exchange and electrodialysis processes have received considerable Soviet research attention. An electrodialysis plant of unknown size is reported in operation in Alma Ata. The prospect of using nuclear power as a source of thermal energy has rejuvenated Soviet interest in distillation as a large-scale method of salt removal and has diverted interest from other methods. Research on multieffect evaporation (distillation) with film and drop condensation, and on prevention of scale, is now being carried out on a level comparable with that of Western research. Successful research has resulted in three medium-size, fossil-fuel-fired distillation plants in operation at Shevchenko, Baku, and Krasnovodsk.

Future Soviet desalination development will continue to emphasize distillation, electrodialysis, and ion exchange processes, with concentration of effort on the use of nuclear reactors as sources of electric power and of thermal energy for saline water distillation. Considerable

[redacted]

technical assistance is expected from the US as a result of the two-year US-USSR joint agreement on cooperation in nuclear desalination scheduled to start in 1965. The USSR plans to build at Shevchenko on the Caspian Sea a 1,000-megawatt thermal, fast nuclear reactor coupled to a desalination plant; the plant is to have an eventual fresh water output of up to 50 million gallons per day. However, this reactor represents a 200-fold scale-up of present Soviet reactor technology, and it is likely that there will be slippage in the projected completion date of 1969.

SUMMARY

The Soviet desalination program was small and slow moving up to 1962 when it was transferred from the control of the State Committee for Chemistry to the State Committee for Utilization of Atomic Energy. The transfer reflects Soviet efforts to elevate the national status of the program and the intention to develop the use of nuclear power sources for desalination purposes.

Soviet work on distillation appears to have concentrated on prevention of scale formation on heat transfer surfaces, a problem intimately associated with distillation. They have had some success in preventing scale build-up through use of chemical and ion exchange treatment of feed water, and crystal seeding of water in the evaporator. The Soviets realize that present distillation practices is too expensive in terms of fuel consumption to be utilized in the USSR on a large scale. However, they believe that if scale formation can be controlled sufficiently, distillation is the only method sufficiently developed to be adaptable to large-scale operation. Present Soviet plans contemplate the use of dual-purpose fast nuclear reactors which will supply electrical energy as well as thermal energy required for distillation.

In the USSR, lime is being used increasingly to precipitate calcium and magnesium salts from saline or low-salt-content waters prior to distillation. A thermochemical refinement of this process, a combination of precipitation and ion exchange, also is finding favor with the Soviets. Initially it was developed by them as a method of softening boiler feed water but it is now being used to pretreat saline water fed directly to evaporators in the distillation process. The method is designed primarily to control scale formation.

The Soviets have made satisfactory use of chemical methods for desalting—ion exchange being the principal one used. Ion exchange resins now being used in the USSR are quite similar in function to those made in the West but are not as efficient and apparently are in short supply. Soviet developments in ion exchange resin technology have not shown any recent major gains.

Electrodialysis holds great interest and potential for the Soviets. They seem convinced that the method represents an economical approach to solving their immediate problem of removal of salts from brackish water and are aware that extensive Western research has shown the method to be very satisfactory for low-salt-content water. Using published Soviet scientific literature as a measure, more Soviet research and development

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work has been done on both ion exchange and electrodialysis than on all other methods combined. The Soviets appear to be considering the more extensive use of electrodialysis for removing salts from boiler feed water used by electric power plants. Extraction, crystal hydrate, reverse osmosis, ion osmotic, and biological desalting methods are in very early stages of research in the USSR.

Actual operating Soviet desalting plants include: a 1.5-million-gallon-per-day fossil-fuel-fired distillation plant at Shevchenko utilizing a seeding method to reduce scale; a 0.9- to 2.25-million-gallon-per-day distillation plant at Baku utilizing thermochemical treatment of feed water; and a 0.5-million-gallon-per-day distillation plant in Krasnovodsk believed to have been operating since 1946 in conjunction with an electric power station. In addition, an electrodialysis plant of unknown size has been reported in Alma Ata.

Of considerable significance is the ambitious plan of the Soviets to utilize a fast nuclear reactor of 1,000-megawatt thermal capacity, to be built at Shevchenko, to provide both electricity for general use and steam for desalting water. This reactor represents a 200-fold scale-up from their BR-5 research reactor. It will be several years before this becomes a reality. [redacted] 25X1

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SOVIET RESEARCH AND DEVELOPMENT IN SELECTED FLUID SEPARATION TECHNIQUES*

25X1A [redacted]
General Sciences Division
OSI/CIA

SUMMARY

The Soviets have a large and comprehensive effort in the study of fluid separation techniques.** Their theoretical studies of these chemical engineering unit operations compare favorably with those of the United States, except for distillation in which the USSR is considerably behind. The Soviets are particularly competent in adsorption theory and in its application to equilibria and mechanisms of adsorption, and to the structure of absorbents.

In general there seems to be poor communications between Soviet theoreticians and engineers and in applied aspects, Soviet fluid separation efforts are in general three to five years and, in some instances, ten years behind the United States, except for specialized nuclear applications. In the extraction of nuclear materials using aqueous media, the Soviets are probably on a par with the United States with regard to the theoretical aspects but they still lack considerable experience in application. The use of computers to assist in complex separation calculations and for automating and controlling plant separation processes is in an early stage in the USSR. The Soviets can be expected to maintain their high level of competency in the fundamental aspects of fluid separation processes and to continue to narrow the gap between their level of achievement and that of the United States in the applied areas.

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* A more detailed paper on this subject is available on request.

** The separation of fluids, i.e. gases and liquids, is an essential operation of the chemical, petroleum and nuclear energy industries. It is accomplished by various means such as distillation, adsorption, absorption and solvent extraction. The evaluation of Soviet fluid separation capabilities is important in determining their ability to progress in these industries.

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DISCUSSION

General

Published Soviet literature for the period 1960 to early 1964 contained more than 700 articles relating to various aspects of the general subject of separation of fluids by chemical engineering techniques. About 40 percent of the Soviet work relates to absorption and adsorption, about 30 percent to distillation, and about 15 percent to solvent extraction, with the remainder on such miscellaneous subjects as diffusion, centrifugation, and evaporation. The USSR is committed to a large and comprehensive effort in the four areas of fluid separation discussed in this study.

Theoretical concepts usually are presented by mathematicians with little appreciation of industrial problems. Although much fine theoretical work has been supported by data obtained from laboratory equipment, considerable development and testing usually are necessary before conclusions based on laboratory-scale systems can be applied to industrial situations.

In their theoretical studies the Soviets keep abreast of Western developments and are quite competent with respect to fluid-separation theory. However, most of the Soviet applied work in fluid separation lacks originality and is imitative of Western studies carried out a few years earlier.

Adsorption

The Soviets are competent with regard to adsorption theory and its application to adsorption equilibria, mechanisms, and absorbent structures. In much of their work, efforts have been made to correlate the adsorption data with various theories and also to reduce the data to mathematical equations useful for describing and predicting adsorption behavior. Two Soviet scientists, M. M. Dubinin of the Institute of Physical Chemistry, Academy of Sciences, USSR and A. V. Kiselev of Moscow State University, have achieved world-wide reputations for their studies of the theoretical aspects of adsorption phenomena. Dubinin and co-workers have carried out extensive studies aimed at predicting the adsorption of a wide variety of gases and vapors and also the adsorption properties of adsorbents of various characteristics and porous structures. These scientists have used adsorption theory as an aid in predicting adsorption equilibria and in the development of methods for synthesizing adsorbents with specific adsorption properties. Kiselev and co-workers have experimentally studied adsorption properties and structures of a wide range of adsorbent materials to change their basic structures and selective adsorptivity. In attempting to obtain a basic understanding of adsorption, Kiselev has re-examined fundamental principles to a greater extent than have U.S. workers.

Much of the applied research undertaken by the Soviets in the adsorption field duplicates earlier work done in the West. For the most part the Soviet studies were carried out on a small laboratory scale, and in many instances involved only slight modifications in operating conditions. The lack of adsorption-isotherm and capacity data on their own adsorbents has slowed down the Soviet work with pure gaseous hydrocarbons and their mixtures. The Soviets now are actively characterizing their adsorbents, but in this respect they are five to ten years behind the United States. On the other hand, they have been actively investigating molecular sieves and their use for gaseous separation. They have studied the application of such sieves for removing trace atmospheric contaminants from controlled environments for manned space missions.

Absorption

The Soviets have been very active in basic absorption research during the last five years. Physicochemical, hydrodynamic, and mass-transfer relationships were developed from absorption experiments conducted under a large variety of operating conditions in many different types of absorption equipment. Many of the Soviet studies were directed toward obtaining a better understanding of the absorption mechanisms and also toward providing mathematical expressions that would permit better equipment design and prediction of absorption equipment performance. Much of the work appears to have been an extension of existing Western work. The Soviet work has shown technical competence; however, they have originated few new developments in absorption technology. Various absorption theories have been proposed by both Soviet and U.S. researchers, but these theories are admittedly limited to explaining the absorption process. The Soviets have exerted considerable effort at obtaining a better understanding of the fundamentals of absorption column performance. V. G. Levich, Corresponding Member, Academy of Sciences, USSR, of the Moscow Engineering Physics Institute, an outstanding authority in surface phenomena, has presented an exhaustive mathematical treatment of the movement of drops and bubbles in liquid media. The Soviets are competent and well informed regarding most of the theoretical aspects of absorption technology.

In the important area of absorption plate and tray design, studies at the leading Soviet chemical engineering institutes indicate that the Soviets lag in the evaluation and utilization of new tray design, in the utilization of more modern processing equipment or techniques, and in process know-how. In contrast to U.S. practice, the Soviets make very little use of computers for carrying out absorption calculations or for use in plants carrying out absorption operations. N. M. Zhavoronkov and coworkers at the Moscow Chemical Technology Institite imeni D. I. Mendeleev, the most active Soviet organization in applied absorption, have studied absorption in both standard packed columns and new rotary-type spray equipment under a variety of operating conditions. These efforts extended earlier U.S. research to take into account the area factor by using carefully stacked packing to arrive at more meaningful mass-transfer coefficients. The Soviets have done no work in the development of new, more efficient absorption equipment, but seem to be involved in catching up on a variety of perforation- and drip-type plate designs of Western origin.

Extraction

The Soviets keep abreast of the theoretical aspects of liquid-liquid extraction, expending considerable effort on research involving the related theories of mass transfer, extraction kinetics, and hydrodynamics. They are particularly active in the development of related mathematical expressions. Leading Soviet chemical engineers P. G. Romankov, A. N. Planovskiy, V. V. Kafarov, and A. M. Rozen have contributed considerably to understanding the extraction process. So far, they have only been able to copy rather than to develop advanced equipment such as packed columns, rotating disc extractors and injector columns.

In the area of industrial applications of liquid-liquid extraction, the Soviets are quite poor with the exception of projects in the field of nuclear energy. The application of solvent extraction to the recovery of uranium from ores, to its subsequent purification and to the processing of the radioactive materials from nuclear reactors represents the most highly developed Soviet solvent extraction technology. However, since the recent developments in this field both in the United States and the USSR are classified, a valid comparison cannot be made. However, in almost all instances, U.S. published work in this field predates Soviet work. Although they still lack considerable experience in large-scale applications, the Soviets are probably on a par with the United States in the theoretical aspects of aqueous solvent extraction systems for the separation of fission products. However, the Soviets definitely lag in the application of solvent extraction in the petroleum, chemical and petrochemical industries. Competent groups under B. N. Laskorin of the Institute of Organic Chemistry imeni N. D. Zelinskiy and V. S. Shevchenko of the Moscow Institute of Chemical Technology imeni D. I. Mendeleev are active in other types of applied extraction.

The Soviets have done very little in the development of improved extraction equipment. A belated Soviet follow-up of Western equipment developments was evident in the case of centrifugal extractors, pulsed extraction columns, and sieve plate columns.

Distillation

The bulk of the Soviet theoretical work on distillation is aimed at developing better mathematical and thermodynamic relationships for correlating and extending phase equilibria data and more precise mathematical representation of the fluid flow and mixing characteristics for various types of distillation equipment. Soviet effort in distillation theory is directed toward refining well-known equations, whereas U.S. work is directed toward the development of completely new, less restrictive correlations. There are a few very competent Soviet distillation theorists, but they are so occupied with keeping up with Western developments and keeping other Soviets up to date that they produce few original contributions.

Research and development in applied distillation are concerned with new equipment design and performance and other industry-oriented topics. Although the Soviet applied effort in distillation is more extensive than their work in the theoretical phases of this field, the results are even less noteworthy. The most prolific research worker in the applied aspects is I. N. Bushmakin of Leningrad State University, who concentrates on packed columns. The Soviet distillation progress is hampered by inaccurate tray-efficiency predictions, a factor necessary for proper design of distillation equipment. Practically no innovations in distillation equipment have originated in the USSR, and the Soviets have been slow in adopting Western improvements in this field. In the industrially important fields of azeotropic and extractive distillation the Soviets have made little progress -- partly because of a poor understanding of the basic phenomena involved. To overcome these deficiencies, the Soviets are emphasizing applied research on such topics as liquid overflow devices and downcomer design. [redacted]

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SECOND PROMINENT SOVIET METEOROLOGIST IDENTIFIED AS A MEMBER OF THE COMMITTEE FOR THE EXPLORATION AND UTILIZATION OF SPACE

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[redacted]
General Sciences Division
OSI/CIA

M. I. Budyko, Director of the Main Geophysical Observatory in Leningrad, recently has been identified as being a member of the Committee for the Exploration and Utilization of Space (CEUS) of the Academy of Sciences, USSR. Budyko is the second meteorologist known to be a member of CEUS; K. Ya. Kondratyev, Rector of Leningrad State University, is Vice Chairman.

Budyko, internationally recognized as one of the most capable and promising Soviet meteorologists, is best known for his work on the heat budget of the earth. Determination of the earth's heat budget is an important meteorological objective which can be approached by meteorological satellite measurements. The fact that both Kondratyev and Budyko are members of CEUS suggests that the Soviets are working on a meteorological satellite program which includes experiments related to the earth's heat budget, particularly measurements of the earth's thermal radiation in the infrared portion of the spectrum.

In addition to Kondratyev and Budyko, A. A. Blagonravov is known to be the Chairman and I. V. Milovidov the scientific secretary of CEUS. Other Soviets who have been identified as members of CEUS include L. I. Sedov, G. L. Grodzovskiy, Yu. N. Ivanov, V. V. Tokarev, G. Ye. Kuzmak, N. J. Lavrenko, V. K. Isayev, V. V. Sonin, D. Ye. Okhotsimskiy, V. A. Sarychev, O. G. Gazenko, V. A. Zlatoustov, and A. P. Troyevskiy. The Soviets reported when CEUS was formed that it would be composed of about 50 scientists and engineers; however, the names of the remainder of this committee have not been [redacted] 25X1

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QUALITY OF SOVIET SATELLITE STUDIES OF THE IONOSPHERE PROBABLY LOW

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[redacted]
General Sciences Division
OSI/CIA

Soviet studies of the ionosphere using the Cosmos satellite series are believed to be of low quality. Investigations are made of electron content and irregularities which are of importance in providing information for fuller understanding of long range radio communications and the cause of short wave radio blackouts.

The Soviet satellite experiments, utilizing the commonly-used techniques of single frequency Faraday rotation and differential Doppler of coherent frequencies, reveal a number of limitations. Unnecessary assumptions are made about the earth's magnetic field, time variations are ignored, the ionosphere is considered to be only a two-dimensional inhomogenous medium, and only a limited amount of data are analysed. The approach used by the Soviets permits the data to be treated more easily, but leaves considerable uncertainty in the conclusions. (OFFICIAL USE ONLY)

THE SOVIET SA-2 SURFACE-TO-AIR MISSILE SYSTEM*

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[redacted]
Defensive Systems Division
OSI/CIA

With Contributions By

25X1A [redacted]

CONCLUSIONS

The Soviet SA-2 system, the most extensively deployed surface-to-air missile (SAM) system in being, constitutes the major air defense weapon of the USSR and the European Satellites. It is also installed or being deployed in eight other countries, both Communist and non-Bloc. Since its initial deployment in 1958, the SA-2 system has been upgraded frequently. With further revisions in the design of the system and subsequent modification of the deployed units, the SA-2 will probably continue to be an essential component of the Soviet Bloc air defense system for the next decade.

The existing SA-2 system poses a serious threat to all operational Western attack and reconnaissance aircraft, except those flying at very low altitudes. As deployed in quantity and depth, this weapons system has a potentially high kill probability against medium- and high-altitude targets operating at velocities up to Mach 2 with a reduced capability against faster targets. The SA-2 has been previously reported to be effective against targets flying between [redacted] Recent design changes, which may not have been extended to all units, probably will provide a system capability against targets flying as low as 1,600 feet. With degradation in maximum intercept range and lethal radius, the SA-2 system probably can be employed successfully against targets flying at altitudes somewhat under 1,600 feet. Low-altitude capability will vary somewhat from site to site depending upon terrain.

[redacted] cent modifications in the FAN SONG radar suggest further efforts to reduce

* Reprint of Conclusions and Summary of OSI-SR/65-18, 3 May 1965, SECRET/ [redacted]

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The major limitations of the SA-2 system are its inability to cope with high-altitude, high-speed targets at long range; marginal effectiveness against very low altitude targets; inability to handle more than one engagement at a time per site; and long reloading period following the expending of the six missiles on the launchers. Additionally, while the system is transportable, it requires 4 to 6 hours to disassemble a site and a similar period to set up in a new location. The first two limitations presumably are problems which must be overcome by the employment of other weapons systems, and the other drawbacks are compensated largely by the great number of deployed SA-2 sites.

The Soviet SA-2 system has been designed to emphasize simplicity in operation and high kill probability against single targets through intentional limiting of intercept range and application of weapon redundancy. Design features of the system include conservative engineering practices, a minimum of automatic procedures, and fairly simple operation that can be carried out by relatively unskilled operators. However, the system does require large unit strengths and, apparently, an extensive maintenencance effort involving skilled technicians.

SUMMARY

The SA-2 system, probably first deployed in 1958, is the most widely deployed SAM system in the Communist Bloc. At least 1,100 SA-2 sites have been identified in the Soviet Bloc (about 950 of them within the USSR) and in Communist China, North Korea, and Cuba. Approximately 20 additional sites are deployed in such nonaligned countries as Indonesia, Egypt, India, Yugoslavia, and Afghanistan.

The SA-2 system is transportable and is relatively simple in design and operation. Unlike the earlier SA-1 system, all components of the SA-2 system, including the missile launchers and radar, are on wheels. The design concepts on which the SA-2 system is based are different from those followed by the United States in the design of the Nike systems. Whereas the Nike systems have multiple radars for target and missile tracking and as a source of missile guidance signals, the SA-2 uses one radar, the FAN SONG, for these functions. The use of one radar alleviates to a large extent the problems of parallax, boresighting, and synchronization which a surface-to-air system would normally encounter.

Of the five different FAN SONG models which have been identified, three of them, FAN SONGs A, B, and probably D, operate [redacted] and appear to be essentially similar to each other. The other two models, FAN SONGs C and E, operate [redacted] and appear to differ

[redacted]

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significantly from the [redacted] models and from one another. Regardless of model, the FAN SONG radar is a track-while-scan type which combines target and missile tracking functions in one radar along with the missile guidance function. The antennas, transmitters, receivers, tracking circuits, and guidance computers and transmitters utilize combinations of standard techniques. The radar system relies on manually aided automatic tracking in fulfilling most of its functions.

An SA-2 site consists of (i) a FAN SONG tracking and guidance radar, which [redacted] (ii) six launchers arranged in a ring around the FAN SONG; (iii) one Guideline missile per launcher and provisions for 6 additional missiles in hold positions; (iv) missile transporters; (v) operational vans, including separate ones probably for power distribution, control, computer, and generators; (vi) an acquisition and identification section, usually SPOON REST A radar and IFF equipment of the SCORE BOARD A type with associated equipment; (vii) a Mercury Grass communications van; (viii) support equipment; and (ix) administrative and housing facilities.

The performance characteristics of the SA-2 system with the [redacted] FAN SONG radar are believed to be as follows:

[redacted]	[redacted] nautical miles
	[redacted] nautical miles
Maximum missile guided flight time	55 seconds
Missile flight distance (before self-destruct)	22 nautical miles
Missile intercept capability:	
Minimum altitude	About 1,600 feet (possibly lower, depending upon terrain conditions and target velocity)
Maximum altitude	About 85,000 feet
Minimum range	5 to 6 nautical miles
Maximum range	17 nautical miles

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[redacted]

Maximum target speed intercept capability	Mach 2 with a reduced capability above this velocity
Number of targets which can be engaged simultaneously	1 (group targets can be engaged when closely bunched)
Number of missiles which can be controlled simultaneously	Up to 3

The Soviet-stated probabilities of kill for 1, 2, and 3 missile firings against a single target are 70, 81, and 97 percent, respectively, within the estimated range and altitude limitations noted above.

The specific performance characteristics attributed to the [redacted] FAN SONG SA-2 systems by the USSR are unknown but are estimated to be similar to or better than those of the [redacted] FAN SONG SA-2 system.

[redacted] missile intercept capability for the improved [redacted] SA-2 system probably has been increased to an estimated maximum range of about 27 nautical miles.

Certain important characteristics of both the [redacted] systems are not known. These include (i) detailed sequences and times required for tracking and firing and (ii) some missile details relating to the radio fuze, the autopilot, and the receiver/transponder section. Additional unknown aspects of the [redacted] the twin parabolic dish reflectors that are mounted on top of the horizontal scanning antenna of the FAN SONG E, and the extent of [redacted] improvements over the [redacted] system. The most likely explanations of the purpose of the twin dishes on the advanced FAN SONG E are that they act as an electronic counter countermeasure (ECCM) modification or that they serve to enhance the detection capability of the radar against small targets. The former purpose is believed the more likely. However, these dishes may be for a completely different purpose.

The Guideline missile in the SA-2 system uses a microwave radio fuze for detonation of the warhead after it is armed by the guidance link from the FAN SONG. A considerable amount of detail on the missile-associated electronics, however, still is not fully known.

[redacted]

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In November 1963 a modified Guideline missile (Mark III) was identified at the SA-2 site at Glau, East Germany. The configuration of the missile and probably the propulsion parameters of its sustainer engine had been modified, but the extent and purpose of these changes are unknown. Significant physical characteristics of the three known models of the Guideline missiles are as follows:

	Mark I	Mark II	Mark III
Sustainer:			
Length (ft.)	26.24	26.24	26.86
Diameter (ft.)	1.60	1.60	1.60
Total weight (lb.)	2,310	2,756	Unknown
Burning time (sec.)	42	48-50	Unknown
Thrust (lb.)	5,940	6,600	Unknown
Booster:			
Length (ft.)	8.57	8.57	8.57
Diameter (ft.)	2.12	2.12	2.12
Total weight (lb.)	2,266	2,266	*
Thrust (lb.)	59,400 to 110,000 depending on ambient air temperature of -40°C to +50°C	*	*
Duration of thrust (sec.)	4.3 to 3.0	*	*

* Assumed to be the same as Mark I.

The SA-2 system has been upgraded frequently since its initial deployment in 1958. Technical improvements have been noted in each successive model of the three SA-2-associated Guideline missiles that have been detected since 1957. The five different versions and [redacted] of the FAN SONG radar also probably reflect improvements. Hence, the system probably has been developed to meet a number of different operational situations in as simple a manner as possible and at the least possible cost. Further improvements expected in the system include (i) an increase in the missile booster thrust, (ii) a provision for launching the missile when the FAN SONG is [redacted] and (iii) the inclusion of an automatic facility

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to handle some of the tasks presently performed by human operators, particularly in the critical fire control area.

The SA-2 system has some serious limitations -- in particular, the inability to track more than one target or compact group of targets at the same time and the lack of good very low level coverage. For the earlier [redacted] versions, a long time between detection and firing (up to 40 seconds) and a short "readiness" time (25 minutes) before recycling (which takes 10 to 15 minutes) were reported. These limitations for the [redacted] version may have been reduced during the development of the newer [redacted] systems.

The inability of the SA-2 system to track more than one target at a given time is due to design restrictions. Hence, to improve this particular characteristic, the complexity of the system would have to be increased to a large degree.

The reported 40-second timelag for the [redacted] system between detection and firing of a missile cannot be explained. The capability of the system could be handicapped severely if this 40-second period occurs at a critical time. It is probable that 40 seconds is an average figure rather than a minimum required time.

The 25-minute limit on the readiness state of the SA-2 system appears to be necessitated by overheating of missile components. A 10- to 15-minute recycling time is needed, apparently to allow the critical components to cool. If the problem of overheating is solved, the readiness time probably could be extended until some other factor, for example, gyro precession, becomes the [redacted]

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SOVIET CAPABILITY IN BATHYMETRIC SURVEYS FOR SUBMARINE AND ANTISUBMARINE WARFARE*

25X1A

[redacted]

General Sciences Division
OSI/CIA

CONCLUSIONS

The Soviets have the capability to conduct very accurate bathymetric surveys in their own coastal waters which could aid significantly their antisubmarine warfare (ASW) forces in these waters. They have carried out many bathymetric surveys in the Bering Sea and in the Kurile Ridge -- Sea of Okhotsk area, and there is some evidence that they have conducted such surveys to a lesser extent in the Arctic. The Soviets do not now have the capability to conduct bathymetric surveys off the U.S. and U.K. coasts accurately enough for a very precise system for submarine navigation. However, in these areas they have collected bathymetric data which could be used for a less precise system that provides navigational position accuracy of ±1 mile. These data also would be useful in the submarine forces for evasive purposes.

The lack of a long-range navigational system that could provide position accuracies of about ±100 yards is the Soviet's most serious deficiency in conducting very accurate bathymetric surveys throughout the world. The Soviets have developed some native capability to produce echo sounders needed for bathymetric surveys, but they still tend to rely to a large extent on Western devices. Soviet development of precision depth recorders (PDR) and precision graphic recorders (PGR) lags that of the West. The Soviets can be expected to conduct additional precise bathymetric surveys in their own coastal waters. They probably will increase their surveys off the U.S. coasts, especially those off the Pacific coast. Nevertheless, the Soviets will not be able to conduct precise surveys off the U.S. coasts until they improve their electronic navigational capability. There is no evidence than an im-

[redacted]

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* Reprint of Conclusions of OSI-SR/

[redacted]

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NOTES

IRKUTSK SCIENTIFIC CENTER TO EMPHASIZE EARTH SCIENCES

25X1A [redacted]
General Sciences Division
OSI/CIA

The Soviets are developing a scientific center in Irkutsk which will emphasize the earth sciences, including geology, geophysics, geochemistry, and geography. The establishment of such a research center could improve considerably Soviet capabilities in the earth sciences, and their ability to exploit the minerals and other natural resources of the region. The center, to be similar to but smaller than the one at Novosibirsk, now has eight research institutes, a computing center, a control and measuring laboratory, and a library. (OFFICIAL USE ONLY)

SOVIET SPECIALISTS IN VACUUM DIFFUSION BONDING* NOMINATED FOR 1965 LENIN PRIZE

25X1A [redacted]
General Sciences Division
OSI/CIA

Seven Soviet scientists, led by Dr. Nikolai Kazakov, have been nominated for a 1965 Lenin Prize for "Development of the Method, Technology, and Equipment for Diffusion Welding of Metallic and Nonmetallic Materials in Vacuum." Dr. Kazakov is head of the Laboratory for Vacuum Diffusion Welding of the Moscow City National Economy Council for Scientific Research.

Recent Soviet published research, including that of Dr. Kazakov, has included advanced work on the vacuum diffusion bonding of porous niobium to dense molybdenum. Such compacts would be used as filters for liquid metal coolants in nuclear power plants. The Soviets also have investigated the vacuum diffusion bonding of dissimilar metal thermoelements which could be used for thermionic power converters, and of tungsten to steel for possible rocket engine applications. [redacted] 25X1

* Vacuum diffusion bonding is a process for joining materials in a vacuum by utilizing pressure and heat. It is used with high-melting-point metals which cannot be easily welded or brazed, with dissimilar materials whose coefficients of thermal expansion vary considerably, and with porous structures where a welding or brazing operation would cause undesirable liquefaction.

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SUCCESSFUL LABORATORY SYNTHESIS BY CHINESE COMMUNISTS OF A HIGH-STRENGTH ION EXCHANGE RESIN

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[redacted]
Nuclear Energy Division
OSI/CIA

Personnel at the Nan-Kai University at Tientsin, one of the major centers in Communist China for work on ion exchange resins, succeeded in 1964 in the laboratory synthesis of a porous high strength ion exchange resin, probably for use in processing nuclear fuel. The reported physical properties of this resin, which include high mechanical strength, high ion exchange speed, chemical stability and radiation resistance, suggest that it was developed for processing irradiated reactor fuel. In the past, Communist China has imported other ion exchange resins from Japan and possibly other countries. [redacted]

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ADVANCE IN GERMAN NUCLEAR PROPULSION

[redacted]
Nuclear Energy Division
OSI/CIA

The West German Association for Nuclear Energy Exploitation in Shipbuilding and Navigation has been granted approval by the United States for the lease of up to 3,300 kilograms of uranium enriched to 2.3 to 4.9 percent U-235. The material will be used in the nuclear propelled surface ship, Otto Hahn, a 16,000 dead-weight ton ore-carrier, now being built by the Germans.

The assurance of the availability of fuel will permit the Germans to complete this project. The Otto Hahn, the hull of which was launched in mid-1964, will have a 38-megawatt (thermal), pressurized water reactor which will provide 10,000 shaft horsepower. With the completion of this vessel (now scheduled for late 1967), West Germany will become the third nation to [redacted]

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[redacted]

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