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East Germany

August 1973

Science

NATIONAL INTELLIGENCE SURVEY

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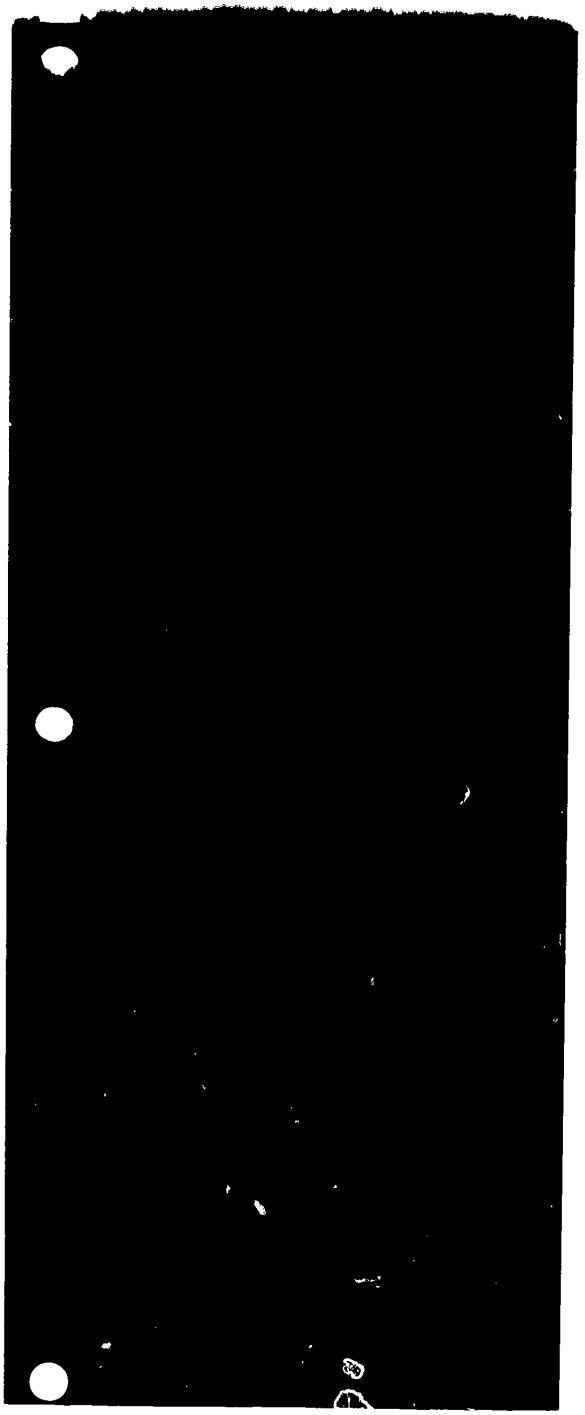
This chapter was prepared for the NIS by the Central Intelligence Agency. It includes contributions by the Defense Intelligence Agency and the Departments of the Air Force, Army, and Navy. Research was substantially completed by January 1973.



East GERMANY

CONTENTS

This chapter supersedes the scientific coverage in the General Survey dated February 1970.

FIGURES

Science

A. General (S)

The quality of East German scientific research is good in fields which it has emphasized and supported. In overall technical competence East Germany ranks with the best among the Eastern European countries. When compared with the West German scientific effort, the country lags significantly in basic research but is nearly on a par in applied research and industrial technology. In general, research is still hampered by government restrictions, a lack of equipment, and the loss of scientific-technical manpower suffered in the 1950's. The constant reforms and reorganizations of the inner structures within scientific organizations, key personnel replacements, and rigid controls of scientists and technologists at all levels have resulted in low morale and distrust among dedicated scientists in the country. Despite losses of large numbers of scientists and engineers who defected before the erection of the Berlin wall, however, the personnel situation at research institutes is relatively good.

Before World War I Germany was considered the leading country in the world with respect to overall scientific accomplishments and capabilities. The scientific community enjoyed unusually good support from the government, and the country in general was oriented toward science and technology, providing a good environment for research in all branches of science. The outstanding achievements of German scientists in all important fields of science, as shown by the large number of Nobel prize winners, served to lend prestige to and stimulate interest in scientific research in Germany. Several factors contributed to the decline in Germany's relative position in the scientific world, including the unfavorable intellectual climate prevailing during the period of National Socialism and the rapid growth of science in other countries. During the period when the country was under Nazi rule, many prominent scientists left Germany, and emphasis was placed on military research and development. The scientific effort was affected seriously not only by the destruction during World War II of many universities, technical schools, research institutes, and laboratories but also by the Soviet occupation following the war. Much laboratory equipment was removed, and many scientists, engineers, and technicians were deported to the U.S.S.R.

Research and development activities are oriented toward the economic needs of the country and requirements of the U.S.S.R. East Germany plays a leading role after the Soviet Union in the Council for Economic Mutual Assistance (CEMA). The planned economy of the country retards progress in some technical fields as research becomes more and more adjusted to industrial production. Although the official position regarding support to basic research has vacillated, such research appears to be declining, while applied research is increasing in importance.

As a result of Soviet pressure, scientific relations between East and West Germany have been very limited. At least up until 1972, the Government has discouraged East German scientists from belonging to West German scientific societies and has applied pressure to force scientists to resign their memberships

in various professional and scientific societies in West Germany. During 1969 the government discontinued cooperation with West Germany in the publication of *Chemisches Zentralblatt*, the German chemical abstracts, which for many years had been an outstanding example of a highly successful joint effort by East and West German chemists. What influence the recent thaw between East and West Germany will have on scientific relations is unclear at this time.

East German authorities recognize that the country is unable to conduct a comprehensive program of research in all fields of science and technology but must enter into cooperative scientific agreements with other countries. In 1968 East Germany and the Soviet Union signed an agreement providing for direct consultation between specialists of the two countries on long-range plans for the development of science and technology. Other agreements provide for the exchange of literature, scientific personnel, and new technical methods. At times the situation has been one sided, with the Soviets dominating the exchange, imposing work programs on East Germany, and exploiting the results obtained. During the past 15 years, 8,000 East German specialists were trained or have engaged in joint research investigations and studies in the U.S.S.R., and approximately 4,000 Soviet scientists had visited or spent some time in joint research activities in East Germany. East Germany has also entered into agreements for scientific and technical cooperation with Poland, Czechoslovakia, Hungary, Romania, and other Communist countries. There is some evidence that the East Germans are reluctant to provide research results to other Eastern European countries in fulfillment of the agreements.

East Germany has observer status in the United Nations and is a member of the specialized U.N. agency UNESCO. It participates in assistance programs in the less developed countries by extending credit, developing industries, and providing technical assistance and technicians. The country is a member of the Joint Institute for Nuclear Research at Dubna in the Soviet Union and of other worldwide Communist organizations. It also is a member of the International Astronomical Union, the Committee on Space Research (COSPAR) of the International Council of Scientific Union, and the International Union of Geodesy and Geophysics.

B. Organization, planning, and financing of research (S)

Although the East German organization for science and technology has undergone many changes since World War II, the structure has become more stable in recent years. Some internal reorganization appears to be continuing, however, within the major scientific bodies. The trend has been toward stronger governmental domination over research and development. Scientific affairs are controlled and financed entirely by the government, which in turn is under the control of the Communist party. The executive power of the government is vested in the Council of Ministers. The central agency of the Council of Ministers for the planning and management of the national economy is the State Planning Commission. The major responsibility for organization and planning of research is borne by this commission and its subordinate organization, the Council for Research and Development in Natural Sciences and Technology, usually referred to as the Research Council (FR). The State Planning Commission also directs international cooperation in science and technology (Figure 1).

The FR is the highest scientific planning organization in the country and acts for the Council of Ministers in an advisory and coordinating capacity on research and development of concern to the economy. It was established in 1957 to introduce scientific and technical research results in all branches of industry. The FR has control of research resources, the training of researchers and their utilization, and the expansion of existing facilities. It is assisted in its advisory function by central working groups, which determine priority areas for research and are responsible for formulating research and development plans and programs in a specific area of science and technology. A special commission of the FR coordinates and directs research on long-range problems and provides the means of collaboration with other Communist countries.

The Ministry for Science and Technology is the administrative arm of the FR. This function was held by the State Secretariat for Research and Development until its replacement by the ministry in July 1967. The ministry is responsible for the execution of the research and development plan, primarily by providing financial assistance to scientific and technical institutes and other research installations. It has jurisdiction over the general direction of research and the areas of emphasis and may assign projects to individual institutes, including those under the Academy of Sciences of the German Democratic Republic (*Akademie der Wissenschaften der DDR*—AW), East Berlin. The ministry coordinates the work of the FR's central working groups and also coordinates the activities and reviews reports of the

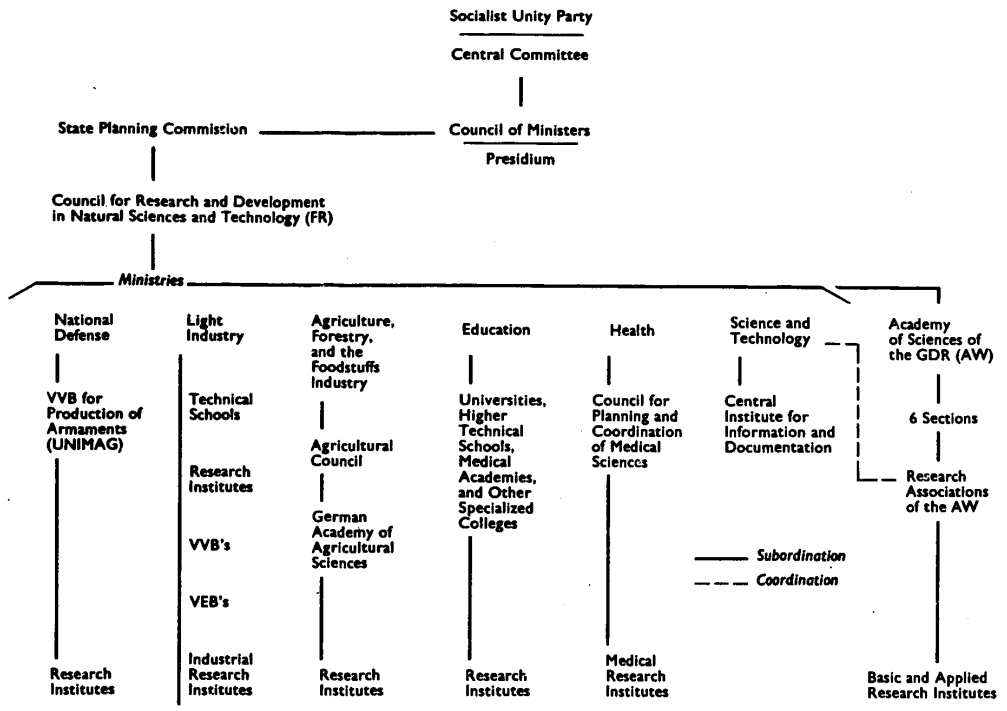


FIGURE 1. Organization of scientific and technical research (S)

many advisory councils which have been established throughout the research and development sector at the management level.

The regime is continuing its efforts to align research and development more closely with economic requirements. In the mid-1960's the role of governmental ministries in research and development was strengthened when various "people-owned enterprises" (VEB's) were placed under appropriate ministries. The VEB's operate numerous industrial research and development laboratories and are grouped by type of industry into associations of people-owned enterprises (VVB's). The VVB's maintain about 100 industrial research institutes, constituting about 10% of the country's industrial research, development, design, and construction installations. In every industrial concern there is a new technology committee, the tasks of which are to monitor production rates, promote research and development activities, and arrange for interchange of technical information. All scientific workers and technicians within the industrial enterprises are required to cooperate with the committee, which in turn cooperates with the research centers of the VVB's. The main research organization is the AW. Formerly the German Academy of Sciences (DAW), it was renamed in October 1972; the statute and all rights and duties of the academy remained unchanged. The AW has a number of permanent advisory commissions under its presidium and operates almost 100 research installations grouped under six sections. The institutes are organized into research associations, such as the Research Association of the Natural-Scientific, Technological, and Medical Institutes, which establish priority for AW's research and assign to appropriate institutes the research projects placed with AW by other governmental agencies on a contractual basis. These associations work closely with the FR. The

AW has made an effort to induce industrial establishments to conduct as much of their own research as possible so the AW institutes can concentrate on pure research. The AW is concerned also with personnel assignments and foreign travel for scientists and engages in research agreements with academies of sciences of other Soviet-bloc countries. It has about 20 national committees which are affiliated with international organizations. A reorganization of the academy has been underway since May 1968 with the objectives of making it an economical self-supporting organization, obtaining better government control over the academy, and consolidating small institutes with related missions. In 1970 the Leipzig branch was reorganized. Its projects concerning fundamental research were transferred to institutes of universities and replaced with industrial and applied research work.

There are several other scientific academies, The German Academy of Agricultural Sciences in Berlin, with 33 research institutes, is subordinate to the Agricultural Council. The institutes are grouped into six sections dealing with general agricultural research, studies of plants and seeds, and agrochemical research. The Saxon Academy of Sciences in Leipzig and the Leopold-Caroline German Academy of Naturalists in Halle maintain libraries and publish journals but do not engage in scientific and technological research in their own institutes. Their members, however, are active in several institutes of the AW. Four academies promote medical sciences: the Medical Academies in Erfurt and Magdeburg; Carl Gustav Carus Medical Academy in Dresden; and the German Academy of Advanced Medical Training in Berlin-Lichtenberg.

Military research is under the VVB for Production of Armaments (UNIMAG), which is responsible to the Chief of the Armament and Technology Directorate in the Ministry for National Defense. Medical research is carried out in institutes under the Ministry for Health and in medical higher schools under the State Secretariat for Higher Education.

An important part of the scientific research, particularly basic research, is conducted in the universities and higher technical schools which have university standing and in the many large research institutes affiliated with the universities. Major research projects are assigned to individual faculties and institutes by the State Secretariat for Universities and Higher Technical Schools on the recommendation of the FR. In each higher educational institution there is a prorector who is responsible for supervising research contracts negotiated between industrial enterprises and the institutes of the universities; some of these institutes work almost exclusively for large VEB's which finance the contractual research and provide the research equipment. The Friedrich Schiller University, for example, works closely with the Carl Zeiss Works in establishing a closely related curriculum and research program in instrument design and production.

Scientific and technical research and development function under long-range research plans and annual working plans. The plan for national research is one of four sections incorporated in the New Technology Plan, which is part of the national economic plan. The directives for research and development are drafted by the FR with assistance from the Ministry for Science and Technology, amended by the State Planning Commission, and approved by the Council of Ministers. East German research planning has been influenced by directives of CEMA, which in theory directs work throughout the East European countries under the overall control of the U.S.S.R. Each country is assigned responsibility for research in certain areas, and under CEMA the Academies of Science of all of the member countries have working agreements for broad exchanges of personnel and information on research and development. CEMA has established a Central Research Council in Karl-Marx-Stadt to coordinate research efforts among the member countries. In practice, there has been some reluctance on the part of the East Germans to divulge technical information to other Eastern European countries. Only meager information is available concerning expenditures by East German industry, scientific academies, and universities for research and development, and the reporting is ambiguous. In general, research appears to be adequately financed with about 1.3%-1.5% of the gross national product allocated for research purposes. The shortage of personnel limits the amount East Germany is able to spend on research; the country apparently has been unable to utilize efficiently an increase greater than DME 100 million annually. Part of the funds provided by the government to higher educational institutions is used for research, but a major portion of the support of research in the higher educational institutions and in the institutes of the AW is derived from contracts with industrial enterprises. The Ministry for Science and Technology is assumed to be responsible for the allocation and approval of funds for research and development projects. During 1966 more than DME 2.3 billion reportedly were allocated to research and development centers. Of this amount, about 90% was allocated for research and development in industry,

agriculture, construction, and transportation, and about 10% for research under the AW and the Ministry for Education.

C. Scientific education, manpower, and facilities (S)

Public expenditures on education are high. All education is under state control and is free up to and including the university level for all who can obtain admittance. Admission to a university depends to some extent on social background, with preference given to students from politically reliable families and to the children of workers and peasants, although this emphasis appears to be lessening. East Germany has placed high priority on educating qualified scientists and engineers, and plans for expanding scientific education have been implicit in the objective of increasing general enrollments by 6% to 7%. Plans formulated in 1968 set a goal to meet the need for 1.2 million advanced and technical school graduates by 1980. However, since about 1971 the Honecker regime has shown considerable distrust of the scientific community and has indicated a desire to limit its potential influence by measures which include a reduction of enrollments in scientific fields in the higher schools.

East Germany has seven universities and a number of institutions of higher education (*Hochschulen*), including technical, agricultural, and engineering schools. The universities offer high-quality education in the sciences. During 1969-70 the total enrollment in the universities, including the Technical University of Dresden, was about 67,000 students. In 1968 approximately 141,000 students were studying scientific and technical subjects in all of the higher schools. Of this number, 59% were full-time students. Approximately 37,000 were studying mechanical and electrical engineering; 10,000, natural sciences; 10,000, medical sciences; 7,200, agricultural and forestry subjects; and 1,400, metallurgy. Among the technical schools, the Technical School for Chemistry, Merseburg, which has an enrollment of about 2,500 students, is important in training chemists and chemical engineers; and the Freiberg Mining Academy, with an enrollment of 3,500, specializes in mining and metallurgy. Several other technical schools emphasize various fields of engineering.

The influence of the U.S.S.R. is strong in educational activities. The Ministry for Education has urged professors to consider the Soviet Union and not the West as the leader in science. Allotments provided by the ministry for the purchase of Soviet textbooks far outweigh the amount allowed for the acquisition of scientific and technical publications from other countries. Because few East German scientists and engineers can read the Soviet textbooks, the Central Institute for Information and Documentation has undertaken translation and dissemination of the scientific publications. Restrictions have been placed on the purchase of laboratory equipment in the West, partly to conserve currency but probably also as a means of directing attention to the Soviet Union. A substantial number of East German science and engineering students have been trained in the U.S.S.R., and many of them hold responsible positions in government and industry.

Serious shortages of scientific and technical manpower developed between 1948 and 1961 when more than 2 million persons defected to West Germany. About 10% of these were skilled workers and craftsmen, a large proportion of whom were under 45 years of age. About 20,000 highly trained technical personnel and about 1,700 scientists with postgraduate degrees had defected by 1964. Approximately 1,400 of the latter group came from the AW and the faculties of universities and higher schools. Additionally, hundreds of physicians, pharmacists, teachers, lawyers, judges, and other professionals defected. Losses sustained by faculties of higher schools retarded attempts to train personnel to replace those who defected, and by 1958/59 some teachers were holding two professorships at higher technical schools to accommodate the increased enrollments. In an effort to halt the exodus, special concessions such as relief from party activities and political pressure, a moratorium on military duty, and an increase in material comforts were made for professionals. But defections continued at a high rate until erection of the Berlin wall. East German research scientists are well paid, however; their average salary amounts to the equivalent of US$10,000 a year. Among teaching personnel, professors with lengthy tenure receive approximately $24,000. Younger teachers receive considerably less, about $4,000 a year.

The government recognizes that economic progress depends on increased productivity and the use of modern technology under the supervision of highly trained personnel, and it has attempted to channel students into priority fields in higher education. The prevailing emphasis on applied science has provided the impetus for university-level training at factory institutes, where some diploma and doctoral theses are written while the candidates work as salaried employees. For most candidates the theses are not assigned by professors but by industry, which provides

the equipment and space needed for research. In this way, more graduate engineering personnel have been drawn into industrial installations.

Reliable statistics on the supply of scientific and technical manpower are not available. In 1966 an estimated 18,000 were employed in various types of governmental research institutes. Mid-1968 publications from East Germany indicate that about 100,000 graduates from universities, polytechnical schools, and trade schools were employed in research and development activities at 1,800 research centers. Approximately 23,000 of the workers with diplomas from higher schools were employed by industry in research and development. During 1965 the Academy of Sciences employed about 12,000 workers, nearly 3,000 of whom were scientists with professional degrees.

The number and quality of research facilities vary greatly depending on the field of science. Most of the institutes employ 10 or less full-time employees. Some of the AW institutes are well equipped, while research institutes at the universities generally have insufficient equipment. Chemical research facilities appear to be adequate for the level of the research effort, although modern, well-equipped facilities are lacking for research in certain aspects of organic and inorganic chemistry related to production. The research equipment associated with nuclear physics is of high quality and sufficient for the limited research being done. Good quality facilities are available for research in solid-state and plasma physics.

D. Major research fields

1. Air, ground, and naval weapons (C)

Since World War II East Germany has not attempted indigenous development and production of air, ground, and naval weapons and has conducted very little military-related research. The country lacks the manpower and diverse research and production facilities needed to undertake any major weapon system development program. Aside from small arms, nearly all weapons used by the military forces are of foreign design and manufacture. There is no evidence of significant growth in ground or naval weapons developmental capability nor of any aeronautical system development, although some significant research and development are being accomplished on certain support equipment.

A post-World War II attempt to reestablish an aircraft industry was abandoned in the early 1960's with the collapse of an indigenous jet transport development project and the phase-out of licensed production of Soviet transport aircraft. Since that time, only aeronautical research of an academic nature has been carried out in institutes and schools located primarily in East Berlin and Dresden. Although some residual capability in aerodynamics and structures may exist, the absence of any important development programs has diverted most of the remaining engineers into other fields. The only effort in the aircraft field consists of the maintenance and overhaul of fighter and support aircraft of the air force and transports of the state airline, INTERFLUG. There is some glider and amateur aircraft design and construction in progress, but these activities are not significant in terms of a national capability.

East Germany lacks the scientific and technical manpower and the diverse research and production facilities necessary to undertake an independent native guided-missile program. Under Soviet supervision, some research was performed on rocket motors suitable for small tactical missiles. Although there has been no well-defined propulsion technology program, work is underway in related fields. The chemical industry is contributing to the development of propellants by its research on fluorine, hydrazine, ammonia, and a variety of nitrates. Work related to solid propellants includes the study of binders and the effects of ultrasonics.

Naval design and construction has shown neither originality nor conspicuous success. The country designs and constructs its own naval craft mainly in the patrol, minesweeping, and auxiliary classes and has developed a class of sophisticated gas-turbine submarine chasers. In general, all armament is of Soviet origin, although navigation radars for naval use are domestically designed and produced.

East Germany is capable of producing conventional slow-speed diesel propulsion units up to 8,150 horsepower for merchant vessels and has developed a successful series of higher speed diesels for naval use in minesweepers and patrol craft. Research is being conducted on a crosshead-type diesel to run on cheap residual fuels. Research and development on gas turbines, including marine applications, has resulted in one operational gas-turbine propulsion system for naval use, but only after 10 years of frustration.

The East Germans appear to have a large, clearly defined organization for ship construction research and development, primarily directed toward merchant ship production, although a major deficiency is the lack of extensive model test facilities. There is, however, a modest model test basin at Marquardt, near Potsdam, and the Institute for Shipbuilding,

Rostock, has a model construction shop and computer facilities. A jetty and test basin at Penne Shipyard, Wolgast, may carry out dockside testing of new construction and experimental propeller design.

No important ground weapons have been developed, and there is no evidence of any interest in improving the country's development and production capabilities in this field. Most of the research work concerning ground force materiel has been on engineer-type equipment, particularly topographic and camouflage. Among the Communist countries, East Germany is second only to the U.S.S.R. in the ability to develop and produce a full range of topographic mapping equipment. Much of this equipment is developed and produced at the VEB Carl Zeiss Jena complex, and devices developed since the early 1960's have become increasingly competitive with the best equipment from West Germany and Switzerland. In many instances, Zeiss Jena equipment models are better than similiar Soviet designs. Land navigation systems are virtually the only category of topographic equipment for which the East German Army is totally dependent on Soviet production.

The East Germans have developed all varieties of conventional field survey instruments—theodolites, tachymeters, optical rangefinders (some with infrared sensing attachments), laser rangefinders, north-seeking gyrotheodolites, electronic and electro-optical distance-measuring equipment, and desk-top calculators. Van-mounted photogrammetric equipment has been developed for military use, together with a complete line of modern stereophotogrammetric equipment for base-plant operations. Aerial (frame) cameras, ground stereo cameras, and phototheodolites are available together with photographic laboratory processing and mensuration equipment. Recent innovations include several photographic interpretation devices for both field and office use. New Zeiss Jena equipment for orthophotography has been adapted for use with several stereoplotting systems and, because of its quality design, should be of particular military value for the production of accurate photomaps. Zeiss Jena also has nearly completed development of an analytical stereoplotting instrument, designated stereodicomat, which is constructed from a stereocomparator operating on-line with a small electronic computer. Another example of the breadth of East German research in topographic fields is the development by Zeiss Jena of the Cartimat, an extremely versatile modular automatic map compilation system (Figure 2). Modification research is continuing on the Cartimat. Highly specialized research and development on map

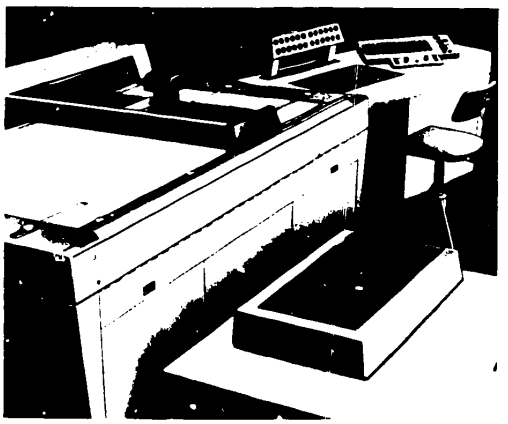


FIGURE 2. Modular automatic map compilation system, Cartimat, developed by Zeiss Jena (U/OU)

reproduction equipment is underway, and the country's multicolor offset presses and associated map reproduction equipment are in demand among all the Eastern European countries, as well as in non-Communist areas.

East Germany has the capability to develop and produce a variety of military transport vehicles, ranging from light- through medium-payload classes. In bridging and stream-crossing equipment, engineers have achieved two significant developments, a tank-launched scissors bridge, designated BLG-60 (Figure 3), and an echograph, the FP-10. The BLG-60 is equipped with an infrared night-vision device and snorkel and is estimated to have a carrying capacity of 60 tons. The echograph is used to determine the profile of a river bottom by registering the depth of the water with reference to the bank and according to the scale on an acoustic recording chart.

Research on concealment equipment and practices is on a par with the best in the world. The apparent

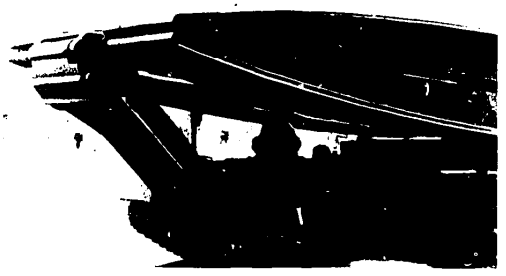


FIGURE 3. Tank-launched scissors bridge, BLG-60 (C)

research goal is to develop lightweight, weather-resistant materials (paint, coatings, nets) with good anti-infrared, anti-radar, and anti-ultraviolet characteristics. Little research is done on engineer construction equipment. The East Germans have attained a leading position among East European Communist countries in the development of military electrical equipment and are doing good work on direct energy conversion units.

Quartermaster equipment research and development have included work on military clothing, including helmets; POL-handling equipment, and primarily collapsible containers; and packaging and containers. East Germany is not engaged in research and development of materials-handling equipment specifically for military use, but the potential exists to develop and produce equipment that would satisfy army requirements.

2. Biological and chemical warfare (C)

There is no known offensive biological warfare (BW) agent or munition research and development in East Germany. Various microbiological research institutes and pharmaceutical production facilities give the country the technical competence to make biological warfare agents. BW programs, however, are believed to be directed and restricted by the U.S.S.R., and outputs of agents are limited to those types and quantities used in research. Research applicable to defensive BW is conducted at various military and medical microbiological research institutes and laboratories.

Significant research is being conducted in areas pertinent to BW agent detection and identification. Research and testing applicable to defensive BW is conducted on disinfectants, insecticides, transducing bacteriophages, aerobiology, bioengineering, microbial filtration, and bacterial and viral culture media. East German scientists have acquired considerable skill in preparing microorganisms on a large scale while pursuing research on methods to control medical and public health problems of humans and animals. Equipment and advanced techniques for culturing, concentrating, and stabilizing microbiologic agents are available, and large drying facilities are capable of processing significant amounts of agent materials. Scientists are actively using the drying technique for the production of vaccines and sera for cholera, poliomyelitis, ECHO (Enteric Cytopathogenic Human Orphan) viruses, psittacosis, plague, salmonellosis, typhoid, tetanus, influenza, foot-and-mouth disease, tularemia, toxoplasmosis, smallpox, erysipelas, and ornithosis, which represent a broad spectrum of pathogens, including several candidate BW agents.

The Military Medical Section of the Ernst Moritz Arndt University, on the island of Riems, is the only military institute in East Germany conducting research and development in BW. It is administratively under the Ministry for Education, but its research program is directed by the Ministry for National Defense. The section has a number of institutes under its direction, including the Institute for Biological Protection, which has been concerned with fungal research aerosol studies, experiments with BW materials involving animals, and tests of protective materials. BW-related research is conducted under two institutes of the AW: The Institute of Microbiology and Experimental Therapy, Jena, and the Institute of Comparative Biology, East Berlin. The former is well equipped and the most outstanding microbiological installation in the country. Its work in molecular biology is of high quality. The latter facility has conducted research on the identification of disease agents with the use of flourescent antibody technique. The Institute of Epidemiology, East Berlin, and the Veterinary Vaccine Research Institute, Dessau, both under the Ministry for Health, produce sera and vaccine. The Friedrich Loeffler Institute, on the island of Reims, subordinate to both the ministry responsible for agriculture and the Academy of Agricultural Sciences, has excellent facilities for research, development, and production of antianimal agents. All BW research is done in collaboration with colleagues from other Warsaw Pact countries, especially the U.S.S.R. and Hungary, by means of visits and exchanges of information and technology. The quality and quantity of the research effort are impressive.

Research in chemical warfare (CW) covers a broad range of subjects related to both offensive and defensive aspects of CW. Offensive research includes the synthesizing and testing of organophosphorus nerve agents, including V-type agents. New lethal agents apparently are not under development, although scientists appear to be searching for methods to improve the persistence and effectiveness of the older nerve agents. Research on psychochemicals is of high quality, strengthening the potential for developing incapacitating agents. A strong interest is evident in hallucinogenic agents, and numerous studies have been done on ergot alkaloids, the raw material for lysergic acid diethylamide (LSD), and on glycolic acid derivatives.

Scientists appear to be conducting a significant amount of research and development oriented toward

CW defense. A number of institutes are conducting research on CW detection. Research on new detection techniques involves the use of paper chromatography, thin-layer chromatography, enzymatic assays, and luciferin-luciferase luminescent systems. Excellent results have been achieved on detection, protection, and decontamination equipment, which has been standardized for the East German and other armies of the Warsaw Pact countries. Along with the Soviets, the East Germans are leaders among the East European countries in the development and improvement of chemical-biological-radiological (CBR) decontamination vehicles, but no recent developments have been reported. East Germany has been assigned the leading role among the East European countries in the development of decontamination ointments.

Research is underway at several institutes in CW prophylactics and therapeutics, including antidotes for nerve agents. Under study are the effects of cholinesterase reactivators such as toxogonin bromide—N, N'Trimethylene-bis (pyridinum-4-aldoxime) dibromide (TMB-4), pralidoxime (2-PAM)—and other pyridine aldoximes.

Detection equipment efforts have included the development of a neutron dosimeter for personnel. The technique employed allows the incident neutron to interact with a uranium foil. The uranium nucleus splits, yielding fission fragments which are collected in a mica foil. The fission fragment principle is not new, but its use with a mica foil is a recent development. The main advantage of mica is that the etched traces can be easily identified because of their rhombic shape.

3. Atomic energy (S)

The nuclear energy program was initiated in 1955, but all nuclear research was curtailed in 1962. It was heavily supported and strictly controlled by the Soviet Union. Although achievements lagged behind those of West Germany, they were on a par with or better than those of other East European countries; during this period the East Germans made some significant contributions in the production and utilization of radioisotopes. The major factors underlying the accomplishments were the considerable Soviet financial and technical assistance, well-developed industrial support, and the availability of German scientific and technical personnel repatriated from the U.S.S.R.

During the early stages of the program, emphasis was placed on the establishment of a nuclear research center and facilities for training personnel. The first and only significant nuclear research institute established in the country was the Central Institute for Nuclear Research at Rossendorf, near Dresden. The equipment for this institute, including a 2-megawatt (MW) research reactor and a 25 million electron volt (MeV) cyclotron, was provided by the U.S.S.R. Although most of the research concerned radioactive isotope production and utilization, some effort was devoted to power reactor development.

Nuclear research probably was curtailed at the direction of the U.S.S.R. In June 1963 most of the training programs were discontinued. A major reorganization occurred in 1963 which dissolved the Office of Nuclear Research and Nuclear Technology and transferred its functions to the SFT. Many of the nuclear scientists and technicians were assigned to nonnuclear tasks. Although the U.S.S.R. has continued its assistance, the East German nuclear program remains under severe curtailment.

East Germany has a small nuclear power program which is viable only by Soviet permission and because of massive Soviet assistance. The first power station, a 70-MW electrical (MWE) pressurized water reactor, was built at Rheinsberg, north of East Berlin, and started operation in early 1966 (Figure 4). The Soviet Union provided the reactor and fuel for it and still retains control of the facility. All spent fuel elements are returned to the U.S.S.R., thus depriving East Germany of access to the plutonium produced in the reactor. East Germany does not have any plans for the construction of fuel reprocessing facilities. A second nuclear power complex is under construction at Greifswald near the Baltic coast. This station is to consist of at least six reactors, the first of which is to be operational in 1974-75, and the remaining five at 12-month intervals. The first four reactors reportedly will be 440-MWE pressurized water units identical to the third and fourth units at Novovoronezhskiy in the U.S.S.R. The two final units (supposedly operational in 1979 and 1980) are to be 1,000-MWE each. The reactor under construction is being provided by the Soviets under conditions similar to those for the Rheinsberg reactor: the fuel will be provided by the Soviets and the spent fuel will be returned to the Soviet Union for reprocessing. Preliminary studies are underway for locating a 1,000-MWE nuclear power facility in the Merseburg area to serve the chemical industries there.

There are no indications that the Soviets have relaxed or will relax their control over the East German nuclear program to such an extent that military-oriented research has been or will be possible.

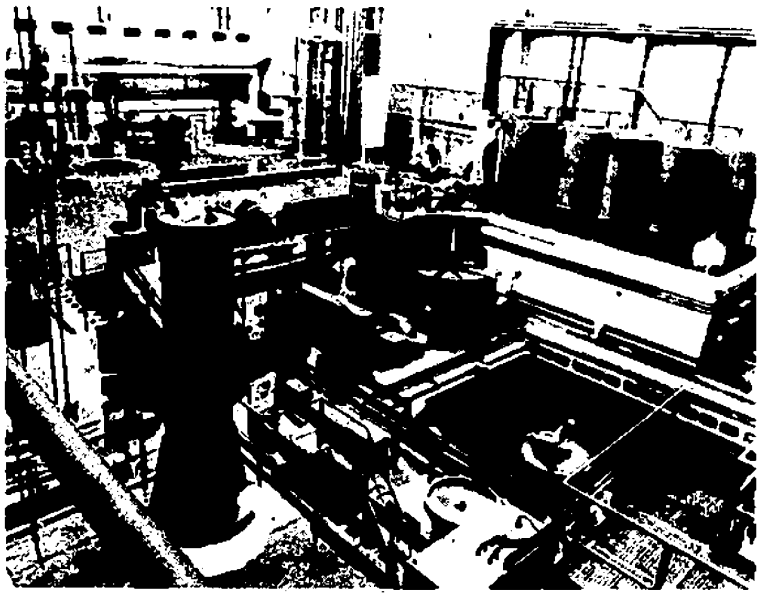
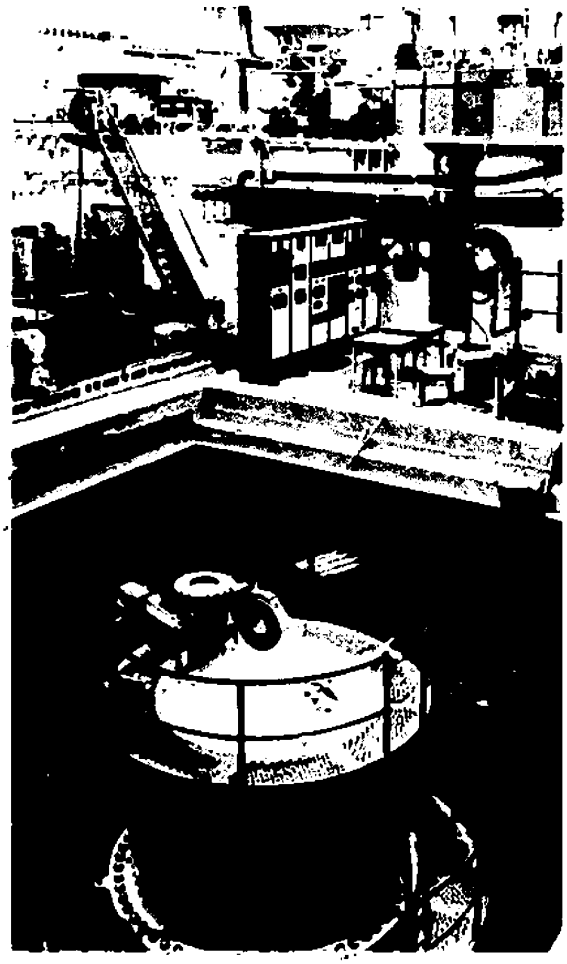


FIGURE 4. Reactor hall and nuclear power reactor at Rheinsberg atomic powerplant (U/OU)



4. Electronics (S)

The electronics industry is advanced in the sophistication of the products developed and is continuing to increase steadily in the rate of production. The major portion of the electronics research and development effort emphasizes applied aspects. The trend reflects recognition of the need for new concepts and techniques, particularly improving on automated manufacturing processes and military equipment and systems. In general, the country leads all Eastern Europe in electronics research and development and is second only to the U.S.S.R. in the development and production of laser devices and military signal equipment. The greatest concentration of electronics research activity is in East Berlin, Leipzig, and Dresden. The largest and best equipped research and development facilities for electronics research are those of industry. Research facilities maintained by the AW, universities, and technical schools are small when compared with those of industry; but their equipment, though less abundant, usually is capable of more precise operation than that used by industrial laboratories. Future research programs of AW are expected to involve closer cooperation with industry, including an increased number of contracts.

Electronics research and development programs arise primarily from the need of industry and from requirements of the Soviet Union for technical equipment. CEMA assigned to the East Germans the

responsibility for providing direction to the Warsaw Pact countries in thin-film technology. A very significant development was achieved by Dr. Manfred von Ardenne of the Von Ardenne Research Institute, when he brought the development of electron-beam micromachining of thin-film components to the production stage. He has been acclaimed by technologists of both East and West for the accomplishment. The institute also has done research in molecular electronics, emphasizing evaporation techniques and the development of equipment. The Soviet Union and East Germany have collaborated in research and development of microelectronics. Electronic furnaces and other modern methods have been developed for purification of elements used in semiconductor and crystal experiments. Work in thin-film techniques has contributed to the development of integrated circuits, improved diodes, and fast-switching transistors.

The East German semiconductor industry generally lags that of the West. Experimental investigations have been carried out on large band-gap crystals of zinc-sulfide and other materials, including germanium, selenium, and silicon carbide. Theoretical and applied research are conducted on Schottky and Gunn effect devices, as well as on radiation and photosensitive materials. Efforts on microwave tubes have included work on magnetrons, klystrons, amplifiers, and both backward and forward traveling wave tubes. Work at wave lengths only down to 8 millimeters has been reported and only mediocre results have been evidenced. Reliability and miniaturization research follow conventional germanium low-frequency types. A silicon transistor with pulse transit time of about 4 nanoseconds has been produced.

Much research is conducted in opto-electronics, and good-quality infrared image converter tubes and vidicons are being produced, although they are basically copies of Western tubes. The Institute for Data Transmission has produced infrared data transmission equipment, consisting of pairs of optical receiver and transmitter devices, with a range of 4 to 5 kilometers.

In signal and communications work, the East Germans have appeared to rely less on Soviet research efforts than in most other fields. The East Germans have developed radio-link and high-capacity carrier equipment, automatic, transistorized telephone exchange equipment using printed circuits, and a large number of teleprinter and facsimile units that are in wide use throughout the Communist countries. These are excellent, high-quality products. Theoretical investigations are being performed on pulse code modulation and millimeter waveguide systems. Measurement work is underway in the 10-15 gigahertz range with open resonator (quas-optical Fabry Perrot resonators with two parabolic mirrors). Microwave sources are klystron oscillators and varactor multiplier chains.

The Central Wire Telecommunications Laboratory in East Berlin has done extensive research on communications equipment for marine use in arctic and tropical conditions.

The Institute for Communications Technology in East Berlin has designed and developed a transistorized navigational radar system which operates in the Q-band (8.6 millimeters) for employment in riverboats. The institute has developed and produced directional microwave radio frequency generators, switching devices, and microwave antennas. It also has directed and financed research in digital communications techniques at the Higher School of Technology in Ilmenau. Three naval radar systems, designated TSR-222, -333, and -444, are under development by the Electrical Instruments Plant in Leipzig; the designs are based on U.K. developments.

East German interest in laser development stems from the potential application of lasers to communications, space navigation, guidance devices, industrial and medical usage, and possibly antimissile systems. The research program initiated in 1961 has resulted in substantial contributions to the state-of-the-art in military applications. The effort has been limited to more conventional lasers of modest power, such as ruby, neodymium glass, gas, and semiconductor lasers. Much of the research has concerned gallium-arsenide lasers and their applications.

The most important laser research and development program is centered at the VEB Carl Zeiss. Experimental work has been devoted mainly to the applications of lasers in welding, precision machining, communications, and ranging. Several laser devices for microwelding and micromachining have been developed. Work also has been done on the use of lasers for eye surgery and cancer cell destruction. Because of their work on laser modulation techniques, the East Germans may also have developed laser communications systems. The Institute of Communications Technology in East Berlin has used gallium-arsenide devices in telephone and television research. Ruby lasers have been used in sighting devices for military applications.

Computer development has been slow despite an effort dating from as early as 1954. None of the early efforts was successful in providing East Germany with

high-quality computers, although as many as 50 computers of the ZRA-1 type were produced by VEB Carl Zeiss. In 1963, production of these computers was suspended because of technical difficulties and because it was more economical to procure computers from foreign sources. By 1965, the East Germans had begun development of good-quality small- and medium-sized computers, such as the Cellatron series, some of which were exported to the U.S.S.R. and other Warsaw Pact countries. A small-capacity, fully transistorized computer, the Cellatron D4a, was developed at the Institute for Electronic Computation of the Technical University of Dresden and is produced by the VEB Mercedes, Zella-Mehlis. The Robotron 100, 300, and 400 digital computers were developed by the VEB Robotron, Karl-Marx-Stadt. The Robotron 300, which is similar to the IBM-1410, has been a very successful model satisfying mostly domestic requirements for computers. Ambitious plans for the development of relatively advanced models, the R-400 and R-500, were dropped, although a somewhat less advanced model, the R-21, which is based on the IBM-360 model, is in production. A more powerful follow-on, the R-40, is under development. Progress in developing the later Robotron series has been very slow due to the lack of high-quality components such as multilayer printed circuits. The best known analog machine developed in East Germany is the Endim-2000. It utilizes vacuum tubes and reportedly is unreliable.

5. Medical sciences, including veterinary medicine (S)

East German biomedical research occupies a leading position among the East European countries and compares favorably in some theoretical and applied areas with the best work in the West. The government has a pragmatic approach to its medical research programs, most of its funds are allocated to research directed toward protecting the health and productive capacity of the national working force. The center of biomedical research is the Institute of Biology and Medicine of AW at Buch and its subordinate units. The AW laboratories are generally well equipped, and the best research is done by them, while university research facilities lack adequate equipment. The FR has named five areas of priority research: cancer, cardiovascular diseases, industrial medicine, immunology and preventive medicine, and pathology and diagnosis. Units have been created within these fields to coordinate the activities of the medical institutes of AW, the medical faculties of the universities, and the medical academies and research facilities under the Ministry for Health.

A concentration of effort on cancer research has led to the development of a unique but controversial multistage therapeutic technique. The complex treatment involves the use of a high temperature environment, hyperacidification, and the administration of cancerostatic drugs and nonspecific supportive agents. Some good fundamental research at the Institute for Cancer Research of AW in East Berlin is conducted on intracellular reversibility of cancerogenic reactions induced by radiation or chemical injury. Biochemical and biophysical approaches are being utilized in cancer research and epidemiological studies to establish methods for early diagnosis. In addition, a search is underway at AW's Institute for Microbiology and Experimental Therapy in Jena for new cancerostatic agents. The State Central Office for Radiation Protection, which is subordinate to the Council of Ministers, undertakes research on nuclear safety and control of exposure to radiation.

Good-quality research is done in biochemistry, especially on subjects such as enzyme activity in the developing rat brain, therapeutic antimetabolites, the nature of biosynthesis of alkaloids, the chemical regulation of plant growth, and genetic disturbance of aminoacid metabolism.

Pharmacological research is of high caliber. A coordinated approach is employed by government facilities in the development of pharmaceuticals; supporting research is undertaken by industrial laboratories. Research has emphasized practical aspects and is directed to the development of high-quality drugs, especially agents for the treatment of cardiovascular disorders and infectious diseases and for psychopharmacological and diagnostic use. The AW's Institute of Pharmacology in East Berlin has advanced the level of glycoside, reserpine, and antihypertensive drug therapy. Excellent research is done on plant alkaloids. The AW's Institute for the Biochemistry of Plants, Halle, is doing good basic research on physiologically active derivatives of naturally occurring compounds.

Microbiological research is strong. The emphasis in virological research is on enteroviruses, tick encephalitis, and hepatitis. Outstanding work is being done on plant viruses. Productive work has been accomplished in the development of methods for prophylaxis and control of infectious diseases; important areas of research include microorganism resistance to therapy, industrial production of antibiotics, and genetics of microorganisms.

The East Germans have made significant contributions to research in internal medicine. The work in gerontology has received international recognition; specific studies have concerned the neuroanatomy of the brain and the relation of age to the structure of cerebral blood vessels. The Central Institute for Industrial Medicine in East Berlin, using athletes and soldiers as test subjects, is conducting good research on work hygiene, work physiology, and occupational diseases.

Significant advances are being made in the development of biomedical instrumentation, especially by the VEB Scientific Technical Center in Dresden. The East Germans have suffered from a shortage of good quality research equipment, and much that is in use has been imported. Production has begun on equipment for cardiovascular and oncological diagnosis, machines for kidney dialysis, and pacemakers for heart therapy.

The veterinary research capability compares favorably with that of other European Communist countries but ranks below that of West Germany. Creditable research has been accomplished which has contributed materially to the more effective control of animal disease epizootics and increased animal production. The loss of scientific veterinary personnel to the West has hampered veterinary research, but the exchange of information and personnel with the Soviet Union and other Eastern European countries has offset the loss to some extent. An active and well-organized veterinary service has reduced significantly the incidence of economically important diseases. Veterinary research has stressed applied aspects, but an increasing emphasis is being placed on basic and fundamental research. Research has been directed toward the development of new and improved vaccines and diagnostic techniques for the control of foot-and-mouth disease, rabies, glanders, swine fever, Newcastle disease, viral pneumonia, tuberculosis, and equine infectious anemia. Good research has been done in parasitology and pathology.

The Ministry for Agriculture, Forestry, and the Foodstuffs Industry is responsible for the planning and coordination of the research effort with guidance provided by AW. The most important facilities conducting veterinary research are the Friedrich Loeffler Institute, on the island of Riems; the Veterinary Vaccine Research Institute, Dessau; the Institute of Bacterial Epizootic Research of the Academy of Agricultural Sciences, East Berlin; the Institute for Bacterial Studies of Infectious Diseases of Domestic Animals of the Friedrich Schiller University, Jena; and the Institute of Tropical Veterinary Medicine, Leipzig. Humbolt University in East Berlin and Karl Marx University in Leipzig also have been active in veterinary research.

6. Other sciences (S)

a. Chemistry and metallurgy

East Germany ranks high among the European Communist countries in both basic and applied chemical research. All of the important fields of chemistry are well covered, and competent scientists conduct good-quality research in each field. The government is encouraging scientists to emphasize applied research at some sacrifice to basic studies.

Organic chemical research is strong and many of the outstanding chemists in the country are active in this subfield. Extensive research is being done in the universities on organic synthesis, physical organic chemistry, and organometallic compounds. The AW's Institute of Organic Chemistry, East Berlin, is doing important research in synthesis: Helmut Dorn and his associates at the institute are working on the synthesis of heterocyclic compounds related to pyrazolidine and oxazolidine and on the synthesis of potential cytostatic agents. The institute also is engaged in research on organophosphorus compounds. A variety of synthetic organic problems is being studied at the Martin Luther University in Halle, which has a very active department of organic chemistry. The most outstanding work is done by Prof. Kurt Issleib on phosphines and phosphine oxides and on the reactions of alkali phosphides with organic compounds. A group of researchers at Karl Marx University in Leipzig is doing strong work on heterocyclic nitrogen compounds (quinoxalines, quinazolines, and pyridazines), aminoalkylations, cycloalkanones, and the addition of carbenes to bicyclic nonoterpenes. The most prominent of these researchers is Manfred Muehlstaedt, who is active in physical organic chemistry, including conformation studies, molecular orbital calculations, hydrogen isotope exchange reactions of nonbenzenoid hydrocarbons, and other studies on reactions. The Friedrich Schiller Univeristy, Jena, formerly outstanding in organic chemistry, has become much less important in this field because of the retirement of Professors Guenther Drefahl and Franz Hein, the former noted for his work on stilbenes, aminoalcohols, and nitrogen-containing steroids, and the latter, an expert on organochromium and other organometallic compounds. Some research on organic chromium compounds is being continued by others at this university. Physical organic chemistry research at Humboldt University has concerned the kinetics and

mechanism of oxidation reactions. The total volume of industrial organic chemical research is substantial. Good research is done in support of the organic chemical and pharmaceutical industries. Much of this work involves organic synthesis and the development of processes for industrially important substances such as organic intermediates, agricultural chemicals, textile chemicals and dyes, synthetic polymers, and pharmacologically active compounds. In the latter category, work is being done on nitrogen-containing steroids and other steroids and on heterocyclic pharmaceuticals at the VEB Jenapharm. Also active in organic research, including catalytic processes, is the VEB Leuna Works at Leuna-Merseburg. Petrochemical research is becoming increasingly important with the growth of the State-owned Petroleum Refinery at Schwedt.

Research in inorganic chemistry is of high quality and has concentrated on organochromium compounds and various types of metal complexes with organic compounds. A leading researcher in inorganic chemical research is Egon Uhlig, professor of inorganic chemistry at Friedrich Schiller University, who has done extensive work on coordination chemistry of oximes and aromatic amino-carboxylic acids and on nickel and cobalt complexes. Considerable research on selenium compounds also has been done at this university. Researchers at the Humboldt University have studied inorganic fluorine compounds. Applied research on industrial inorganic chemicals and catalysts is conducted by a variety of facilities throughout the country.

Several universities are active in biochemical research. Martin Luther University has done work on nucleic acid models, labeling of insulin with iodine-125, and proteins and peptides. The Central Institute for Microbiology and Experimental Therapy of AW in Jena has a strong biochemical research program, which has included studies on antiviral activity of various types of organic compounds and the binding of metal ions to nucleic acids.

Research in physical chemistry is receiving significant attention. The best work is done in the subfield of electrochemistry, and the most important effort is under the direction of Kurt Schwabe, professor of physical chemistry and electrochemistry at the Technical University of Dresden. He and his associates have done extensive research on polarography, electrochemical technology, fuel cells, kinetics of anodic passivation, corrosion, corrosion inhibitors, and electrode kinetics. The University of Rostock is engaged in studies of physico-chemical properties of gases. The Central Institute for Physical Chemistry, Adlershof, is doing work on molecular orbital calculations, as well as research on electron-impact-induced decompositions and on catalysts.

East Germany has a comprehensive metallurgical research and development program of high quality, directed primarily to applied aspects. It is not as broad as that in West Germany, however. Strong areas include vacuum technology, ultrapure metals technology, nonferrous metallurgy, welding technology, and thin-film technology. Only average quality research is underway in such areas as process metallurgy, foundry technology, and ferrous and nonferrous physical metallurgy. The weakest subjects of research are fundamental physical metallurgy and metallurgical solid-state physics. Because East Germany is not a major steel producer, research and development on steel production has been limited.

Freiberg has long been a center of metallurgical education and research. The principal school for training metallurgists is the Freiberg Mining Academy. Some of the most important metallurgical research facilities are located in the city and include the Research Institute of Nonferrous Metals, the Metallurgy and Materials Institute, the Iron Metallurgy Institute, and the Institute of Metal Forming. The Research Institute of Nonferrous Metals has done significant research in vacuum metallurgy, analytical chemistry, metal deformation, and general nonferrous metallurgy. The Metallurgy and Materials Institute has conducted important fundamental research in defect structures, diffusion, thin films, and stress corrosion. The main interest of the Iron Metallurgy Institute has been the metallurgy of low alloy steels, while the Institute of Metal Forming is concerned with research on metal fabrication, including forging and deep drawing, as well as explosive forming. The Freiberg Mining Academy has a broad research program covering such diverse subjects as electrolytic refining of copper, the metallography of aluminum alloys, slag-metal reactions in steelmaking and transformations occurring in steel, impact forging dynamics, the mechanical metallurgy of hot rolling operations, and the study of dislocation movements. Research also is being done on the development of tantalum-niobium alloys, possibly directed toward nuclear applications.

Appreciable metallurgical research is undertaken at the Technical University of Dresden and at institutes associated with the university, especially the Institute of Metal Physics and High Purity Metals and the Institute of Metals and Special Materials. Other facilities conducting metallurgical research include the higher technical schools in Karl-Marx-Stadt,

Ilmenau, and Magdeburg, and the University of Rostock. Since 1967 the amount of metallurgical research at the higher technical school in Karl-Marx-Stadt has increased markedly. Considerable research, both fundamental and applied, has been conducted on thin metallic films. Studies have been done on the growth of sulfides and oxides in thin cadmium and zinc films, the growth of thin silica films, and the conductivity and magnetic properties of thin films. The higher technical school in Ilmenau has done work on plasma arc welding, internal stresses in vapor deposited metallic films, and the use of ion exchange in electrometallurgy. The Otto von Guericke Higher Technical School in Magdeburg has directed its research toward the adhesive bonding of metals. Researchers at the University of Rostock have concentrated on structural applications, including the effect of plastic deformation on transformation and hardening in metastable austenitic iron-manganese-nickel steels. Other research institutes conduct research on the production of very-high-purity metals, the basis of which is the advanced capability of the East Germans in vacuum technology. Dr. Manfred von Ardenne is a renowned expert in electron-beam and vacuum technology, and the Von Ardenne Institute is a leader in the field of electron-beam melting, micromachining, and thin-film deposition. Excellent research on very-high-purity metals has been conducted at the Institute of Metal Physics and High Purity Metals. The Central Institute for Welding Technology in Halle is well known for its welding research. All phases of welding technology are studied at the institute and its capabilities are excellent. Its research is somewhat more theoretical than that of the Soviet or Czechoslovak facilities. Much of the research at the institute in Halle has concerned weldability, flame-sprayed coatings, and the welding of dissimilar metals. The development of welding electrodes and wire for joining ferrous and nonferrous alloys has been undertaken at this facility. Relatively little metallurgical research is done in plant laboratories and the little effort undertaken is directed toward the solving of production problems.

b. Physics and mathematics

Almost three-fourths of the physics research effort is in solid-state physics. Most of the remaining research is in nuclear physics, with a small effort devoted to relativity and gravitation, plasma, quantum electronics and optics, optic instrumentation, and vacuum technology. East Germany lags behind West Germany in nearly all subjects of physics research.

Most of the solid-state physics research is concentrated on spectroscopy and optical properties of solids, structures and mechanical properties of solids, and electrical and magnetic properties of semiconductor materials. Facilities of AW and Karl Marx University are the most active participants in solid-state physics research. Limited applied research is conducted by various VEB facilities and technical colleges. A sizable portion of solid-state research is devoted to developing high-quality laser materials. The facilities of AW and Karl Marx University conduct most of the solid-state physics research. Among the specific research projects underway at AW institutes is the study of the effect of selenium and tellurium donor levels on the properties of gallium and arsenic, which indicates an interest in Gunn oscillators and control devices. Research on silicon and other semiconductor materials involves investigations of electron and hole drift velocities in silicon at low temperatures, optical constants of silicon, germanium, and selenium, as well as study of interface states of semiconductors for establishing free electron and binding models. In an effort to improve East Germany's capabilities in manufacturing field-effect transistors, the AW is examining the magnetoconductivity of carriers in many-valley silicon semiconductors. Some of the AW solid-state physics research overlaps into metallurgy, especially in relation to high strength and corrosion-resistant steels. Much of the work involves the study of mechanical properties of metals. Attempts are being made to detect properties by determining the nature of inhomogenieties in metallic substances.

Research in solid-state physics at the universities is more basic in nature than that undertaken in AW institutes. Work at the Karl Marx University on spectroscopy and optical properties of solids has included studies on nuclear magnetic resonance and relaxation phenomena for the various groups of semiconductors and optical transitions in highly doped and impure semiconductors. In crystal growth technology, vacuum specialists at the university are engaged in some research dealing in single crystal synthesis for the properties of lithium-gallium, lithium oxide, and mixed compounds to improve their capabilities for growing crystals from fluxes. Most of the research associated with magnetic properties of solids, powder-core, and films is pursued at the Karl Marx University, although some specific areas are explored by the AW and Humboldt University. Other universities and technical colleges engaged in solid-state physics research include the Friedrich Schiller

University, University of Rostock, Martin Luther University, and Technical University of Dresden.

Strong research is being done in plasma physics, although much of it is based on work done in other countries. A few highly competent researchers pursue research in the field, especially at the Institute of Plasma Research in Ilmenau and the Physical-Technical Institute of the AW in East Berlin. They have engaged in research on many aspects of plasma generation, confinement, and applications. Past accomplishments have shown good capabilities in magnetohydrodynamic power generation and development of plasma jets. One of the most noteworthy achievements has been the construction of an ion-source duoplasmatrons which is effective in creating a high-density plasma. The Physical-Technical Institute has shown a special interest in research concerning cyclotron radiation propagation in nonequilibrium plasma by measurements of emission coefficients. There has been some decline in basic studies but applied research has continued at the same rate.

In basic and applied optics, East Germany lags behind the U.S.S.R., which it once led, but appears to be significantly ahead of other Soviet bloc countries. A major portion of the research and development in applied optics is being done at the Friedrich Schiller University's Institute of Applied Optics, Jena. All of the departments at the institute conduct research for the VEB Carl Zeiss and the VEB Schott and Genossen Glass Plant at Jena. The Institute of Optics and Spectroscopy of the AW in East Berlin is well equipped and adequately staffed for research in nearly all aspects of basic research in optics. Among recent developments has been the completion of a design for a geodetic beacon lamp of high performance which is low in systematic errors.

A small program of research in high- and low-energy nuclear physics is underway. The low-energy physics aspect is associated primarily with isotope production and nuclear engineering. Most of the work occurs at the Central Institute for Nuclear Physics; Institute of Applied Radioactivity, Leipzig; Institute of Applied Isotope Research, East Berlin-Buch; Institute of Stable Isotopes, Leipzig Institute of Radioisotope Applications at the Dresden Technical University; and the radiochemical division of Dresden Central Institute of Solid State Physics and Materials. These facilities promote the use of irradiation techniques, particularly of radiation sterilization of metal articles, use of tracer techniques to investigate reaction mechanisms, production of sealed sources, and isotopic analysis; development and production of dosimetric devices and nuclear-physics and isotopic instruments; and development of a variety of radiation detectors. In high-energy nuclear physics, the major interest and activities are at the institutes of AW, University of Leipzig, and Karl Marx University. Interest is centered on the study of elementary particles involving pion-nucleon theories, and the sum-rules of energy-momentum for single- and multi-particle distributions resulting from energy momentum conservation. Hadron interactions also are being studied to gain understanding associated with models of multi-particle production.

Research in relativity and gravitation is conducted by competent physicists at the Friedrich Schiller University and institutes of AW. Theoretical studies underway at the university have concerned the exact solutions associated with perfect fluids. Researchers at AW institutes are examining the formalism of the tetrad theory of gravitation. Studies also are in progress on the relations between the velocity of light and gravitational theories. Researchers are attempting to disprove the theory that vacuum velocity of light is a function of the gravitational field and are working along lines which involve the theory that frequency and wavelength of light also affect the vacuum velocity.

East Germany has profited from the strong German tradition for research in mathematics. Before World War II Germany had an outstanding reputation in both pure and applied mathematics. The war and subsequent division of the country spread the mathematical talent not only throughout the two German sectors but all over the world. During the late 1950's many of the mathematicians in East Germany defected and mathematical research subsequently declined in quality. The young mathematicians who have grown up in East Germany are adding to the research underway in the country. The quantity of mathematical research is extensive, and the quality is very good. There is little participation in international mathematical journals or meetings, although one of the leading international journals for applied mathematics, *Zeitschrift fur Angewandte Mathematik und Mechanik*, is published in East Germany.

Most of the effort is directed toward applied mathematics. Some research is underway in pure mathematics and the greatest effort has been on analysis and algebra; within these two general areas, the subjects of function theory, sets, and logic are receiving the most attention. Some research in algebraic and differential geometry is being pursued, but the interest in topology remains low. The emphasis in applied areas is on probability, statistics, numerical

methods, and operations research. The research in numerical analysis is applications oriented, and although rather elementary, indicated considerable activity in the fundamental mathematics necessary for the use of electronic computers.

c. *Astrophysical sciences*

(1) *Astronomy, upper atmosphere, and space sciences*—Capabilities in astronomy, upper atmosphere, and space sciences are limited to a few areas in which competent work is done by one or two highly capable researchers. Although East Germany has one of the largest telescopes in Europe and engages in some stellar and solar observing, the country in general has only mediocre capabilities in observational astronomy. It is well known, however, for its excellent compilations of star positional data, and good work is done in theoretical astrophysics and cosmology.

The most important and best equipped astronomical observatories and radioastronomy stations are under the AW's Central Institute for Astrophysics and the Central Institute for Solar-Terrestrial Physics (Heinrich Hertz Institute), both in Potsdam. The former has subordinate to it the Sonneberg Observatory, Sonneberg; the Karl Schwarzwald Observatory at Tautenburg, near Jena; the Potsdam Astrophysical Observatory, Potsdam; and the Babelsberg Observatory and its Institute for Relativistic and Extragalactic Research, in the Babelsberg area of Potsdam. The Sonneberg Observatory is the most active in observational astronomy, particularly the study of variable stars, comets, and lights of the night sky. The Karl Schwarzwald Observatory, established in 1960, is rapidly becoming a leading East German observatory. It is equipped with a Zeiss 2-meter reflector, one of the largest in Europe, and has engaged in the study of open star clusters and extragalactic nebulae, in which there was some cooperative effort with Soviet astronomers. Other observational work has included photographic studies of compact galaxies and of galactic outer-border stars, and photometric investigations of quasars and variable stars. Stellar astronomy and both optical and radio solar astronomy are pursued actively by the Potsdam Astrophysical Observatory, Potsdam. Some astrometric research is done at the Babelsberg Astronomical Observatory and its Institute for Relativistic and Extragalactic Research, Babelsberg. Scientists at the observatory have done theoretical studies of the gas dynamics of meteor trails and the characteristics of meteors as they relate to artificial satellites. The Babelsberg Observatory publishes a catalogue of stars and has been engaged in a massive study of the compilation of all determinations of places for individual stars reduced to one epoch. The Central Institute for Solar-Terrestrial Physics routinely conducts optical and radio solar patrol studies. The institute has a solar tower at Potsdam and radioastronomical stations at Adlershof, Neustrelitz, and Tremsdorf. Research has been conducted on the influence of inhomogenous solar magnetic fields on magnetograph measurements, on the structure of the solar corona, and on the nature of solar X-ray emissions and solar radio bursts.

Space research is restricted to theoretical investigations and ground-based measurements. The country is a member of Intercosmos, a cooperative space research program of Eastern European countries with the U.S.S.R., and has ground stations at Neustrelitz and Potsdam to receive very high frequency (VHF) telemetry from Intercosmos satellites. The East Germans have provided pay-load instrumentation for the Soviet-sponsored Vertikal scientific rocket program and participate in the Soviet Interobs program, an intrabloc cooperative effort in optical tracking of foreign satellites. Of the 25 tracking stations operating within Eastern European countries, five are located in East Germany—at Bautzen, Eilenburg, Schwerin, Ruderitz, and Potsdam. The East Germans also have provided instrumentation for some Intercosmos satellites.

East Germany is the leading Eastern European country in ionospheric research. The main centers for such research are the Central Institute for Solar-Terrestrial and its subordinate Observatory for Ionospheric Research in Kuehlungsborn.[1] It also has an ionospheric station at Juliusruh on the island of Ruegen. Some of the research has included an extensive investigation of ionospheric-stratospheric coupling; inquiry into atmospheric dynamo effects in the ionosphere; studies of ionospheric aeronomical, dynamical, and phenomenological processes; and radiowave propagation. The director of the Central Institute, Dr. E. A. Lauter, is one of the three members who comprise the International Reference Ionosphere Working Group, established jointly in 1969 by the International Union of Radio Science and the Committee of Space Research (COSPAR) of the International Council of Scientific Unions (ICSU).

(2) *Meteorology*—Meteorological research covers a broad spectrum of topics with the emphasis on agricultural meteorology, climatology, and forecast-

[1]For diacritics on place names see the list of names at the end of the chapter.

ing. While good work is done, it is not of international significance. The main organization for meteorological research is the Meteorological Service, with headquarters in Potsdam. It has a research division, which is responsible for the coordination of research, and a climatology division. A number of facilities are subordinate to the service, including the Research Institute for Agrometeorology, Halle; the Research Institute for Bioclimatology, and the Research Institute for Hydrometeorology, both in East Berlin; and the Institute for Large Scale Weather Research, Potsdam. It also directs three observatories: the Main Meteorological Observatory, Potsdam; the Lindenberg Aerological Observatory, Lindenberg; and the Dresden-Wahnsdorf Meteorological Observatory, Wahnsdorf.

Studies have been undertaken on noctilucent clouds, stratospheric ozone, and stratospheric warmings. Some effort has been devoted to studies in aerology and forecasting and observing techniques, various climatological parameters, and micrometeorology. Research also has been carried out on atmospheric optics, atmospheric radioactivity, and terrestrial heat balance. Very little cloud physics research appears to be underway. Some work is being done in dynamic meteorology, but it does not relate directly to numerical forecasting. The Meteorological Service's Central Forecasting Office in Potsdam has an automatic picture transmission (APT) station for receiving transmissions from U.S. meteorological satellites. A shipboard APT station to service the East German fishing fleet is planned.

(3) *Terrestrial geophysics and geology*—The principal center of geomagnetic research is the AW's Geomagnetic Institute in Potsdam and its subordinate facility, the Adolf Schmidt Observatory for Geomagnetism in Niemegk. The research is of good quality and has emphasized geomagnetic variations associated with ionospheric processes. Studies have been carried out in the morphology of the quiescent field. Some research is conducted in paleomagnetism. Magnetotelluric sounding investigations have been made by the AW's Central Institute of the Physics of the Earth in Potsdam and are being extended to the maritime region.

Research in seismology is routine. It is centered at the Institute for Geodynamics of the AW in Jena, which has a seismic station at Moxa. The work has included macroseismic and microseismic studies, the compilation of earthquake catalogues, and the development of instrumentation. Seismological exploration is underway throughout East Germany. Crustal structure work also is pursued by industrial concerns.

Geological research is undistinguished. Most of the effort is devoted to exploration for new reserves of petroleum and natural gas, because East Germany relies mainly on imports of these resources. There is considerable activity in geochemistry and some geologically related selenological research is done.

(4) *Geodesy*—The most noteworthy research and development efforts in geodesy continue to be focused on new and improved geodetic instruments. Modern geodetic techniques and instruments, including electronic, electro-optical, microwave and satellite methods for obtaining horizontal and vertical geodetic control, are being used. Among the Eastern European countries, East Germany is second only to the U.S.S.R. in the ability to develop and produce a full range of geodetic instruments and equipment. VEB Carl Zeiss is the center for geodetic instrument research and development. The Central Geophysical Institute of the AW in Potsdam and the Geodetic Institute of the Technical University of Dresden are the most important geodetic research organizations in the country. The institute is the foremost educational facility offering instruction in surveying and higher geodesy.

Significant instruments of East German design include the EOK 2000 electro-optical distance measuring instrument which uses an infrared light source; the EOS telemeter; the SLG and PSK satellite tracking camera; an automatic camera for astrogeodesy; and the Theo 002 geodetic-astronomic universal theodolite. The Theo 002 is an instrument of the highest precision and is the first such instrument to be built in any of the Communist countries since a Soviet development in 1935. Automatic data processing systems for geodesy and mapping have been designed primarily for instrumentation produced by VEB Carl Zeiss, mostly for export to other Communist countries.

Horizontal surveying activity has resulted in the completion of the first-order trigonometric net. Vertical work has centered around the preparation of reobserving the first-order leveling net to increase its accuracy and to increase significantly the recording of the vertical movements of the earth's crust. Vertical studies have included systematic errors in precise leveling, horizontal components of the tidal forces in conjunction with the first-order leveling net, and the development of the techniques and implements of motorized precision leveling.

East Germany has been fairly active in geodetic astronomy. Research at the Central Geophysical

Institute has concerned latitude and time determinations; the development of a method for very exact comparison of crystal clocks over long distances using the direct ultra-short waves of a TV network; and the determination of systematic and individual errors of time observations and time systems from approximately 3,000 time observations. Astronomical determination of longitude were studied to explore the efficiency of the transit instrument procedure for the investigation of recent horizontal movements of the earth's crust.

Research in the field of satellite geodesy is carried out at the Central Geophysical Institute in Potsdam. As a member of the East European Subcommission for Satellite Geodesy, East Germany participates in geodetic observations and studies based on these observations. The satellite tracking station in Potsdam is taking part in the International Satellite Geodesy Experiment (ISAGEX) to observe faint satellites for dynamical purposes. Studies in geometrical satellite geodesy include the theory of errors with regard to stellar and space triangulation. Activity in dynamical satellite geodesy has led to a highly efficient method for measuring the earth's gravity field from satellite observations. Other studies in this field were concerned with the orbit theory of artificial satellites.

(5) *Hydrology and hydraulics*—Research is competent and mainly applied, with emphasis on methods for improving the efficiency of inland waterways, increasing hydroelectric power output, and draining and reclaiming land. Research underway at laboratories in East Berlin and Dresden is concerned with hydraulic models to study seepage, sedimentation, irrigation, lock and weir design, river channeling, and current velocities in navigation channels.

East Germany is a leader among the East European Communist countries in coastal research, which consists mainly of studies pertaining to geology, hydrology, tides, littoral drift, harbor protection, and conservation. The two leading institutes engaged in coastal research are the Institute of Oceanography, Rostock, and the Institute of Physical Hydrography, East Berlin. The Institute of Oceanography has analyzed subsoil for the construction of seawalls in the Rostock port area and has charted submarine gravel layers in the Baltic Sea. The Institute of Physical Hydrography studies littoral drift by using luminescent-dye techniques.

(6) *Oceanography*—The oceanographic research capability, although below that of most other European countries, has shown gradual improvement. Oceanographic research has been restricted by the loss of oceanographers through defections, and by insufficient funds, poor instrumentation, and ineffective management. East Germany is attempting to recruit oceanographers from other Communist countries, and, at the same time, more students are encouraged to enroll in oceanographic studies at the Karl Marx University in Leipzig and Humboldt University.

The oceanographic fleet is adequate to satisfy East German research requirements for the Baltic and North Sea areas. Out-of-area fisheries research expeditions have been accomplished off West Africa and in the northwest Atlantic Ocean. Oceanographic ships, ranging in length from 120 to 180 feet, include the *Karl Liebknecht, Professor Albrecht Penck* (Figure 5), the rebuilt *Meteor* (Figure 6), *Eisenach, Johl Kruger,* and the *Hydrograph*. The 223-foot fisheries research ship *Ernst Haeckel* was built in 1963 and has recently been overhauled. The newest addition to the research fleet is the 192-foot oceanographic ship *Alexander von Humboldt*, which was commissioned in July 1970. In 1966 a class of large oceanographic ships was constructed for Soviet oceanographic organizations.

Since about 1960 a gradual increase in basic oceanographic research has developed, although such applied investigations as fisheries surveys in the Baltic Sea area receive the most emphasis. Particular attention is being given to light diffusion studies as related to pollution measurements in the Baltic. Harbor development and nearshore surveys are of primary importance, and considerable work is being done to prevent coastal erosion. Such work includes statistical analysis of wave recordings, sediment transport, and coastal hydrography. Information pertaining to the effort expended on military oceanography is sparse; however, research and development in hydroacoustics is known to be improving, but it remains inferior to and dependent upon that of the U.S.S.R. Some oceanographic instrumentation is of East German origin, such as wave recorders, current meters, temperature and salinity sensors, and instrumented buoys, while other oceanographic instruments are acquired from the U.S.S.R. and West Germany.

The most important East German oceanographic organization is the Institute for Oceanography at Warnemuende, subordinate to AW. Its primary interests are in physical, chemical, and dynamic oceanography. Other organizations that conduct

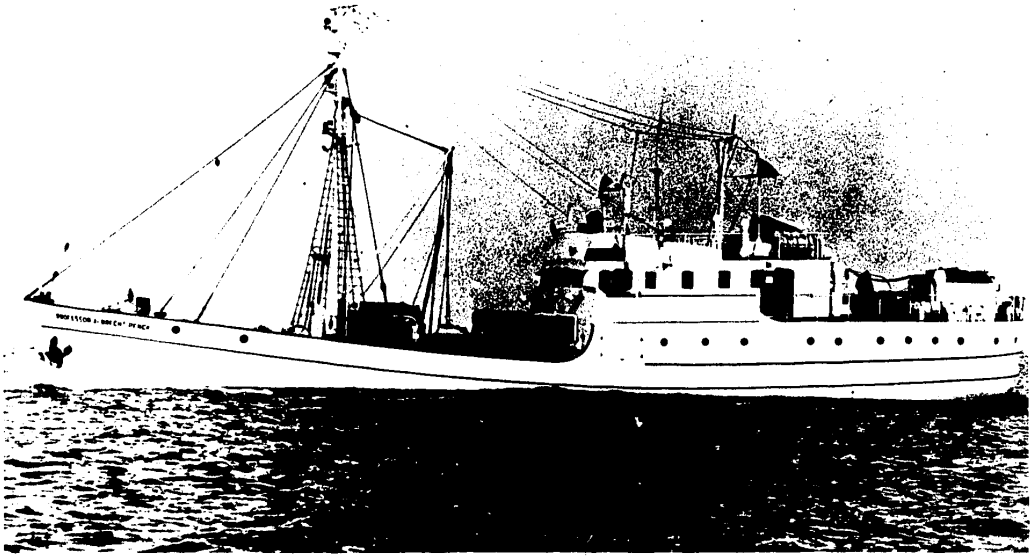


FIGURE 5. Oceanographic research ship, *Professor Albrecht Penck*, in the Baltic Sea (S)

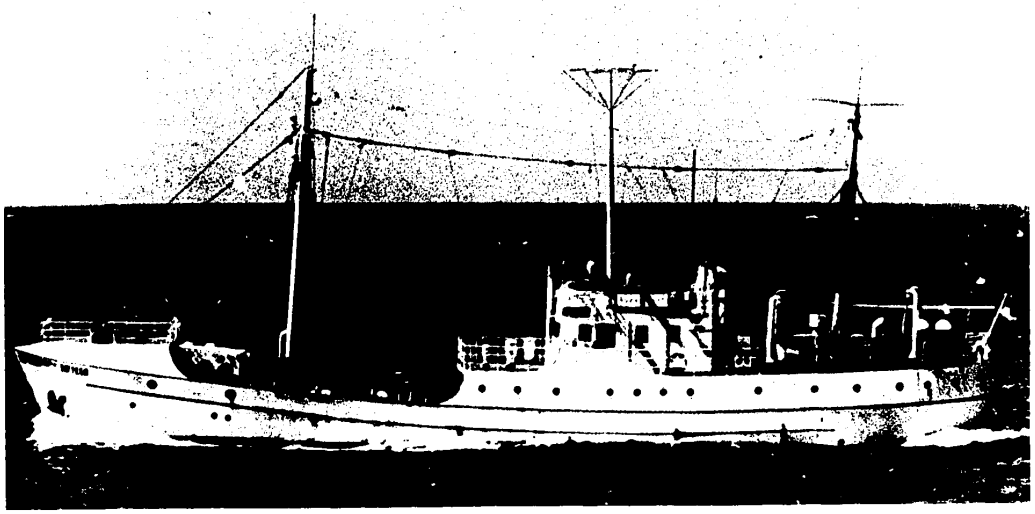


FIGURE 6. Oceanographic survey ship, *Meteor*, underway in Danish waters (S)

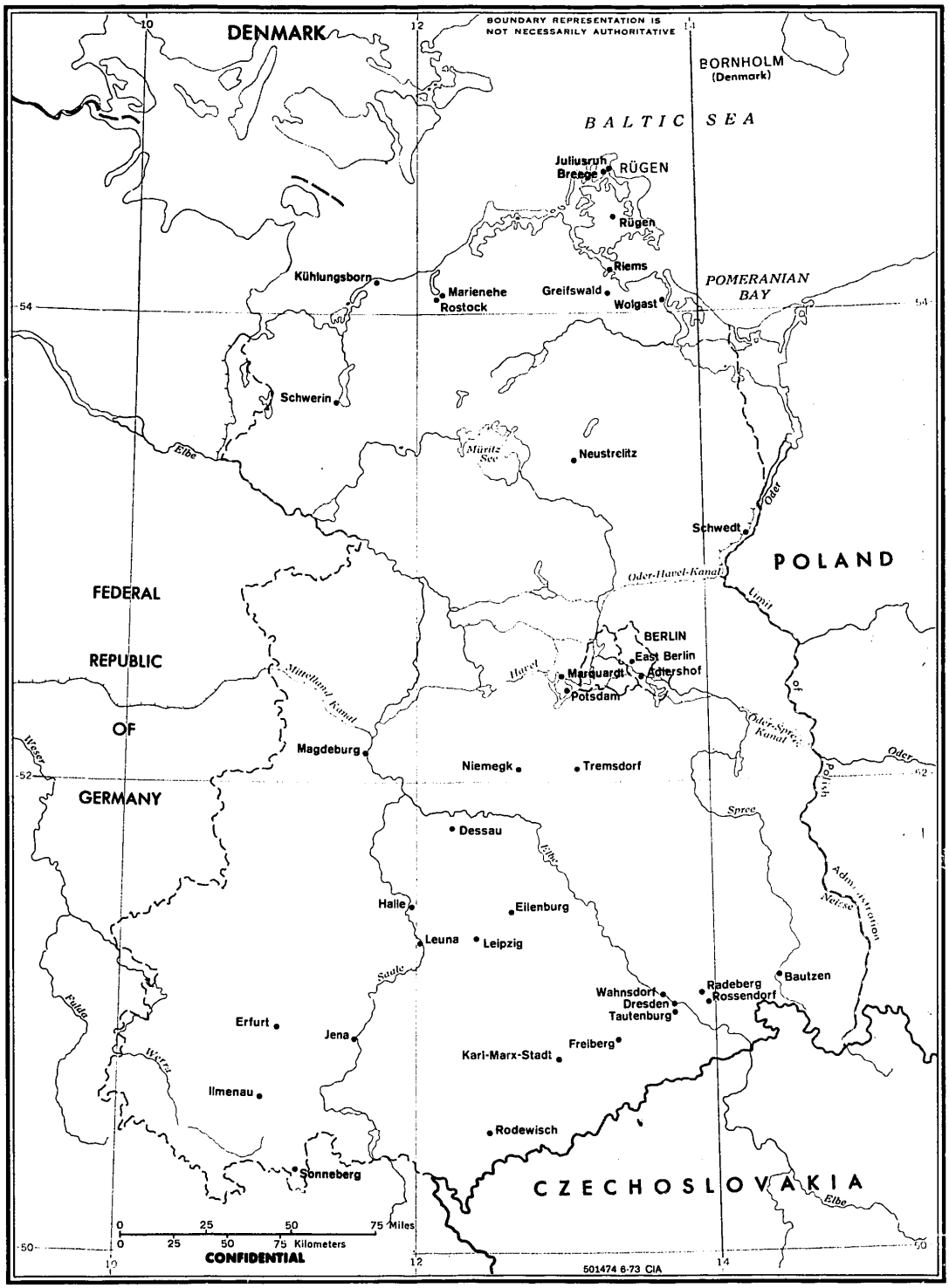


FIGURE 7. Selected sites of scientific activity (C)

oceanographic research are the Institute for Physical Oceanography in East Berlin and the Institute for High Sea Fisheries and Fish Processing at Marienehe.

Although East Germany could improve its international oceanographic stature through more cooperation with the leading countries in the marine sciences, it has restricted itself to oceanographic conferences and programs involving Eastern European countries, particularly the U.S.S.R. However, East Germany does continue to participate in joint oceanographic surveys of the Baltic Sea with the U.S.S.R., Sweden, Finland, and Poland. The International Baltic Sea Year (1969-70) concentrated on studying the physical properties of these waters. The Institute for Oceanography hosted a conference in early 1972 for Warsaw Pact nations which participated in various cooperative oceanographic studies. In October 1972 East Germany joined the United States and the U.S.S.R. in a current meter evaluation survey off the U.S. east coast. Personnel from these countries will have the opportunity to compare their current meters during this investigation.

Places and features referred to in this Chapter (u/ou)

	COORDINATES	
	° ′N.	° ′E.
Adlershof (*sec. of East Berlin*)	52 27	13 32
Babelsberg	52 24	13 06
Bautzen	51 11	14 26
Breege	54 37	13 21
Buch (*sec. of East Berlin*)	52 39	13 30
Dessau	51 50	12 15
Dresden	51 03	13 45
East Berlin	52 30	13 33
Eilenburg	51 28	12 37
Erfurt	50 59	11 02
Freiberg	50 55	13 22
Greifswald	54 06	13 23
Halle	51 30	12 00
Ilmenau	50 41	10 54
Jena	50 56	11 35
Juliusruh	54 37	13 22
Karl-Marx-Stadt	50 50	12 55
Kühlungsborn	54 09	11 43
Leipzig	51 18	12 30
Leuna	51 19	12 01
Lindenberg	52 12	14 08
Lubmin	54 07	13 36
Magdeburg	52 10	11 40
Marienehe (*sec. of Rostock*)	54 07	12 05
Marquardt	52 27	12 58
Merseburg	51 22	12 00
Moxa	50 39	11 38
Neustrelitz	53 22	13 05
Niemegk	52 05	12 42
Potsdam	52 24	13 04
Radeberg	51 07	13 55
Rheinsberg	53 06	12 53
Riems (*island*)	54 11	13 22
Rossendorf	51 03	13 56
Rostock	54 05	12 08
Ruderitz	50 25	12 01
Rügen (*island*)	54 25	13 24
Schwedt	53 04	14 18
Schwerin	52 12	13 53
Sonneberg	50 21	11 10
Tautenburg	51 00	11 43
Tremsdorf	52 16	13 07
Wahnsdorf	51 07	13 40
Warnemünde	54 10	12 05
Welzow	51 36	13 46