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SCIENTIFIC INTELLIGENCE STUDY

SCIENCE AND TECHNOLOGY IN COMMUNIST CHINA THROUGH 1970

[redacted] (b)(3)

June 1965

SCIENTIFIC INTELLIGENCE COMMITTEE (b)(3)

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Approved for Release: 2018/01/30 C00659420

Scientific Intelligence Study

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PREFACE

Communist China's significant advance toward nuclear weaponry in recent months indicates a pressing need for comprehensive scientific and technical information for use in estimating the industrial and military strength of the Chinese. Hence, the Scientific Intelligence Committee has undertaken this study to provide the intelligence community with an up-to-date background document of broad scope and coverage depicting the current status of Chinese science and technology and estimating future potentials through 1970.

Contributors to this interdepartmental study are:

- Scientific Intelligence Committee/USIB
  - Electronics Subcommittee
  - BW/CW Subcommittee
  - Biomedical Subcommittee
- Joint Atomic Energy Intelligence Committee/USIB
- Guided Missile and Astronautics Intelligence Committee/USIB
  - Non-Soviet Working Group
- Economic Intelligence Committee/USIB

The study was approved by the Scientific Intelligence Committee on 3 June 1965.

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SCIENCE AND TECHNOLOGY IN COMMUNIST CHINA THROUGH 1970

PROBLEM

To assess Chinese Communist capabilities in science and technology through 1970, particularly in relation to military and industrial programs.

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CONCLUSIONS

1. China will continue to lag far behind the more advanced nations of the world in the major areas of science and technology over the next 5 years. The country's ambitious research and development programs will continue to be retarded by major weaknesses, and accomplishments, in general, will be limited to the gradual improvement of a generally backward technology. This does not preclude significant successes in a few priority areas, such as in the advanced weapons field. Indeed, by shrewd allocation of scarce human resources and with the benefit of past Soviet aid, the Chinese have been able to explode nuclear devices, undertake a diversified missile program, modernize their air defense system considerably, and embark on other military R&D programs of some significance.

2. The major shortage of research and development resources seriously limits China's ability to make significant progress except in selected military research and development areas. Thus, despite a body of about 850,000 living graduates in the science and technology fields, there are only enough competent scientists and sufficient research materials to undertake a small portion of the host of

interdependent projects necessary to meet military and economic needs. At present, possibly as many as 100,000 persons are supporting scientific research and development. The availability of about a half million engineers, nearly all of them narrowly or poorly trained, presently means that China's research and development effort is devoted to the introduction of foreign technological advances and their adaptation to China's industrial and military programs. Over the next 5 years, despite continued progress in science and technology education, the numbers available to make significant contributions to research and development activities will probably increase by only a few thousand.

3. The Chinese are making energetic efforts to provide research facilities and equipment to support their ambitious development plans for the next decade. [redacted] Following the virtual collapse in 1960 of the 12-Year Plan for Science Development (1956-67) which was premised on sizable Soviet assistance, a new and probably more realistic long-range plan for research for the period 1963-72 emerged. We believe that the major objectives of the earlier plan have been maintained, but its details are not known.

4. Although foreign research in the physical and life sciences is energetically monitored and exploited in a systematic fashion by the Chinese, virtually all indigenous efforts are concerned not with fundamental research but with the solution of urgent practical problems. Nevertheless, as the number of trained scientists has grown, the amount of fundamental research has slowly risen. While there is no evidence of significant accomplishments from this research to date, the vital base is being enlarged at a steady pace. Thus, the chances of worthwhile advances by the early 1970's will increase.

5. We now believe that a major share of all scientific and technical resources is allocated in direct or indirect support of advanced and conventional weapons programs. The demands of these programs on S&T resources probably soared after the withdrawal of Soviet aid. This concentration of effort is believed to be retarding seriously the growth of a strong S&T base for the broader, longer range needs of the economy as a whole. The exact proportion of resources allocated to various sectors, however, cannot be determined.

6. [redacted] The first nuclear test in October 1964 was the detonation of a 19-kt device [redacted] (b)(1) (b)(1) Although there are still many uncertainties in this program, the Chinese could now begin to stockpile aircraft-deliverable bombs based on these initial devices.

7. Along with warhead development, the Chinese are believed to be developing a medium-range (about 1000 nautical miles) ballistic missile. While much of our evidence is indirect, we believe that a few of these missiles with compatible nuclear warheads, in keeping with the above nuclear estimate, could be ready to begin deployment in 1967 or 1968. (b)(1)

8. There is some reason to believe that the Chinese may also be planning to develop a range of other missiles for various weapon systems. They have shown interest, for example, in short range tactical missiles and coastal defense missiles. They may desire to develop submarine launched and patrol boat missiles. Limited deployment of a SAM system of the Soviet SA-2-type, of which the Chinese may be developing a modification, has already taken place.

9. Ample evidence of the development of conventional weapons also exists, although items produced to date have been based primarily on foreign designs. At present, native design and development of high-performance military aircraft are believed to be beyond Chinese capabilities and probably will remain so during this period. Serial production of certain Soviet-designed aircraft, however, is within present Chinese capabilities, and there are indications that production of one or more of these may be resumed.

[redacted] (b)(1)

[redacted] In naval weapons, although the Chinese have assembled some Soviet-designed submarines, destroyer escorts, and smaller vessels, the capability for indigenous research and development is probably very limited. The capability in this area, however, is expected to improve considerably by the completion within the next couple of years of a large installation which is believed to be a model basin. [redacted]

[redacted]

11. The level of industrial technology in China apparently varies sharply between sectors. On the whole it is very backward, and in most industrial fields progress has been extremely slow since 1960. During the period covered by this study, significant improvements in the level of industrial technology probably will be confined to a few selected industries. By 1970, however, new industrial techniques will begin to be introduced more generally.

SUMMARY

12. China's original 12-Year Plan for catching up with the industrialized nations in science and technology by 1967 was a casualty of both the "great leap forward" (1958-60) and the withdrawal of Soviet assistance, a keystone to the fulfillment of the plan. A new 10-Year Plan for Research (1963-72) was formulated both to fill the gap left by the Soviet withdrawal and to support the Chinese determination to attain a high degree of self-reliance. This long-range planning for research and development was done in a period of general retrenchment characterized by *ad hoc* short-term economic planning. The plan's adoption under these circumstances points up the important role assigned to research and development in China's total effort to reach first class power status.

13. During the period extending from the present through 1970, China will remain far behind the world's more advanced nations in the major areas of science and technology for several reasons. Probably the key factor is the shortage of well-trained scientists and engineers in the middle and upper brackets of competence and experience in almost all fields of interest. This shortage of skilled manpower has caused most of the able workers to be taxed to the limit. Another conspicuous weakness is the nationwide shortage of research apparatus, test equipment, modern and specialized machine tools, and various technological materials that require sophisticated processing. Efforts to strengthen science and technology have included: (a) setting up a sound system of technical standards, (b) developing new sources for the equipment and technical assistance formerly supplied by the USSR, and (c) strengthening the quality of education.

14. China is gradually increasing its exploitation of foreign science and technology and will continue to do so during the period of this estimate. [redacted] China has been obtaining technical data designs and prototypes of reliable equipment, new instrumentation, highly advanced methods and processes, unique apparatus, critical raw materials, components, spare parts, and production plant facilities.

15. China is also using science and technology as a basis for enhancing its relations with the less developed countries. Scientific and technical cooperation agreements have been signed with a number of such countries and contacts have been made through scientific conferences and symposiums, touring delegations, scientific survey teams and training of foreign students in China. By such means, China has attempted to increase its penetration and domination among the less developed countries.

16. Chinese work in the physical and life sciences is primarily applied and concerned almost wholly with urgent practical problems. There are, however, some examples of original fundamental

research being conducted on a small scale in such areas as molecular biology, low-energy physics, and medicine. We do not expect any significant advances from this small basic effort over the next 5 years, but because of the increasing amount of good applied work, significant technological advances could occur at any time. Foreign research and development accomplishments, both basic and applied, are readily available to the Chinese who monitor and exploit them routinely. During this period, it is unlikely that the Chinese will tie up their limited scientific manpower in extensive basic research.

17. In physics, China has accumulated a good foundation of research data that will aid normal scientific growth and support the general needs of the nation, but outstanding research achievements are lacking. The amount of basic solid-state work is increasing in several areas, but none of it is likely to result in startling advances. China has made modest achievements in low-energy nuclear physics, but accelerators available for research are relatively few in number and variety. High-energy physics in China is confined largely to theoretical aspects because of a shortage of experimental facilities. However, some scientists are being trained in this field at Dubna in the USSR.

18. Chinese mathematicians are competent and fairly active, especially so by comparison with the situation in 1949. Their work follows the lead of foreign mathematicians and most of it deals with applications in the areas of computers, automatic control, statistics, operational research, and linear programming.

19. In computer technology, native competence is growing, but China will remain behind the West for some years. Although the Chinese now are producing industrially general and specialized purpose analog and digital-type computers, no achievements of note in computer technology are known. The availability of computers is marginal for many highly technical needs, and strict allocation of computer time is required to solve priority economic and military problems. Nevertheless, an increasing number of special purpose analog computers and fairly high-speed digital computers are becoming available for various types of routine scientific and technical computations.

20. Current research projects in chemistry and chemical engineering are concerned chiefly with mastering known processes and adapting them to conditions in China in order to support present military, industrial, and scientific programs. The research results are neither outstanding nor very original. Much good work in analytical chemistry is conducted by the Chinese, particularly on the methods of analysis, separation, and preparation of pure materials, especially for applications in the fields of electronics and nuclear energy. Some of the research could be valuable in the development of other areas of interest. Chinese organic chemistry is far behind Western work. A small amount of very good original work, however, has been performed on pharmaceuticals. The program on high polymers is a major undertaking, yet workers are capable of only a small amount of high-quality basic research. A sizable amount of generally low-level chemical research supports the agricultural needs in the preparing of insecticides.

21. Specialty steels have a high priority in China's metallurgical research program. This program is attempting to satisfy the needs of the agricultural chemicals industry and the military services for corrosion- and heat-resistant steels. A large part of the metallurgical effort also is directed toward the development of substitute alloy compositions that require a minimum of scarce alloying materials, such as nickel. China is producing a modest variety of alloy steels, including ordinary grades of stainless steel, high-speed tool steels, and some spring steels. By 1970, the Chinese should have acquired sufficient experience with modern alloy melting and refining techniques to make possible at least small-scale production of specialized alloy types, such as precipitation hardening stainless steels and maraging high-strength steels that may be required in some missile applications. The improvement of welding practices continues to be the subject of widespread work throughout China.

22. Little is known about China's ability to produce and fabricate titanium, but there are no indications that the work has progressed beyond laboratory scale. Some research is in progress on processes for extracting the nonferrous metals, such as zirconium, hafnium, and tantalum. Investigations of the processing of the more common nonferrous metals, such as aluminum and copper, emphasize

improvements in ore beneficiation and reduction techniques. Although substantial progress is being made, China's metallurgical research effort still is far behind that of the West and is not expected to catch up for many years.

23. The research and developmental activities in basic electronics, including communications, indicate that China now is concerned with a wide range of techniques. During the next 5 years, it will continue to give serious attention to engineering research to known and proven goals, but it is unlikely to progress significantly in any one aspect. Heavy reliance will continue to be placed on the use of foreign devices, equipment and systems with the short supply of electronics research manpower and resources being allocated only to the most critical items. Efforts in other industries, notably precision instruments, metallurgy, and chemicals, are dynamic factors that will affect the level of Chinese electronics technology. Any lack of progress in those fields would act as a considerable brake. Solid-state devices and masers are hampered by a scarcity of apparatus and test equipment. Work on lasers is handicapped by lack of suitable high-quality crystals. Although more than 70 types of germanium transistors are being produced and at least 20 types of diodes are being manufactured in good supply, China lags considerably in industrial-scale techniques for refining germanium and silicon. Nevertheless, suitable materials for almost all military applications are expected by 1970.

24. The geophysical sciences in China collectively are slowly improving but will remain below the level of the scientifically advanced countries in 1970. Meteorology is probably the most active of these sciences, with work programmed on better weather forecasting and equipment. Geodesy capabilities are adequate for supplying all geodetic parameters of an IRBM test range but not for an over-water ICBM range. Work in the other geophysical sciences is also relatively limited despite some active work in such areas as exploring natural resources, setting up a network of seismological stations, oceanographic support to the fishing and shipping industries, and cosmic ray observation.

25. A severe shortage of qualified investigators and technological materials hinders research and development in the medical sciences. Reforms in education will not rectify the situation by 1970, but by the mid-1970's, the quality of graduate physicians may compare favorably with that of Western graduates. Chinese medical research is directed toward infectious and neoplastic diseases with increasing emphasis on basic disciplines. A broad nutritional research program is underway, but it is hampered by a slow data build-up and a shortage of personnel and will not provide meaningful results during this period.

26. China has directed its research on biology toward the practical problems that occur in agriculture, industry, and public health. The quality of the small amount of published research generally is very good. The number of research institutes is adequate to support the limited basic research program. China's capabilities in biological science will increase gradually during the next 5 years, but no outstanding accomplishments are to be expected.

27. China has accorded high priority to the agriculture sciences, and the quantity of the work will increase during the next 5 years. The most important advancement in agricultural research has been in crop breeding. New native strains of rice, wheat, and corn have been successfully introduced and have significantly increased yields on experimental plots. Chinese plant breeders are Western-trained. Entomologists have successfully adapted and implemented foreign control methods, virtually eliminating destructive migratory locust attacks. Research on the utilization of agricultural chemicals is critically inadequate, though these chemicals offer the most important means for increasing China's food resources. Plant pathological research is not impressive by Western standards. Although the small quantity of research in the animal sciences has successfully improved the health and the breeding stock of swine, sheep, and poultry, the development of the livestock industry will be very slow. With support from other segments, the fishing industry can be expected to grow moderately through 1970. Research on unusual foodstuffs—wild and aquatic plants—during the next 5 years will contribute to the supplementary nutritional reserves

in times of food scarcity. The microbial conversion of agricultural wastes and by-products into foodstuffs has been successful, but the processes are not yet economical.

28. Military technology in China is characterized by considerable emphasis on the manufacture of duplicates, modifications, and adaptations of foreign equipment of proven capability, especially Soviet guided missiles, aircraft, ground weapons, naval weapons, and electronics systems. The different sectors of production vary widely in strength.

29. The nuclear weapons program in China apparently has received the support of a number of old and new research facilities. A major complex now under construction near Koko Nor in North-Central China may become a new main center for nuclear weapons research and development. The first test of a Chinese nuclear device of 19 KT yield was conducted on 16 October 1964 at the test site located at Lop Nor in Western China. [redacted] If they so choose, the Chinese probably could stockpile bombs based on these initial devices for their medium bombers as soon as fissionable materials are available.

30. Energetic efforts have been underway for some time to provide nuclear materials for the weapons program. A complex near Lanchou for producing U-235 could have begun operation between August 1962 and March 1963. This complex probably includes a gaseous diffusion plant that was supplied by the Soviets during 1957-60. On present evidence, we believe that the U-235 used in present devices was probably produced by a combination of gaseous diffusion and electromagnetic processes.

31. Two complexes appear to be producing plutonium in China. One, near Pao-t'ou could produce an estimated 10 kilograms of plutonium a year. [redacted] Another and larger reactor is under construction at Yumen, but it will not become operational for two or more years.

32. China has displayed an active interest in a guided missile program for some 10 years. With Soviet assistance, the Chinese constructed a missile test center at Shuang-ch'eng-tzu and a research and development center at Ch'ang-hsin-tien, a southwest suburb of Peiping. The latter center is believed to have achieved full operational status in 1963. The Soviets and Chinese also established a small test range and development center for the coastal defense variant of the Kennel ASM at Lienshan in the Gulf of Liao-tung.

33. The Chinese probably are stressing the development of a land-based strategic MRBM capable of delivering a nuclear warhead at a range of 1000 nautical miles or more. The first MRBM prototype flight test is believed to have taken place in early fall 1963 at Shuang-ch'eng-tzu. The missile is very likely based on the Soviet SS-4, or possibly the SS-3. The system could enter production in 1966 or 1967 and be ready for deployment in 1967 or 1968. There is no evidence that may be exclusively associated with an ICBM. If development is already initiated, it would be 1970-75 before an ICBM could be operational.

34. As to other programs, the Chinese are undoubtedly interested in land-based tactical missile systems similar to the Soviet 150-mile range SSM which was supplied to China. A shipyard at Dairen has fabricated one submarine of the Soviet G-class, and an intent to obtain or produce the SS-N-4 type of missile for which this submarine is designed must be assumed. SS-N-2 missiles may have been supplied by the Soviets for use in the several *Osa/Komar* guided missile patrol boats sighted in China. Coastal defense missiles of the AS-1 type could be produced at Chinese aircraft plants. (b)(1)

35. [redacted] Although a SAM research and development program of some sort undoubtedly exists and probably carries a high priority, 2 or 3 years will be required before production on a large scale is within China's capability. An unknown number of Soviet Guideline SA-2 missiles were made available to China. Although 23, possibly 25, SAM sites have been noted, no more than 6 have been observed with equipment at any one time. Some sites apparently were never equipped, and at least 6 have been abandoned completely. [redacted] (b)(1) (b)(1) (b)(1)

target areas to defend against reconnaissance overflights by high-altitude aircraft.

36. Space activities in China appear to be limited at this time. Success with the MRBM program could eventually provide a capability to orbit a small satellite using relatively simple upper stages. Also, if the Chinese efforts to purchase foreign missile equipment and technology are successful, a program to demonstrate a space capability could get underway any time before 1970.

37. Aeronautical research, development, and production are quite limited generally. An abrupt cessation of programs, based on Soviet applied designs and blueprints, was noted in mid-1960, and only recently have we seen signs of a resumption of activity. Although the Chinese probably can produce copies of Soviet MiG-21 aircraft by 1965-66, and the Badger and Camel by 1968, they probably cannot design and build a significant military aircraft of their own until the 1970's. Materials research has met with some success, but high Western standards are still well beyond the reach of the Chinese. [redacted] (b)(1) Spare engines are purchased abroad for Il-18's and Viscounts. Increases in factory floorspace indicate a Chinese intention to produce aircraft and engines on a much larger scale. Soviet aid was withdrawn in 1960, and no appreciable numbers of combat aircraft have been produced since the MiG-17 and -19 programs folded after the rift. The Badger and/or Camel programs have not yet gotten underway. China has an urgent need for military aircraft, but the USSR at least has curtailed the supply of spare parts and has withheld essential elements of support for both the Badger and MiG-21 production programs.

38. Chinese ground weapons developments currently stress a rapid build-up of improved weapons based on foreign designs. They are either modified slightly or copied exactly and are produced in large volume. Emphasis is placed on the reproduction of infantry weapons, antiaircraft artillery, field artillery weapons, and combat vehicles. Indigenous conventional armaments research and development probably will not have developed sufficiently to change this situation much by 1970, although experience will eventually allow much more independence.

39. At present, the Chinese possess a small but improving capability in the design and development of minor warships and their associated propulsion plants. The capability in ship design should be improved considerably by the construction of a model basin [redacted] (b)(1) Wuhsi, about 75 miles northwest of Shanghai. This installation should become operational in the period 1965 to 1967. The Chinese probably will not attain a capability in the design and development of major warships and submarines until beyond the period of this estimate.

40. Antisubmarine warfare research and development efforts appear to be in their infancy. [redacted] (b)(1)

41. Defensive, rather than offensive, chemical warfare doctrine is emphasized in China. Much of the CW material is made from Soviet designs or has been furnished by the USSR [redacted] (b)(1) Chemical personnel receive highly specialized training in all aspects of chemical warfare. China's offensive CW capability is impaired by limited production of agents and stockpiling capabilities. Available ground weapons and Soviet-designed aircraft are capable of disseminating massive quantities of CW agents in a large-scale offensive tactical operation. On the other hand, China within the next 5 years will not produce adequate amounts of either offensive or defensive CW material to rise above training requirements plus a small amount for stockpiling. The Chinese Peoples Liberation Army (CPLA) has an excellent screening-smoke capability and a small but growing flame warfare capability. [redacted] (b)(1) Civilian defensive CW equipment apparently is almost completely lacking.

42. The Chinese are not known to be actively engaged in the research and development of biological warfare agents at this time, [redacted] (b)(1)

[redacted] By 1970, with the expected assets of competent scientists and facilities, China could produce limited quantities of BW-agent material and also develop a munition with a suitable delivery system.

43. China has engaged in limited research and development on original military electronics, though much developmental work is involved where foreign designs are adapted to domestic production. Through 1970, only a few components and systems will be of native Chinese design. Almost all of the more complicated and sophisticated military electronics equipment will be copies, modifications, or adaptations of foreign products, namely Western, Soviet Bloc, and Japanese. [redacted] By 1970, new Chinese designs of EW/GCI, fire control, shipboard, and airborne radars may be expected to appear. In its military communications, China relies heavily on importations, [redacted] Wholly Chinese work on such advanced equipment as burst transmission or scatter will not be realized by 1970. China depends largely on passive electronic countermeasures, such as chaff. Although the Chinese will continue to use chaff, little or no information is available on which to base a confident assessment of other modes.

44. Although there are sharp differences among sectors, the general level of industrial technology in China can be characterized as being far behind that of the United States, the USSR, Western Europe, and Japan. China has mastered the technology of some basic industries, such as steel, coal, electric power, and aluminum, but even in these industries technical assistance from abroad is required to keep up with advances in products, equipment, and production techniques. In more complex fields—for example, the priority fields of precision instrumentation, petro-chemicals, chemical fibers, and chemical fertilizers—China is heavily dependent on imported knowledge and equipment for development. The general backwardness of technology is not a great hindrance in some sectors, such as construction and transportation, because simple techniques can fill most needs.

45. Technological progress in most industrial fields has been extremely slow since 1960. Machinery and equipment have been imported at only a small fraction of the peak levels in 1959-60, for example, about $125 million worth in 1963 compared to $845 million in 1960. Equally important has been the small number of foreign industrial technicians in China compared with the formerly large number of Soviet and Satellite technical personnel helping China's industry.*

46. China is well endowed with most of the raw materials required for industrial development. Raw materials for iron and steel, power, nonferrous metals, chemicals, and construction materials generally are abundant. The major resource deficiency is the lack of arable land in relation to population; thus, major technical improvements in farming are required to increase agricultural production. China has only small forest resources, but these resources will be adequate through 1970. Some of the steel alloying metals, such as nickel, are available only in very small quantities and must be imported.

47. Automation in the Western sense is very limited in China's industry, and no major Chinese advances in automation are expected by 1970. A few industrial processes employ highly automated equipment. For example, such equipment is used in the production of electronic tubes and other electronic components that are of standard design and are required in volume. In most industries, however, automation does not exist.

[redacted] (b)(1)

(b)(1) (b)(1) (b)(1) (b)(1) (b)(1)

(b)(3)

48. During the period through 1970, technological progress in industry is not likely to speed up from the slow pace of the past few years unless China receives technical assistance on a scale at least as large as that of the first decade of Communist rule on the mainland. Technological advance probably will be at a slow rate and will be centered on a small group of industries. In a few fields, especially those related to the advanced weapons program, a high priority in the allocation of scarce resources probably will yield notable improvements in technological capabilities.

DISCUSSION

I. Introduction

ATTITUDE OF THE REGIME TOWARD SCIENCE AND TECHNOLOGY

49. China's leaders have consistently emphasized the key role played by science and technology in helping to build China into a powerful state. Modern science and technology get equal billing as prime national objectives along with modern agriculture, modern industry, and modern national defense. Premier Chou En-lai restated this position at the December 1964 National People's Congress and said further that "we cannot take the beaten track traversed by other countries in the development of technology and travel behind them at a snail's pace" but "must break away from conventions and do our utmost to adopt advanced techniques." Such exhortations for the promotion of science and technology are directed not only at planners, managers, and research scientists dealing with advanced techniques but toward all personnel who in any way are connected with scientific and technical matters, including farmers and industrial workers. The application of scientific experimental methods is urged on all. The objectives being the improvement of working methods, tools, and products at the production level, and the advancement of scientific and technological capabilities all along the line up to the more complex technological developments and advanced fundamental research. The latter being acknowledged by the Chinese as necessary for success in putting China abreast of the rest of the world in scientific and technological capabilities. In China, scientific experimentation, technical innovation, and technical revolution are Communist watchwords.

FOREIGN RELATIONS IN SCIENCE AND TECHNOLOGY

50. The Chinese view science and technology as an important factor in their foreign relations. First, they need the scientific and technological information and materials to be found in other countries, particularly the more advanced countries. Second, they can use science and technology to improve access to less developed countries and thus promote friendly relations.

51. Until mid-1960, China had the kind of relation with the Soviet Union whereby China's needs could be satisfied to a large degree. Two basic agreements were involved: the Scientific and Technical Agreement which was signed in October 1954 and the Scientific Cooperation Agreement in January 1958. The latter agreement provided particularly for close relations between the academies of sciences of the two countries. During 1960, the agreements were abrogated but for the sake of appearances were revised and reinstituted in 1961. Formalities have been followed, but little of substantive value to China has resulted. Recently, the lack of normal activity connected with the agreements indicates that they have both become moribund. China has not discontinued all relationships with the USSR, however, but has continued such contacts as participation in scientific conferences in the Soviet Union, affiliation with the Joint Institute for Nuclear Research at Dubna, USSR, and membership in the Fisheries Research Commission for the Western Pacific, made up of Communist countries. Some contacts in the technological field

probably continue in connection with certain trade items that call for technical services, but the nature of them, if any, is not known.

52. Relations with Eastern European countries have been similar to those with the Soviet Union but on a considerably smaller scale. Formal relationships covered by scientific and technical agreements are being maintained, although the substantive content is believed to have diminished markedly in the last few years.

53. China is now taking steps to establish relations with advanced countries of the non-Communist world as a substitute for the valuable relations formerly enjoyed with the Soviet Bloc. The international political environment combined with China's own hesitancy to open her doors to foreigners has retarded the growth of these relations. China, however, has moved gingerly along the usual avenues of access to foreign scientific knowledge, materials, and assistance.

[redacted] As for the hiring of non-Bloc scientists to do research, consult, or teach for extended periods in China, none are known to have been hired, although official overtures to do so have been voiced in some Japanese scientific circles. There are numerous instances, however, of Western scientists being invited to China for consultation and lecture tours of a few weeks duration. Attendance at international scientific meetings commenced to be an important type of contact with non-Bloc science during 1963, but the "two-Chinas problem" keeps Communist China out of any organization in which the Republic of China is a member. Communist China adheres to none of the bodies under the International Council of Scientific Unions except the History of Science Section of the Union of the History and Philosophy of Science. Contacts have been established between the Chinese Academy of Sciences and the British Royal Society and the Australian Academy of Science. Expansion of such relations is expected.

55. In the less-developed countries, China uses science and technology to promote her interests. The example of China's scientific progress is used as a foundation for influential relations. Under cover of scientific and technical assistance, Chinese geologists, civil engineers, and others are able to explore and map foreign countries. China's biggest effort in the use of science to influence foreign countries was the convocation of the Peiping Science Symposium in August 1964. It was attended by individuals from 41 countries of Asia, Africa, South America, and Oceania (New Zealand and Australia). The main purpose was clearly political. By means of the Symposium and the permanent liaison office established by the Chinese in connection with it, China intends to develop Peiping as a science center and to use science as one of the bonds in welding together an Afro-Asian Bloc under China's domination. (b)(1)

56. Other efforts have included a few Chinese touring delegations, attendance at science conferences in Asia and Africa, and special training of foreigners in China. Scientific and technical cooperation agreements, similar to those signed during the 1950's with Soviet Bloc countries, are appearing. Cooperation documents have been signed by China during 1965 with Indonesia, Cambodia, and the United Arab Republic, during 1964 with Algeria, and in 1960 with Cuba. China's use of science and technology as a vehicle for penetration and influence in Afro-Asian countries is expected to expand steadily in the next few years.

II. National Objectives, Organization and Control

NATIONAL GOALS AND PLANS

57. The ultimate Chinese goal is to overtake and to move ahead of the world's scientific and technological leaders at a rapid pace. Central to all planning and programming is the aspiration for an ever increasing capacity for self-sufficiency, while at the same time making use of all available foreign technology judged useful in speeding up the process.

58. In 1956, China set forth a 12-year Plan for Scientific Development. It's aim was to reach world levels in the common disciplines of science and to concentrate on advancement in the following 11 technological subjects:

- i. Nuclear energy
- ii. Electronics
- iii. Jet propulsion
- iv. Automation and precision instrumentation
- v. Exploration and exploitation of petroleum and other scarce mineral resources
- vi. Metallurgical process and alloys
- vii. Heavy organic synthesis and use of fuels
- viii. New power equipment and heavy machinery
- ix. Important problems in harnessing the Yellow and Yangtse Rivers
- x. Agriculture mechanization, electrification and chemicals
- xi. Countermeasures against major endemic diseases.

A 12th subject (not listed here) cited important theoretical problems in natural science, presumably areas of research intimately related to some of the 11 technological subjects.

59. The Chinese, in 1956, explicitly stated that success in carrying out the plan by 1967 would depend heavily on assistance from the Soviet Union. When the keystone of Soviet aid dropped out of the plan during 1960, the target date of 1967 was no longer tenable. Even before 1960, the schedule had been upset by gross mismanagement of research and training during the "great leap forward" which started in 1958, only a few months after the plan had finally been made firm and a yearly plan prepared in accordance with it. Although the "great leap forward" and the withdrawal of almost all Soviet assistance upset the schedule of the 12-Year Plan and called for some shifting of priorities, the overall aims continued to be in line with national goals.

(b)(1) [redacted]

ORGANIZATION OF RESEARCH AND DEVELOPMENT

61. Under the supervision of the Chinese Communist Party, the National government plans and supervises scientific and technological affairs presumably through the State Scientific and Technological Commission, a senior level body in the State Council. The actual execution of research and development is carried out principally by the Chinese Academy of Sciences and by the research organs of the various technical ministries. The ministries operate central research academies with subordinate research institutes and have additional research facilities attached to industrial plants. The capabilities of ministry research facilities have increased markedly in the last 5 years and now

constitute important research and development strength. Some contributions to research needs of the State also are made by the universities and colleges. A fairly large volume of work is done under the research and development label by provincial and lower political bodies and local production units, but the scientific and engineering level is usually low. The organization for research and development is shown in figure 1.

62. The role of the Chinese Communist Party (CCP) is dominant. Reliable Party members are present in each unit, with top authority resting with a Party man, who, in many cases, is not the formal head of the unit. The only organ of the Central Committee of the CCP known to have regular continuing duties relating to science and technology is the Science Section of the Propaganda Department. This section works through the Chinese Scientific and Technical Association as its control organ and has the responsibility for the mass control of scientists and engineers. Presumably, there is close coordination within the Party of military and scientific affairs. The Chairman of the State Scientific and Technological Commission is an army marshal who is concurrently Vice-Chairman of the Party's Military Affairs Committee.

63. The State Scientific and Technological Commission is the government's top planning, control, and supervisory body in the scientific and technological field. Its work bears on all organizations having duties of a scientific and technical nature. Since its formation in November 1958 by amalgamating the Scientific Planning Commission and the State Technological Commission, it apparently has had broad responsibilities for determining the direction that China should go in science and technology and for seeing that the resulting programs are carried out. Responsibilities known for the Scientific Planning Commission follow. They are assumed to apply to the new organization as well.

i. Determination of the kind and level of technology to be fostered, both for the short- and long-range terms.

ii. Incorporation of the yearly and long-range scientific and technical plans into the overall economic plans by working in conjunction with the State Economic Commission and the State Planning Commission.

iii. Implementation of the scientific and technical plans, especially key projects.

iv. Coordination of work done by the various organs having responsibility for research and development.

v. Administration of scientific and technical personnel. (A new State Council Bureau for Scientific and Technological Personnel was set up in June 1964. It presumably relieved the Commission of detailed operational duties in this field.)

vi. Management of research and development funds.

vii. Operation of the scientific and technical documentation and information services.

viii. Provision of research equipment and materials. (A Ministry for the Allocation of Materials was established in October 1964 and may have taken over responsibility for the details of this operation.)

ix. Establishment and management of weights and measures and industrial standards.

x. Conduct of international relations in science and technology.

64. Within the Commission's organization are possibly 40 or more divisions which handle the affairs of particular substantive fields of science and engineering and perform or manage supporting services. To carry out its work, the Commission has a number of advisory committees of one or two dozen experts each. They meet as needed to provide the expertise needed for the conduct of the Commission's business. Each substantive division of the Commission is believed to have such a committee of experts. The degree of supervision exercised by the Commission varies from one of very general policy direction to one of close detailed supervision for some key projects. The Commission is believed to have a Defense Technology Division for incorporating military problems into the national planning and programming of research and development.

65. The Academy of Sciences is China's leading research and development institution. Most of China's leading scientists are on the rolls of its 80 or more relatively well-equipped research institutes. China's scientific strength and continuity of effort in the various basic scientific disciplines is found in the Academy. It is also a service organization supplying research and development support to both civil and military programs of the country. Direct military control of parts of the Academy or part of individual research laboratories is probable. Another important role of the Academy is the training of new scientists, a role supplementing that of the regular universities and colleges. The Academy's China Universities of Science and Technology founded in 1958, in Peiping and Shanghai, offer a 5-year undergraduate cur-

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riculum heavily biased toward those scientific and engineering subjects especially significant in advanced industrial and military technology. A 4-year graduate training program has been operating since 1956. Facilities of the Academy are located in many parts of China, but the largest concentration is in Peiping, with Shanghai ranking next.

66. One pattern of organization found among some of the technical ministries consists of a scientific committee and a research academy (yen-chiu-yuan) with subordinate research institutes (yen-chiu-so). The scientific committee is a general planning and overseeing body, probably composed of representatives from both those agencies needing the research and those doing it. It would probably be the body in direct contact with the State Scientific and Technological Commission. The research academy and its subordinate research institutes carry out research on key problems or problems common to the field of responsibility of the ministry. Major industrial plants usually have plant laboratories attached to handle local problems. In the cases of both the Ministry of Agriculture and the Ministry of Public Health, the status of the central research body may be higher than in the cases of other ministries, the central bodies being called the Chinese Academy of Agricultural Sciences and the Chinese Academy of Medical Sciences. (The term used in the name is k'o-hsueh yuan.) Both have extensive research facilities extending throughout China and operate the major higher educational institutions in their respective fields in China.

67. A definitive description of the organization for planning, controlling, and supervising defense research and development at all levels cannot be made. Nevertheless, a few facts are available. At the top is the Party's Military Affairs Committee in whose hands rests basic policy direction. Within the government, the highest level body is the National Defense Council, but its role in research and development is not known.

68. The Ministry of National Defense is the logical locus of responsibilities in military research and development, but the degree to which it is responsible for planning and managing the vast military research and development effort that extends into many other ministries and the Academy of Sciences is not clear. Within the Ministry of National Defense, the same pattern of organization for research that is seen in other ministries is indicated by the organizational names—a Ministry of National Defense Science Committee and an Academy of Military Sciences. Also under the ministry is the People's Liberation Army Academy of Medical Sciences. Some research and development facilities are operated by the Ministry of National Defense, and they may be subordinate to the Academy of Military Sciences. Research organs also are known to be subordinate to the Defense Science Committee.

[redacted] (b)(1)

2nd Ministry of Machine Building—nuclear energy

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ELEMENTS OF CONTROL

70. The control of research for defense in these various organs may center in the Ministry of National Defense or possibly in the State Scientific and Technological Commission. Within the Commission there is believed to be a Division for Defense Technology; whether this division has a coordinating and supervising function or is limited to collating for planning is not known. Some key projects, however, are believed to be supervised directly by the Commission; some of these could be military projects.

71. Little is known about the financing of research and development programs, but in general the programs are well supported. In 1960, the science budget was $441,224,000 (2.45 yuan=$1) or 1.54 percent of the national budget which was up from $99,590,000 or 0.8 percent of national budget in 1956, the year that China commenced the "march on science" with a huge budgetary increase over previous years. Research and development have continued to expand since 1960, especially in the expensive advanced weapons field, and we now estimate that China's appropriation for research and development is roughly in the range of one-half to one billion dollars.

III. Resources

GENERAL

72. In the 1950's, the USSR began to aid China with experienced manpower, technology, and some equipment for a nuclear energy program. The Soviets also participated with the Chinese in geological exploration, mining, and the design and perhaps the construction of a uranium-metal plant. In addition, they probably supplied plans and part of the equipment for a gaseous diffusion plant at Lanchou and possibly for a reactor facility at Pao-tou. The withdrawal of Soviet aid in mid-1960 undoubtedly impeded the Chinese program, forcing China to reorient its efforts to develop and to produce, with little or no foreign assistance, the various critical materials and equipment required. Thus, virtually every field of science and technology in China is seriously hampered by acute shortages of well-trained, experienced personnel at the higher levels. To overcome the critical problems in science and technology, China will need the advice and assistance of foreign experts for a number of years to come.

SCIENTIFIC AND TECHNICAL MANPOWER

73. Although a useful degree of competence exists within nearly every scientific and engineering field, the number of well-trained and experienced researchers available cannot cope with a vast number of demands for R&D support. The regime has the resources to assemble a team of research scientists and technologists who would be competent to make progress toward almost any objective, but only at the expense of other projects. Very slow progress has been made in overcoming the very critical shortage of scientists capable of doing advanced-level work, but programs under way indicate that the rate of increase in the numbers of well-trained research workers will begin to go up markedly in the next year or two. By 1970, China's research staff will be considerably strengthened at the upper levels of competence.

74. For the lower level of technical services for which China is in great need, a good supply of technicians and narrowly trained engineers is available.

75. China now has an estimated 1,539,000 living graduates of higher educational institutions. Of these, 846,000 are specialists in scientific and technical fields, including 476,000 in engineering specialties. (See table 1.) Since the Communist takeover in 1949, 1,355,000 students have been graduated from Chinese universities and colleges. By 1970, the estimated total number of graduates will be more than two million. Of the 1,355,000 students graduated since 1949, 780,000 specialized in scientific and technical subjects. Tables 2 and 3 give the numbers graduating each year and the cumulative totals through 1964.

76. The large numbers of scientific and technical graduates cannot be taken as a direct indicator of China's capabilities in research and engineering, because much of the training given since the Communist takeover has not been of high standard, and many have had only a few years of experience. Youth characterizes the scientific and technical graduates, 90 percent having been produced since 1949. In contrast to the low age level of most graduates, the average age of those capable of competent research and engineering leadership is

Table 1

Number of Living Graduates of Higher Educational Institutions

Total	1,539,000
Engineering	476,000
Medicine	144,000
Agriculture	130,000
Natural Sciences	96,000
Teacher Training	388,000
Other	305,000

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Table 2

Yearly College Graduations by Specialty, 1950-64

(In Thousands)

Academic Year	Total	Engr.	Med.[a]	Agric.[b]	Natural Science	Teacher Training	Other[c]
1949/50	18	4.7	1.4	1.5	1.5	.6	8.3
1950/51	19	4.4	2.4	1.5	1.5	1.2	8.0
1951/52	32	10.2	2.6	2.4	2.2	3.1	11.5
1952/53	48	14.6	2.9	2.6	1.8	9.6	16.5
1953/54	47	15.6	4.5	3.5	.8	10.6	12.0
1954/55	55	18.6	6.8	2.6	2.0	12.1	12.9
1955/56	63	22.0	5.4	3.5	4.0	17.2	10.9
1956/57	56	17.2	6.2	3.1	3.5	15.9	10.1
1957/58	72	17.5	5.4	3.5	4.6	31.6	9.4
1958/59	70	55.0	11.4	28.8	17.1	72.1	20.4
1959/60	135						
1960/61	162	54.0	19.0	10.0	10.0	49.0	20.0
1961/62	178	59.0	17.0	20.0	11.0	56.0	15.0
1962/63	200	77.0	25.0	17.0	10.0	46.0	25.0
1963/64[d]	200	77.0	75.0	17.0	10.0	46.0	25.0

[a] Includes health sciences and pharmacy
[b] Includes forestry
[c] Includes economics, political science, law, history, foreign languages, physical education, arts
[d] Apportioned as in 1962/63

Table 3

Cumulative College Graduates 1950-64

(Data Derived from Table 2)

(In Thousands)

Year	Total	Engr.	Med.	Agric.	Natural Sciences	Teacher Training	Other
1950	18	4.7	1.4	1.5	1.5	.6	8.3
1951	37	9.1	3.8	3.0	3.0	1.8	16.3
1652	69	19.3	6.4	5.4	5.2	4.9	27.8
1953	117	33.9	9.3	8.0	7.0	14.5	44.3
1954	164	49.5	13.8	11.5	7.8	25.1	56.3
1955	219	68.1	20.6	14.1	9.8	37.2	69.2
1956	282	90.1	26.0	17.6	13.8	54.4	80.1
1957	338	107.0	32.2	20.7	17.3	70.3	90.2
1958	410	125.0	37.6	24.2	21.9	101.9	99.6
1959	480	180.0	49.0	53.0	39.0	174.0	120.0
1960	615						
1961	777	233.8	68.0	63.0	49.0	223.0	140.0
1962	955	292.8	85.0	83.0	60.0	279.0	155.0
1963	1,155	370.0	110.0	100.0	70.0	325.0	180.0
1964	1,355	447.0	135.0	117.0	80.0	371.0	205.0

Table 4

Estimates of Surviving Graduates of Higher Education in China by Age and Field of Specialization—through 1964

A. NUMBER OF GRADUATES

Age group	All fields	Engineer	Medical Science	Agricultural	Natural Science	Education	Other
All Ages	1,539,056	476,204	143,651	130,069	95,590	388,470	305,072
20-24	563,929	206,480	65,555	50,935	30,661	145,238	65,060
25-29	497,776	148,176	42,303	47,449	34,688	166,060	59,100
30-34	227,917	73,575	21,296	13,681	10,208	50,681	58,476
35-39	102,531	23,840	7,145	8,205	7,375	9,938	46,028
40-44	60,247	11,502	3,327	5,295	4,317	7,734	28,072
45-49	27,996	5,806	1,908	2,129	3,383	2,395	12,375
50-54	31,730	4,056	1,322	1,507	3,031	3,461	18,353
55-59	15,430	1,664	474	558	1,084	1,618	10,032
60-64	6,637	637	186	178	488	777	4,371
65-69	3,018	290	84	82	221	352	1,989
70-74	1,762	170	49	48	128	206	1,161
75+	83	8	2	2	6	10	55
Percent by Category*	100.0	31.0	9.3	8.5	6.2	25.2	19.8

B. PERCENTAGE OF DISTRIBUTION*

Age group	All fields	Engineer	Medical Science	Agricultural	Natural Science	Education	Other
All Ages	100.0	100.0	100.0	100.0	100.0	100.0	100.0
20-24	36.6	43.4	45.7	39.2	32.1	37.4	21.3
25-29	32.4	31.1	29.5	36.5	36.3	42.7	19.4
30-34	14.8	15.5	14.8	10.5	10.7	13.0	19.2
35-39	6.7	5.0	5.0	6.3	7.7	2.6	15.1
40-44	3.9	2.4	2.3	4.1	4.5	2.0	9.2
45-49	1.8	1.2	1.3	1.6	3.6	0.6	4.1
50-54	2.1	0.9	0.9	1.2	3.2	0.9	6.0
55-59	1.0	0.3	0.3	0.4	1.1	0.4	3.3
60-64	0.4	0.1	0.1	0.1	0.5	0.2	1.4
65-69	0.2	0.1	0.1	0.1	0.2	0.1	0.6
70-74	0.1	0.0	0.0	0.0	0.1	0.1	0.4
75+	0.0	0.0	0.0	0.0	0.0	0.0	0.0

* Percentage figures forced to add to an even 100.0 percent. (Prepared by John Aird, FDAD, U.S. Bur. of Census—Dec. 1964.)

higher than might be expected because of continuing dependence on many of those older scientists and engineers trained in America and Europe. Table 4 gives the numbers in each field by group.

77. The quality of students graduating since 1949 varies greatly, depending on when or where the training was received. In the early 1950's, many students were graduated after only 2 or 3 years of study, so urgent was the need for technical personnel in industry and for teaching. By 1955, the 4-year course was common and 5-year courses started to be adopted. The quality of training slipped appreciably during the "great leap forward," when radical training schemes were adopted and much student time was spent in labor on farms and in factories. By 1961, quality in education once again was stressed. More time was made available for study and for laboratory work by cutting down time spent in labor and political meetings; but, beginning in late 1964 under the "social rectification" program, students and graduates alike were once again being ordered to "go to the country-side" to perform menial labor. On the other hand, several reforms have brought improvements. The "open book" method of examination is being introduced to promote independent thinking in place of the traditional emphasis on rote. The very high degree of specialization has been reduced; students are given more training in fundamental principles in broader fields so that they can be used more efficiently as needs for personnel change.

78. The quality of training also has varied between institutions. Graduates of such general universities as Peiping, Fu-tan, and Nan-k'ai and technical universities, such as Tsinghua, Chiao-t'ung and the China University of Science and Technology are better trained than those from some other universities and from most of the specialized engineering colleges.

79. With total enrollments in universities and colleges running between 700,000 and 800,000, shortages of well-trained teachers and laboratory facilities still remain, but a considerable improvement on both counts is expected by 1970. Despite shortcomings in China's educational standards, the country has made remarkable progress in educating large numbers of the population to a level never before attained. Scientific and technical graduates of the better universities and engineering colleges are well qualified to participate in significant research and development activities and their numbers are increasing. Though many of the college graduates do not meet Western standards, they can make a useful contribution to programs for modernizing industry, agriculture, and the military forces.

80. The number of scientists, engineers and technicians engaged in research and development rose from a few thousand in 1952 to 32,500 in 1958, not counting some 10,000 to 20,000 more in universities and colleges who may have been engaged in some level of research work. Since 1958, the research force has continued to expand and is believed to be approaching 100,000. A force of this size could be made up only of large numbers of inexperienced or poorly trained research scientists and support technicians working with a minimum of competent leadership. Much of the work done would be relatively low-level research or engineering development. According to the Chinese themselves, "only several thousand . . . are the higher scientific and technical personnel." It is these few who are capable of planning and directing research projects of significance.

81. A rising rate of increase of well-trained scientists is expected during the next year or two. For some of these, greater leadership ability will come with the knowledge and sophistication gained from being part of China's expanding research program over the last 10 years. Other new leaders will come from more formal programs for advanced training. China has had 4-year graduate training programs under way in the Academy of Sciences and in the universities and colleges. The rate of training has been severely limited by the small number of scientists capable of training them. Progress has also been slowed by the malpractices during the "great-leap-forward" period. The Chinese claim that 12,000 persons have completed postgraduate training since 1949, but most of them completed only short-term (1- or 2-year) programs designed to expand the substandard training of the early 1950's and to give better preparation particularly for teaching. In the fall of 1964, 1,200 new postgraduate students were accepted in universities and research institutes, which is an increase over the 800 of 1963. The proportion destined for 4-

year PhD equivalent training is not known, but the total currently in such advanced training programs is estimated to be not more than 2,500. The Academy of Sciences had over 400 students enrolled in its 4-year program during the 1962-63 year. Through 1970, the formal training program should add more than 3,000 new research workers trained to the PhD-equivalent level.

82. Since 1950, some 7,200 Chinese students have been sent to the Soviet Union as regular undergraduates or graduate students at Soviet universities, colleges, and research institutes. About 4,600 completed their work and returned to China. Others were recalled before completing their formal courses. In early 1965, probably fewer than 50 were enrolled in Soviet higher educational institutions. Those completing graduate studies leading to the Soviet *kandidat* degree total about 1,800. The *kandidat* degree is roughly equivalent to the US doctorate. These Soviet-trained returnees should be a source of some new leadership in research unless held back on the grounds that they may be pro-Soviet as a consequence of their experience.

83. The Chinese in the next few years may commence the training of appreciable numbers in European countries and in Japan, but this is by no means certain. At present, there are very few science and engineering students from China studying in Western countries.

84. In the field of nuclear physics, a special training program is provided at the Joint Institute for Nuclear Research at Dubna, USSR, near Moscow. China is the second largest supporter in this international (Communist) research center, the Soviet Union being the largest and providing about half the support. The number of Chinese doing research or in training there is not known but is probably about 50.

FACILITIES FOR RESEARCH AND DEVELOPMENT

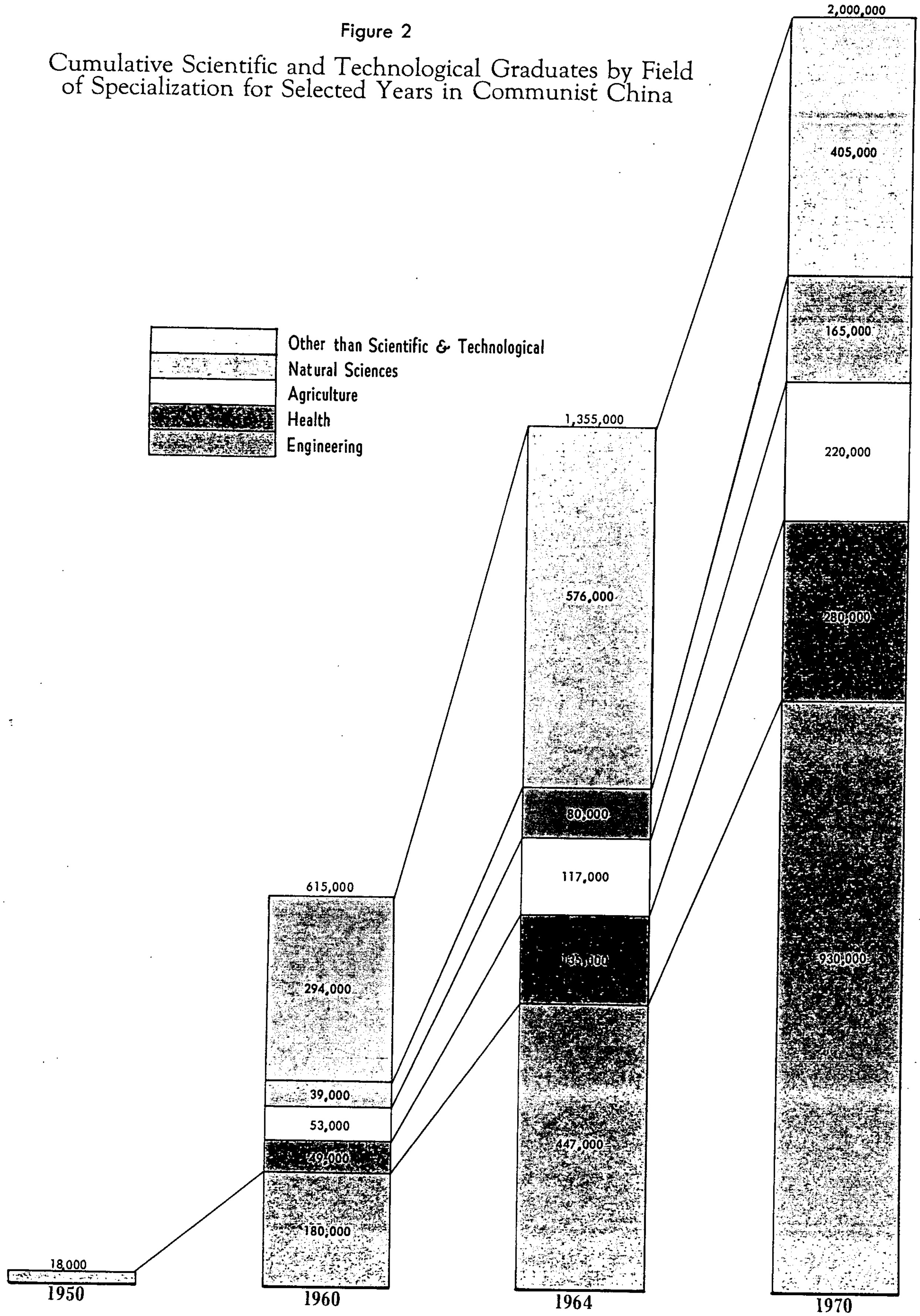
85. Facilities and equipment of widely ranging quality and quantity can be found in the various Chinese research and development establishments. Very large complexes employing thousands of persons are in operation in fields, such as nuclear energy and missiles, and in broad-ranging fields, such as that of the chemical industry. Sophisticated apparatus of the kind expected to be used in the research laboratories of advanced countries can be found in China and probably is available in adequate quantities where very high priority programs are under way. In general, however, Chinese research scientists are commonly handicapped by not having access to the equipment and materials they need because of nonexistence or poor distribution. They must work with considerably less equipment than they need, and they spend an inordinate amount of time making equipment and materials that in advanced countries would be available commercially. Chinese industry is not yet prepared to fill such needs adequately, and foreign purchases are restricted by foreign exchange shortage or export prohibitions.

86. Expansion of research and development facilities has gone forward, even during the post-1960 period of general economic retrenchment. This is especially notable in connection with nuclear energy and missile development, but expansion has not been restricted to those fields. [redacted] (b)(1)

[redacted] (b)(1)

Figure 2

Cumulative Scientific and Technological Graduates by Field of Specialization for Selected Years in Communist China



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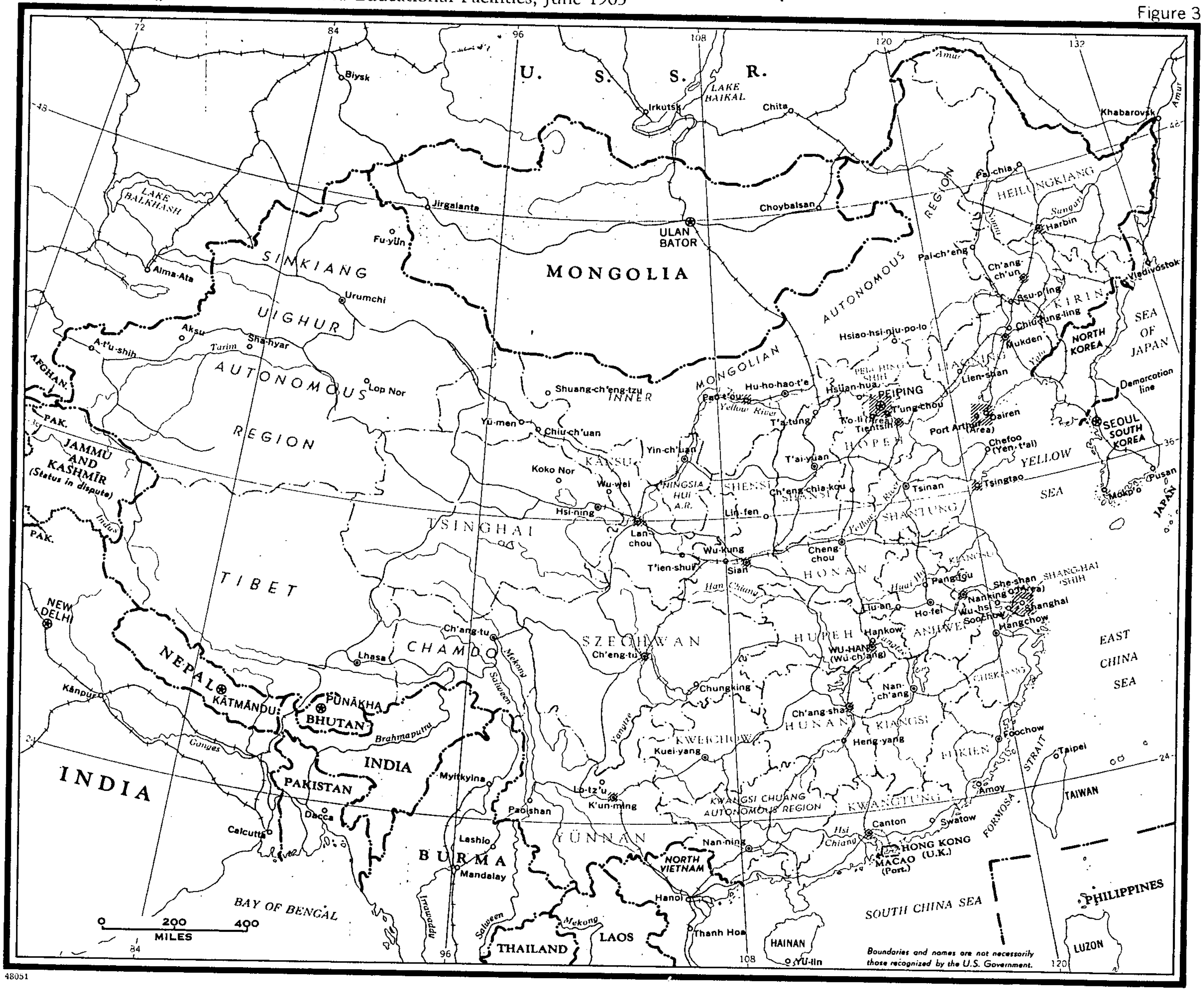
Communist China:
Cities Having Significant Research and Educational Facilities, June 1965

Figure 3



IV. Status and Trends in Research and Development

87. China has achieved certain successes in some areas of its research and development programs in spite of critical shortages of senior scientists and engineers, lack of modern techniques and methods, and deficiencies in the amounts of advanced materials, equipment, and facilities. Nevertheless, China's immediate research and development capabilities and rate of progress in the disciplines and technologies will feel the effects of these far-reaching shortages for several years to come. The assessments that are presented in this study are based on the assumption that there will be no resumption of foreign assistance to Chinese research and development as had been provided by the Soviet Union before 1960.

A. SCIENTIFIC DISCIPLINES

1. Physics

88. China has recognized the importance of basic physics research and has a program of study in that discipline. Although the country has not achieved notable results, a good foundation exists for growth and for general support of economic and military needs.

89. An increasing amount of basic solid-state research is being conducted. A major research effort in solid-state physics has been designed to support the Chinese electronics industry, which obviously can make immediate contributions to advanced weapons systems and to the civilian economy. [redacted] (b)(1)

[redacted] (b)(1)

[redacted] (b)(1)

91. China has made modest achievements in low-energy nuclear physics, and gradual progress in this field can be expected. Accelerators available for research are relatively few in number and variety. [redacted] (b)(1)

[redacted] (b)(1)

92. In high-energy physics, much of the research is done at the Institute of Atomic Energy* in Peiping. This work must be largely theoretical because experimental facilities are limited; many problems in this area are referred to Chinese scientists working at the Joint Institute for Nuclear Research in Dubna, USSR. [redacted] (b)(1) The limitations imposed by inadequate equipment will almost certainly prevent any major advances for the immediate future.

[redacted] (b)(1)

[redacted]

2. Mathematics and Computer Technology

94. China's research in theoretical and applied mathematics is fairly active and competent, especially when compared with the situation before 1949. Most of the research follows the lead of similar work abroad and is directed toward application in such areas as computers, automatic control, statistics, operations research, and linear programming.

95. A dozen or so senior mathematicians are conducting high-level research on such subjects as number theory, differential equations, analysis, topology, differential geometry, and real and complex variables. These men are devoting a considerable portion of their time to training students. As the younger mathematicians gain experience, China should be capable of original research on theoretical and applied mathematics on a fairly large scale.

96. China's computer technology has been highly dependent on foreign assistance, but native competence is growing rapidly. The Chinese are fully aware of modern developments and are exerting considerable efforts to improve their technology which is still considerably inferior to that in the West. The most advanced high-speed digital computer in China, the 16-K, is somewhat inferior to the U.S. IBM 7090, which was commercially available in 1959; [redacted]

97. The availability of computers is marginal in meeting many of China's needs, and strict allocation of computer time is needed to solve even priority economic and military projects. Nevertheless, a dozen or so factories are now producing numerous special-purpose analog computers and lesser numbers of fairly high-speed electronic digital computers, which are adequate for the tasks of numerical weather forecasting, operations r(b)(1) search, business data processing and various types of scientific and technical computations. China's capabilities probably also are adequate to provide some specialized computing devices that may be required as elements of military systems. More sophisticated research in the space sciences and military technology will require advanced types of computers which the Chinese are now building. (See "Computers," para. 338.)

3. Chemistry and Chemical Engineering

98. Most of China's current research projects in chemistry are aimed at mastering the known chemical processes and adapting them to China's conditions. Research results are not outstanding nor are the projects very original, but they do provide support for China's military and economic programs.

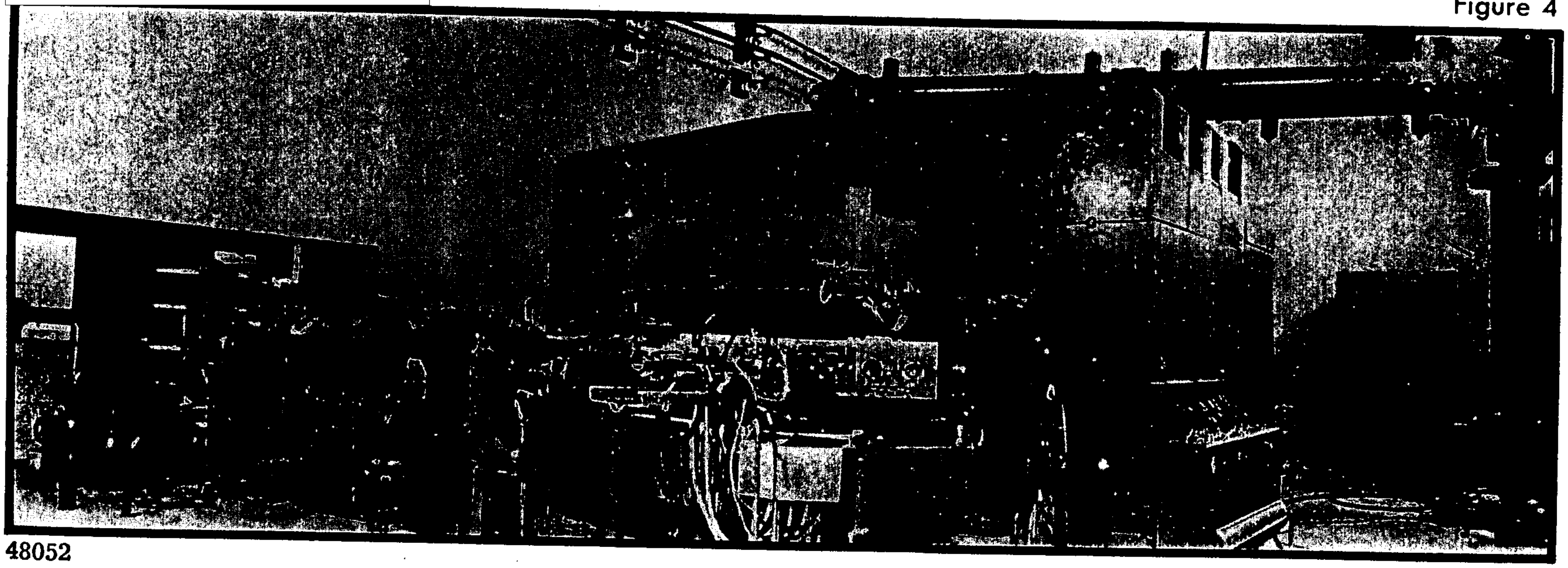
99. Emphasis in chemical research is on: the separation and preparation of pure materials for electronic and nuclear applications; the development of chemical fertilizers and production of insecticides to support agriculture; and the production of polymeric materials, petroleum products, and pharmaceuticals.

100. Chinese research in inorganic chemistry supports the light and heavy industries by developing methods for analysis and for the separation of economically important metals from indigenous ores containing iron, tungsten, manganese, tin, the rare-earth elements, and the radio-active elements thorium and uranium. The preparation of pure materials, such as silicon, rare earth oxides, and borides, that are useful in the electronics industry has been achieved, at least to the pilot-plant stage.

101. The major topic in physical chemistry research is catalysis related to petroleum processing. Here the effort is imitative of Western research (b)(1) with a study on cobalt catalysts, among other (b)(1) Although the effort has not achieved significant results, it will continue to stress the improvement of yields using well-tried processes.

102. Electrochemical research is aimed at the separation and purification of rare metals from molten salts. Research on batteries for use in all types of military vehicles and aircraft is aimed at lengthening the lifetime of the standard lead-acid

Figure 4



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Large 25-Mev cyclotron at Peiping built with Soviet help

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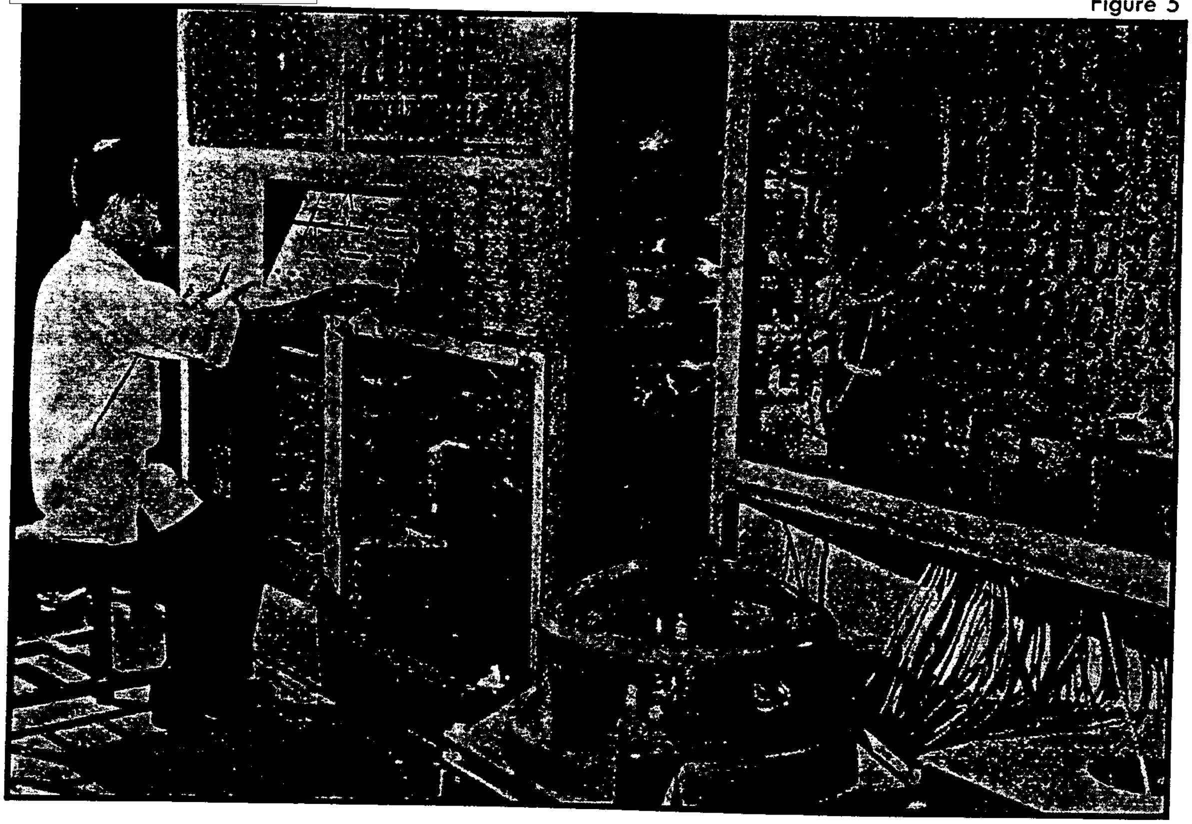
Figure 5



a. Pa-I model electronic digital computer (Soviet model M–3)

b. Pa-I model digital computers under construction in Communist China

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battery. Investigation of newer battery systems, such as the nickel-cadium system is also carried out. There is evidence of some fuel-cell research, but this will not have military significance for many years.

103. Basic research on organic chemistry in China is far behind that in the West, with only a few significant contributions having been made. The Chinese are conducting a small amount of high-quality basic research on the chemistry of high polymers and have a major development program in this field. The application of results produced in the research institutes has been inhibited, however, by a shortage of engineering know-how and inept management.

104. In the field of pharmaceutical chemistry, there has been some success in producing drugs for export. While some of the work was merely copying known methods, some very good original research has been done. For example, the Chinese successfully developed diosgenin and in 1962 began to sell it abroad. (Diosgenin is an extremely important substance used in the preparation of cortisone, hydrocortisone, and progesterone.) Now they are able to export finished cortisone in various forms as well as other steriod hormones.

105. In support of their agricultural program, the Chinese have conducted a sizable amount of research in insecticides, including synthesis of organophosphorous compounds. [redacted]

106. Research has been carried out to exploit waste materials. Agricultural wastes have yielded furfural, and research is being carried out to produce a series of organic chemicals analogous to those derived from coal-tar. There is no evidence, however, that commercial-scale processes have been developed. Attention has also been paid to by-products from petroleum and shale processing, [redacted]

107. Basic research in chemical engineering is rather limited in China and is concentrated at educational institutions, [redacted] (b)(1) (b)(1)

109. Resources in chemical engineering research and development have been devoted primarily to agricultural and military needs. Great emphasis is being given to the development of processes and equipment for synthetic ammonia, urea and other fertilizers, as well as other chemicals for use in agriculture. [redacted] (b)(1) (b)(1)

4. Metallurgy

110. Specialty alloy steels are receiving the highest priority in Chinese metallurgical research. Because of the scarceness of nickel in China, a large effort has been devoted to substitute steel compositions that require a minimum of this element for alloying purposes. [redacted] (b)(1) (b)(1)

111. The high-priority materials requirements of agricultural, industrial, and military programs are reflected in Chinese metallurgical research activity on corrosion- and heat-resistant steels used for the construction of chemical process equipment and on processes for extracting certain of the less common metals. It is questionable whether China now has the capability to produce and fabricate high-temperature alloys required for aircraft jet engines; however, a very limited capability may be developing.

(b)(1)

112. The Chinese are producing a modest variety of alloy steels, including some stainless steels, ordinary grades of precision steels, high-speed tool

steels, and spring steels. They now have corrosion-resistant stainless steels needed for fertilizer plants, and are acquiring applied research experience useful in specialty steel manufacturing. By 1970, China should be able to produce most varieties of specialty steels. The major problem which the Chinese have in specialty steel technology is the poor control of chemical composition and homogeneity. Little is known of the Chinese ability to produce such metals as titanium, beryllium, and molybdenum. China's problems with steel processing suggest, however, that at present it would have difficulty in producing and fabricating these metals on an industrial scale since a more complex technology is required.

113. Powder metallurgy techniques are not yet well developed in China, and apparently little research is being undertaken in this field. Other modern metallurgical techniques, such as vacuum metallurgy, zone-refining, and explosive forming are being studied, though most metallurgical research efforts are devoted to improving more conventional techniques.

114. China probably has been engaged in research on the metallurgical application of radioisotopes.

115. Technological problems concerning the beneficiation of ores for the production of the common nonferrous metals, such as copper, aluminum, tin, lead, and zinc, are still of concern to the Chinese. In addition, Chinese metallurgists are continuing their efforts to develop processes for the extraction of other nonferrous metals, such as zirconium, hafnium, uranium, and tantalum from their ores. A degree of success in these efforts is indicated, but they are still years behind the West and are not expected to catch up until well beyond 1970.

116. The application of research findings to full-scale industrial fabrication of metals is still a problem in China. Chinese difficulties in heat treatment primarily concern the control of furnace atmospheres, furnace automation and mechanization techniques, and quality control procedures. The welding of steel continues to be a problem and is a subject of much applied research throughout China.

117. A limited amount of basic physical metallurgy research is under way in China. Studies of internal friction in metals, being conducted at the Institute of Physics, Academy of Sciences, are outstanding. Other routine studies are being made of metal whiskers, dislocations, creep, and magnetic properties.

118. The most important research institutes in the field of metallurgy are the Institute of Chemical Engineering and Metallurgy, Institute of Metallurgy and Ceramics, Institute of Metals, all under the Academy of Sciences, and the Research Institute of Nonferrous Metals, under the Ministry of Metallurgical Industry. The Shih-ching-shan Steel Plant in Peiping is devoted to investigations of newer steel making processes and to the improvement of the conventional processes in use in China.

5. Basic Electronics

119. While trying to achieve a capability in theoretical research, the Chinese are emphasizing practical research and development for their immediate production needs. In particular, they are concerned with the development of their manufacturing facilities so that they can produce their own telecommunications equipments and adapt foreign equipment to their manufacturing capabilities. In spite of Sino-Soviet ideological differences, China continues to cooperate, at least to an extent, with other Communist countries in research on equipment tropicalization. China almost certainly will have a very formidable research capability within a few years after the period of this estimate.

120. In noncommunications electronic equipment production and deployment for military use, the Chinese already have demonstrated an increasing ability to develop their own equipment and to adapt foreign equipment to their manufacturing capabilities. Their aim undoubtedly is to develop a completely self-sufficient industry for the production of this equipment, though at present they will take whatever help becomes available.

121. To date, Chinese leaders have emhasized the engineering development aspects of electronics research, concerning themselves with adapting Soviet Bloc, Western, and Japanese devices, equipment, and systems in order to meet requirements

which they consider essential. Generally speaking, the requirements considered essential are extremely meager by Western standards.

122. There is no clear-cut division of responsibility for fundamental and applied research among the various categories of Chinese institutions, laboratories, and plants that are concerned with electronics. The responsibilities of institutions and laboratories often overlap those of manufacturing installations, which do a considerable amount of development work. The Fourth Ministry of Machine Building (formerly the Tenth Bureau, Third Ministry of Machine Building), and the Ministry of Posts and Telecommunications are associated with electronics work. Some studies on electrical meters is conducted by the First Ministry of Machine Building.

123. The task of obtaining foreign prototypes to modify or adapt is rapidly becoming easier. Western (except U.S.) and Japanese electronics material, sometimes of the very latest type, is now readily available to the Chinese; the only limitation on purchases being China's ability to pay or to establish credit and, to some extent, on export restrictions. In addition to their use of foreign-made components, equipment, and systems, the Chinese place great emphasis on the publication of translations and abstracts of foreign scientific and technical books, journals, and the like. This includes a large body of material from the Soviet Bloc, probably some "classified" technical data. Much of this material reaches Chinese electronics personnel within a year after its original publication. In their own papers and books, the Chinese generally cite far more Western publications as references than they do Soviet Bloc.

124. From the standpoint of engineering development, as well as more fundamental research and development, no special emphasis appears to be placed on any particular segment of the general field of electronics. However, in the case of high-grade published research (in contradistinction to technical articles describing some unit, such as an electron tube), emphasis is placed on a very few items—semiconductor devices, lasers, masers, parametric amplifiers and wave guides. These papers are an enigma, for the number of Chinese papers is very small in comparison with the number of papers published in scientific journals in Japan and the West. Yet many are of excellent quality, and such excellence is not normally associated with a small-scale technical capability.

125. Engineering development of semiconductor devices based on Western, Soviet Bloc, and Japanese transistors is conducted at a number of plants scattered throughout the whole of China. Examples of such plants are the Peiping Electron Tube Plant and the Nanking Electron Tube Plant. The Institute of Semiconductor Physics (also known as the Institute of Semiconductors) of the Chinese Academy of Sciences is the largest center for more fundamental research on semiconductor devices. The Institute of Semiconductor Physics is an outgrowth of the Institute of Physics, Chinese Academy of Sciences, where a small amount of work on semiconductor devices is still done. A large number of higher educational institutions, such as Peiping University, Fu-tan University in Canton, and Nan-k'ai University at Tientsin are also centers of semiconductor research.

126. During the last 10 years, approximately 100 papers concerned with semiconductor devices were published by some 70 authors. The theoretical work is almost always of high quality and certainly comparable to that which is found in such U.S. journals as *Physical Review* and *Reviews of Modern Physics*.

127. The Chinese probably profited more from Soviet assistance in electronics than in any other field of science. Moreover, electronics seems to have suffered the least when such aid was withdrawn. Chinese scientists of this discipline seem to be far less interested in investigating problems of basic research that would lead to original designs than they are in copy-manufacturing and design-modifying foreign equipment, such as television cameras, transistorized radio receivers, and communications components of reasonably good quality.

128. At the present time at least 70 types of germanium transistors are manufactured in China and are in good supply, not only for essential civilian and military purposes but also for use by radio amateurs, students, and the like. The transistors include low-power, high-frequency types (100 milliwatt, 100 mc/s), audio-frequency power units,

and low-frequency control elements. The majority of these transistors are intended for applications in radio sets, audio amplifiers, power-frequency controls, and similar devices. Some of these transistors can be used for relatively high-speed (on the order of 1 microsecond) logic and computer circuitry. Although the number of transistor types manufactured in China is much less than in the West, the types that are produced probably are quite adequate for the manufacture of most civilian telecommunications and control units which require transistors, and for certain military equipment, such as HF communication sets. However, the apparent lack of Chinese-manufactured silicon-type transistor will prevent the development of mobile-type military telecommunications equipment that must operate at extended temperature ranges.

129. More than 20 types of diodes are manufactured in China and are in good supply. Many of these are silicon diodes.

130. Chinese interest in laser and maser research began in 1961 with one known scientist. The number grew to five in 1962 and subsequently increased to a total of 54 by late 1964. Laser/maser research is known to be conducted under the Department of Mathematics, Physics, and Chemistry of the Chinese Academy of Sciences.

131. Ruby and gas lasers (helium-neon) are believed to have been constructed, and good basic work on doped calcium fluoride laser materials is under way. Crude laser crystals can probably be grown in China, but crystals suitable for meaningful research with lasers are most likely obtained abroad. Western and Russian literature is followed closely, but the time lag is probably as much as 1 year. The full range of possible laser applications is certainly appreciated, but little more than the basic laser experiments have been duplicated. The Chinese indicate an interest in and probably are developing materials for ruby masers and lasers. Although the emphasis has been on the optical properties of these devices, the Chinese probably are aware of the use of masers in the production and amplification of radio frequency oscillations at millimeter and submillimeter wavelengths. However, masers for military applications are not expected to become available until after 1970. If the present rate of growth in this discipline is continued, within 3 to 5 years China's research could represent a major, full-scale program capable of making significant contributions to the state of the art.

132. Altogether, at least 16 facilities are engaged in some aspect of electron tube research, development, and production. Approximately 200 different conventional-type vacuum tubes of good quality are known to be produced in quantity. These undoubtedly are available as needed for essential civilian and military purposes. Although the Chinese claim to be developing and manufacturing special purpose tubes, such as magnetrons, no information is available on the quantity or quality of these tubes. Magnetrons, however, are definitely known to be manufactured at one of the two electron tube plants in Ch'eng-tu, Szechwan Province.

133. Other electronic passive components are produced by the Chinese in quantity and are only considered marginally satisfactory in comparison to Western prototypes.

134. Native-produced electrical measuring equipment for use at frequencies below 300 megacycles per second appear to be readily available in China. This type of equipment is somewhat inferior to the best produced by the West, but it is adequate for its assigned purpose. [redacted]

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6. Geophysical Sciences

135. China's geophysical sciences, with certain exceptions, are just beginning to mature as full-fledged research disciplines. Hence, inasmuch as these regimes are characterized by the same problems of trained-personnel shortages, research-equipment scarcities, and deficiencies in facilities that prevail in other areas, China for some time will con-

Figure 6
Nanking electronic tube plant

a. Workshop

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b. Stem assembly

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tinue to remain far behind the leading nations of the world in geophysical science and technology.

136. a. ASTRONOMY—China has only a few modest programs in areas of astronomy such as asteroids, latitude and time, celestial mechanics, stellar evolution and solar astronomy. There is also an interest in radio astronomy and in the design of astronomical instruments. China maintains an optical satellite observation program which is directed by the country's largest observatory at Purple Mountain, near Nanking. [redacted]

137. The largest telescope in China, a 60-centimeter reflector, is located at Purple Mountain. China's lack of larger telescopes greatly restricts activities in observational astronomy. The observatory also has a horizontal spectrograph and a Lyot chromospheric telescope for solar research, as well as several transit instruments and astronomical clocks.

138. Although the Peiping Observatory has as large a staff as that at Purple Mountain, little observation work is conducted, the emphasis being on basic astrophysics and teaching. A radio telescope is planned for the next solar cycle peak (1968-69) and will consist of 32 6-meter dishes. Observatories at Shanghai and Tientsin are active in time service and latitude determination respectively.

139. b. UPPER ATMOSPHERE AND SPACE—Research is conducted in several sub-fields of upper atmosphere and space geophysics. Greatest emphasis has been on ionospheric studies, with most of the work that is published being on correlation studies of ionospheric irregularities. [redacted] density determinations can be made. The Chinese have stated their intention to develop rockets and satellites for upper atmospheric and space research.

140. The development of sounding rockets is the responsibility of the Academy's Institute of Geophysics, which is responsible for developing an upper atmosphere rocket research program and possibly for designing scientific payloads for earth satellites. [redacted]

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141. A few cosmic ray observatories exist in China, including a new one established near Canton in 1964. This new station was associated with the IQSY in publicity although China is not an official participant. In the next 5 years, China's research will probably be expanded to other subfields, such as aurora, airglow, and meteor investigations.

142. c. METEOROLOGY—In China, meteorology is probably one of the most active and productive of the earth sciences programs. Nevertheless, the status of meteorological research is low compared with the status of similar research in more advanced countries. As with most other sciences, meteorology is expanding in China, and attention appears to be concentrated on establishing a data collecting net and on developing forecasting capabilities to support the military, agriculture, aviation, and industry.

143. Although China has progressed rapidly in meteorology since 1949, the average quality and limited quantity of personnel, instrumentation, and weather communications keeps capabilities lower than in advanced countries. Minimum operational requirements of the armed forces, industry, and agriculture can be met. Better forecasting capabilities and some additional improvement in the observational network will be accomplished in programs during the next 5 years. The Chinese have had research on the theory of numerical weather prediction under way for several years and are now using electronic computers for weather forecasting.

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144. Since Typhoons constitute a major threat to the economy of China, considerable research is conducted in attempting to describe and understand them. The monsoons also are studied extensively.

145. The Chinese recently (1960 and 1961) prepared comprehensive climatological atlases which indicate clearly that much of the effort in this area has been directed toward basic, descriptive programs providing agricultural and economic support.

146. Some native meteorological instruments are produced, although most of this kind of equipment is believed to be adopted from foreign equipment.

147. Little significant research in physical meteorology has been conducted, though interest in weather modification has been indicated and a small effort in cloud physics has been started. By 1970, China will be only slightly nearer the level of advanced countries in meteorology.

148. d. GEODESY AND GRAVIMETRY—Another active area in Chinese earth science is geodesy, though little original research toward describing the geophysical features of the country, so that surveys for cartographic and mineralogic applications constitute a large part of the geophysical effort. Only well-known methods and equipments appear to be in use.

149. A gravimetric base-station network has been established, and the Chinese are capable of establishing geodetic parameters for an IRBM test range. The establishment of an ICBM range in the Pacific will be difficult with current Chinese capabilities in marine geodetic measurements. Routine gravimetry is used in mineral exploration, but instrumentation is in short supply.

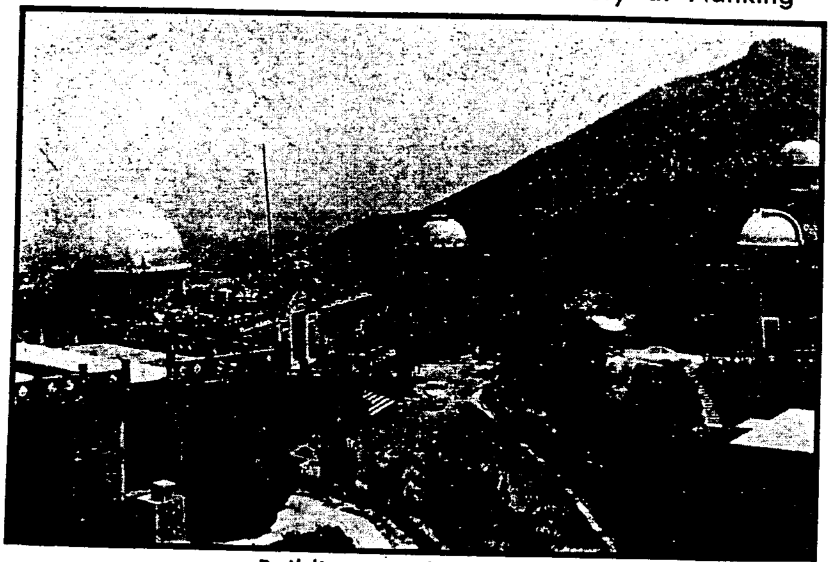
150. e. GEOMAGNETISM AND GEOELECTRICITY—Basic research on magnetic storms and routine geomagnetic observations have been conducted by the Chinese. Both fields have been applied routinely in the exploration of natural resources. There are no indications of geomagnetic investigations that may be associated with a nuclear detection system.

151. f. GEOLOGY—The Chinese have conducted concentrated programs in all subfields of geology, mainly in support of natural resource exploration programs but predominantly on a reconnaissance basis. New deposits of petroleum, various minerals, sub-surface water, and other natural resources have been located. In addition, emphasis is placed on research supporting civil engineering and agriculture. This trend is expected to continue, especially in the exploration for minerals, petroleum, and subsurface water to support an increasing economic demand. In addition, research on rock classification, correlation, and age dating, as well as detailed mapping of economically potential areas, will continue, but no significant contributions are expected by 1970.

152. g. SEISMOLOGY—The Chinese have been active for several years in earthquake recording and zoning, with considerable effort being directed toward antiearthquake construction. Seismology is used extensively in mineral and subsurface water exploration. [redacted] (b)(1) Little basic research is indicated by published literature; and, as yet there is no evidence of programs directed towards marine seismic exploration. A network of seismic stations in China is capable of underground nuclear detection on a limited scale. Most of this network was set up with aid from the Soviets. There are no indications that this network will be improved extensively by 1970.

153. h. OCEANOGRAPHY—A major portion of oceanographic research in China continues to be directed toward the support of marine biology and the fishing and shipping industries. A stronger program may be indicated by the recent establishment of a State Council Bureau of Oceanography. Several extensive and systematic annual surveys have been carried out in the ocean areas adjacent to the China coast but with emphasis on routine data collection. China's participation in the Communist countries' Fisheries Research Commission for the West Pacific is an asset to the country. Such programs as tidal and ocean wave study, harbor erosion and silting problems, beach and coastline studies, near-shore bottom topography investigations, and extensive marine biological programs are expected to continue. Other formerly neglected areas, such as marine physics, chemistry, geology, and research instrumentation are slowly being developed.

Figure 7
Purple Mountain Astronomical Observatory at Nanking



a. Buildings at the installation

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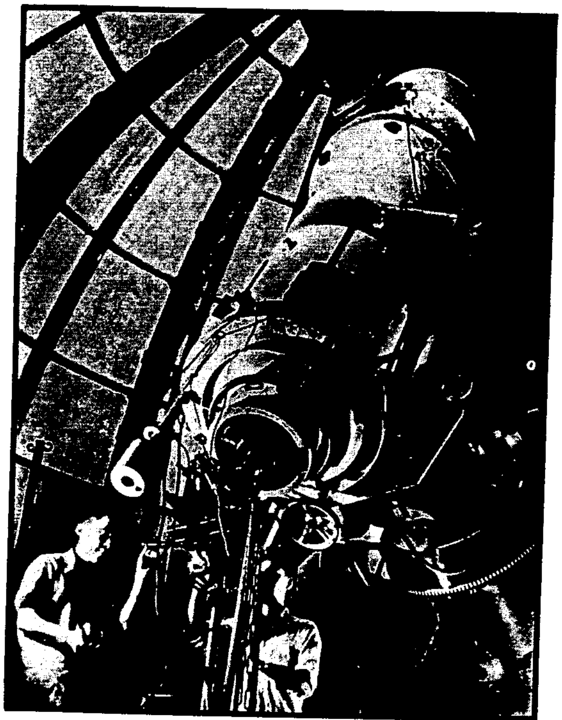

b. The 60-centimeter reflector

[redacted] (b)(3)

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154. Although published material indicates a strong interest in marine seismology, gravimetry, and geomagnetism, no important research programs have been noted. The Chinese possibly have as many as three small oceanographic investigation ships, but they rely mainly on small naval ships for support. Instrumentation is undoubtedly inferior to that of the leading nations. [redacted] No major advance in the Chinese oceanographic program is expected by 1970. (b)(1)

7. Medical Sciences

155. China has a severe shortage of trained medical personnel. Many Chinese medical doctors in comparison with Western-trained physicians are weak in basic sciences, generally demonstrate superficiality in clinical practice, and are strongly influenced by political dictums. The reforms of medical education that have been introduced will not rectify the situation during the period of this estimate, but by 1973-75 they should advance the quality of graduate physicians to a level that will compare favorably with Western standards.

156. Medical research in China is directed toward infectious and neoplastic diseases and along the lines of basic disciplines. Major attention has been given by the Chinese Academy of Medical Sciences (CAMS) to research on the prevention and control of infectious diseases which exact the greatest toll on the working forces—schistosomiasis, tuberculosis, malaria, Japanese B. encephalitis, typhus, bacillary and amebic dysentery, and hookworm. Significant contributions include the isolation of a strain of trachoma virus by Tang and Chang *et al* at the T'ung-jen Hospital at Peiping, and the development by the Ch'ang-Ch'un Vaccine and Serum Institute and the CAMS, of a less toxic vaccine against Japanese B. encephalitis. China has a capability for the production of vaccines and serums for most of her human and veterinary diseases, as well as the production of standard pharmaceuticals and antibiotics in limited quantities. With the exception of this work, little in the way of original research in this area seems to have been accomplished in recent years. Use is now being made of the few highly qualified Chinese microbiologists by giving more emphasis to fundamental research in addition to purely practical aspects. Work is in progress on the use of purine antagonists as antiviral agents, on the nature of drug resistance, on the structure and function of viral nucleic acids, and on the mechanism of antigenicity.

157. Main lines of research on biochemical and biophysical areas of the medical sciences include: (1) the crystallization of proteins, (2) the discovery of active sites on enzymes and their mechanism of action, (3) the structure, properties, and genetic role of nucleic acids, (4) the general study of metabolism, using tracer techniques, and (5) biological effects of radiation. The best of this work is conducted at the Institute of Biochemistry of the Chinese Academy of Sciences (CAS), Shanghai. While none of this work is entirely original, it is well conceived, controlled, and executed. Work in physiology, neurophysiology, and pharmacology, especially the mechanism of drug action, is excellent.

158. Cancer research has included clinical studies on cervical carcinoma, choriocarcinoma, chorioadenoma destruens, esophageal carcinoma, and nasopharyngeal carcinoma; these included histopathologic studies associated with the clinical investigations, principally conducted by the Institute of Experimental Medicine, CAMS, in Peiping.

159. Although individual basic studies on cancer, protein synthesis, and medical virology have attracted international attention, China will be unable to exploit in depth or adequately to broaden its indigenous medical research capabilities before 1970. China is expected to seek Western scientific and technological aid in the next decade in order to overcome domestic research and development deficiencies. Initial contacts and rapport are being sought in part through the biomedical sciences.

160. China is attempting to assure an adequate food supply for its expanding population by increased nutritional research and by birth control. It is supporting a broad program of applied nutritional research designed to identify the food requirements of farmers and workers, to increase the nutritive value of foods, to standardize and simplify techniques for determining nutritional levels, to apply nutritional science in the treatment

of disease, and to promote food hygiene. The research build-up is slow, and manpower training will not yield fruit before 1970. Its efforts in population control have been limited to the support of late marriage, use of contraceptives, and liberalization of abortions and sterilization. No evidence is available of any related drop in the birth rate which is about 2.2 percent of the total population.

161. Traditional Chinese medicine is of two basic types: herbal medicine, which, in many cases, has a pharmacological basis; and the more obscure practice of acupuncture, or needling, and moxibustion, or cautery, which have not been adequately evaluated scientifically. The mixing of Western and traditional medicine serves to increase the number of medical practitioners in the eyes of people, to bring ideas of modern hygiene and public health to the traditional doctor without causing "loss of face," and to extract from a large body of traditional remedies those that are truly efficacious. This practice probably will continue at least until enough Western-style physicians are available.

8. Biological Sciences

162. In general, the quality of Chinese biological research is fairly good. However, the quantity of research is low; so is the number of PhD-level scientists. The number of research institutes is adequate for China's limited basic research program, but, if China extends its biological research, an expansion of these facilities will be necessary. Except in certain areas of molecular biology, where the Chinese are making significant advances, Chinese biological research is not expected to produce any outstanding scientific accomplishments within the next 5 years. However, there probably will be a gradual increase in biological science capabilities during that period. Official emphasis will continue to be centered on the applied rather than the basic aspects of biological research. The main research effort in Chinese biology is directed toward practical problems concerned with agriculture, industry, and health.

163. The taxonomy and ecology of the flora of China continue to dominate the field of botany. Other fields receiving increased attention are plant physiology, genetics, and biochemistry. Investigations are being conducted on photosynthesis, mineral nutrition of plants, tolerance of plants to adverse conditions, induced mutations, and molecular biology. Although China's total genetic research capabilities are limited, some outstanding basic research in molecular biology has been conducted. The Chinese may attempt to make a spectacular contribution to molecular biology, as this is an area in which they might surpass rival Communist countries. Some excellent biochemical research on the resynthesis and regeneration of insulin has been conducted by scientists at the Institute of Biochemistry, Shanghai. Chinese biochemists also have attained high-quality research in enzymology and protein biosynthesis.

164. In Chinese zoological research, the morphological, taxonomical, and ecological fields are most prominent. Investigation in these fields on many insects, fishes, and animal parasites has resulted in the successful development of a number of biological control measures. Though limited, much of this research is on the level of Western work in the zoological sciences.

165. The scope of Chinese microbiological research is fairly broad, and the overall quality of most microbiological research is good. Research in microbial physiology and biochemistry emphasizes the industrially useful microorganisms. Chinese research on microbiological methods of prospecting for gas and oil also has been conducted during the last few years. Considerable advances have been made by the Chinese in the field of antibiotic research, but they have not yet attained a quality of research as high as that attained by Western scientists. The Chinese are currently investigating the possibility of utilizing microbes to convert by-products and agricultural wastes into foodstuffs. Scientists have had some success in this field, although production costs of such processes must be lowered substantially before research findings can be applied practically.

166. Major research progress in hydrobiology in China has occurred in fish rearing and catching, the development of marine shellfish culture, the extensive propagation and utilization of seaweeds for human food and industrial material, and the investigation of the plankton distribution in the China seas. Research on the sea kelps *Laminaria* and *Porphyra* has resulted in more successful propagation of these species, and research on the

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Figure 9

Sika fawns. The velvet antlers of Sika deer are highly valued by the Chinese for traditional medicine.

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Figure 10

(b)(3)

Lecture on the sea animal Amphioxus at Shantung University

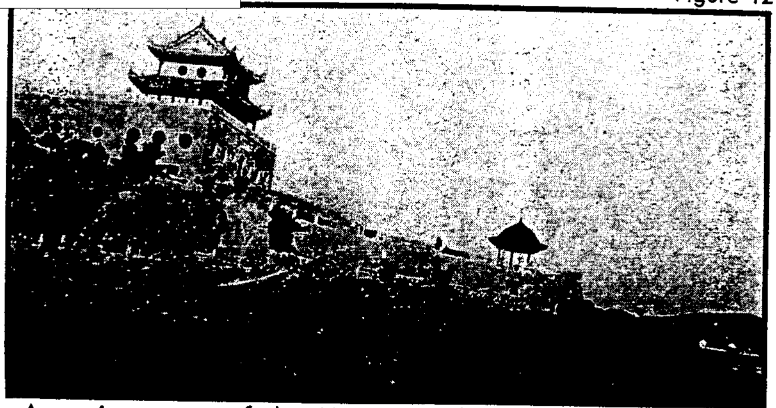
(b)(3)

Figure 11

Students of the Oceanographic Department of Shantung University measuring the transparency of sea water

Figure 12

(b)(3)



Aquarium, part of the Marine and Limnological Museum, Tsingtao, Shantung

Figure 13

Edible seaweed grown by the youth brigade

Figure 14

Cultured kelp

edible green alga, *Chlorella,* is good. There has been a significant growth in the scientific research force in this area and a comparable increase in the number of aquatic products institutes and research facilities in China. This research, however, has not yet reached the advanced scientific stage of that in many Western countries. Based on increased support from its scientific and technological sector, the Chinese fishing industry can be expected to develop at an accelerated rate during the next 5 years.

9. Agricultural Sciences

167. Chinese agricultural research has increased significantly, but as yet has contributed little to increases in the food resources of China. Increased emphasis given to the development of agricultural productivity has been evident since September 1962 when the 10th Plenary Session of the 8th Central Committee of the Chinese Communist Party gave first priority between agriculture and industry to the development of agriculture. The quality and quantity of Chinese agricultural research will probably improve as a result of this priority, but a lack of trained scientists and, to a lesser extent, facilities, and scientific equipment will limit the potential contribution of such research toward meeting China's needs for increasing its food resources within the period of the estimate.

168. The most significant Chinese agricultural research has been in crop breeding. Chinese plant breeders and geneticists have successfully bred improved rice, wheat, corn and other food crops that have significantly increased yields on experimental plots. The Chinese claim the successful selection of more than 400 superior varieties during the last 10 years. The majority of these varieties probably have been obtained through identification and selection of indigenous local varieties, which were increased and distributed with little or no breeding work. A lesser portion was derived through the application of advanced crop breeding methods, primarily using imported genetic material. Many of the Chinese plant breeders are Western-trained and have kept abreast of modern plant breeding techniques.

169. Chinese research on the effective utilization of agricultural chemicals (chemical fertilizers, insecticides, fungicides, and herbicides) is critically inadequate, even though agricultural chemicals, especially fertilizers, offer the greatest opportunity to increase China's food resources. Improperly designed and controlled experiments, combined with the generally poor quality of indigenously produced agricultural chemicals, have hindered the exploitation of the full potential of chemicals in food production. Although Chinese scientists have conducted good research in the soil sciences, their research on chemical fertilizer utilization is very limited, and fertilizer recommendations are based mainly on mass trial and error experiments. The Chinese will place increasing importance on chemical fertilizer and pesticides, and their utilization should have a noticeable effect within 5 years. However, most of their agricultural chemical research will be directed toward the adaptation of foreign practices and recommendations.

170. Chinese entomologists have been engaged chiefly in adapting and implementing foreign control practices to varied conditions of food crop production. Through ecological and life cycle studies on the migratory locust, the Chinese have brought locust attacks under control, and no disastrous outbreaks have occurred in recent years. Other important accomplishments include the identification and control of insect vectors of plant diseases. Although insects are controlled mainly with insecticides, the Chinese have successfully developed biological control methods, using both insect predators and microorganisms. Most of the microorganisms utilized have been imported from abroad. The dangers of upsetting present ecology by the introduction of control insects are not investigated. Research on preventive methods rather than control methods frequently is emphasized. These include cultural methods, reporting and forecasting systems, insect-free and insect-resistant seeds, and chemical destruction of hibernating insect pests. Entomological research has been geared to solving current problems, but Chinese researchers are fully aware of the importance of basic entomological research.

171. Chinese plant pathology research directed toward the control and prevention of food crop diseases has not been impressive by Western standards. The strengthening of traditional practices, however, by the use of modern technology and the adaptation of foreign control methods for

serious fungal and viral crop diseases have accomplished practical results, which have significantly reduced crop losses.

172. China has very little good research in the animal sciences, but its very few competent animal scientists have contributed to the improvement of the swine, sheep, and poultry breeding stock. Nevertheless, in China, the weak scientific foundation and the feed and breeding stock will make the development of the livestock industry extremely slow. Significantly, China has adapted foreign livestock practices to reduce disease incidence, which has nearly eliminated some of the more serious diseases.

10. Nuclear Energy Research

173. INTRODUCTION—The Chinese atomic energy program began in the mid-1950s with Soviet aid that continued until mid-1960. The aid involved technical manpower, technology and some equipment. Western unclassified literature also provided valuable information. The Soviets participated with the Chinese in geological exploration, mining, and the design and perhaps the construction of a uranium-metal plant. In addition, they probably provided plans and possibly some equipment for the gaseous diffusion plant at Lanchou and for the reactor facility at Pao-tou. The withdrawal of Soviet aid in mid-1960 undoubtedly impeded China's atomic energy program, forcing the Chinese to reorient their efforts to develop and produce, with little or no assistance, the varioous critical materials and equipment required.

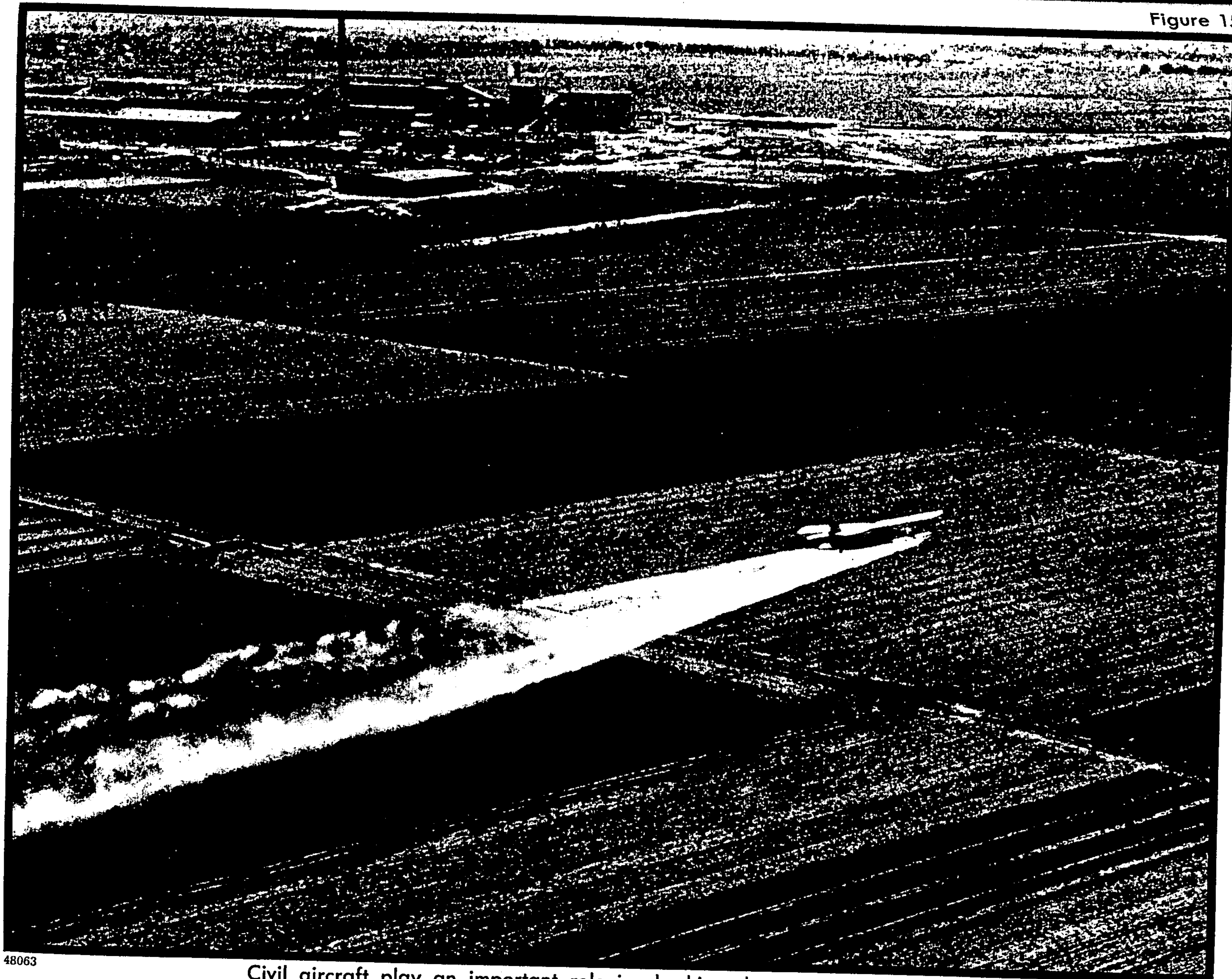
174. Although research in nuclear physics was being conducted as early as 1955 or 1956 by a group of scientists within the Institute of Physics of the Chinese Academy of Sciences, China did not officially announce the establishment of the Institute of Atomic Energy (IAE) until 28 June 1958. The Institute was made subordinate to the Department of Physics, Mathematics, and Chemistry of the Chinese Academy of Sciences. Although the administrative headquarters and some facilities are located in the Chung-kuan-ts'un section of Peiping, the major equipment and laboratories are located near the suburb of T'o-li, approximately 19 nautical miles southwest of Peiping. The IAE also has established branches throughout China in such places as Lan-chou, Hsi-an, Wu-han, Ch'eng-tu, Canton, Shanghai, and possibly at Urumchi and other locations. However, the current status, amounts, and types of equipment at these branches are not known.

[redacted] (b)(1)

176. Other than the Institute of Atomic Energy, many of the colleges and universities offer training in nuclear energy subjects and undoubtedly would support any Chinese efforts in this field by conducting basic research in nuclear energy or associated fields. (See Nuclear Weapons Program, para 304)

[redacted] (b)(1)

Figure 15



48063

Civil aircraft play an important role in checking the spread of locusts

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(b)(1)

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[redacted]

179. The only known U-235 production facility in China is the complex located on the Yellow River near Lan-chou. This facility probably includes a gaseous diffusion plant supplied by the USSR during the 1957 to mid-1960 period. This site layout suggests that original plans included an additional building that would have permitted production by normal gaseous diffusion techniques of highly enriched uranium. However, a second large building has not been constructed. The evidence suggests that the first building could have started operation sometime between August 1962 and March 1963. The Chinese apparently were forced to adopt other methods to achieve highly enriched U-235. Thus, it seems improbable that a completely gaseous diffusion process was used by the Chinese, since they are likely to have used the first nuclear materials available for their first device.

180. We believe that the likeliest source of the Chinese enriched uranium was a combination of processes, where partially enriched uranium produced by the Lan-chou gaseous diffusion plant was further enriched by an unidentified electromagnetic separation facility.

181. A small electromagnetic facility could be located within the Lan-chou complex. [redacted]

[redacted]

[redacted]

184. *Pao-t'ou Plutonium Production Facilities*—A highly secure installation, located about 4 nautical miles to the northwest of the old city of Pao-t'ou, was identified in March 1963 as probably being a plutonium production facility. On the basis of all available evidence, however, we are not able to establish a firm estimate of the operational status of the reactor.

(b)(1)

[redacted]

(b)(1)
(b)(1)

[redacted]

190. Based on all of the above considerations, we believe that the initial start-up of this reactor occurred in late 1963 or early 1964, although the apparent availability of excess electric power in March 1963 suggests that it might have started-up around that date.

191. We estimate that the Pao-t'ou reactor has a thermal power rating of about 30 megawatts. Assuming that the facility is operated so as to minimize the time necessary to obtain sufficient material for a test device, and that no serious difficulties are encountered that would delay production, we estimate that the earliest the Chinese could produce sufficient plutonium from this reactor to fabricate an all-plutonium test device is by early 1965.

192. Sufficient plutonium for a composite device could have been available in late 1964. The Paotou facility, at a power level of 30 megawatts, is estimated to be able to produce about 10 kilograms of plutonium a year.

193. *Yumen*—A large industrial complex has been under construction near Yumen in a remote area of Kansu Province since 1959 or before. [redacted]

(b)(1) [redacted]

195. In addition, within the Yumen complex is a facility that possibly could be a water-cooled reactor, operating in the range of perhaps 50 to 150 megawatts. [redacted] (b)(1)

(b)(1) [redacted] (b)(1) (b)(1)

(b)(1)
(b)(3)

[redacted]

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B. INDUSTRIAL TECHNOLOGY

1. Agriculture, Forestry and Fishing

197. Agriculture in China is characterized by labor-intensive methods of cultivation. The level of mechanization is low, with handtools predominating but supplemented by small numbers of tractors, mechanical pumps, and other types of farming equipment. Chemical fertilizer has been utilized in only small amounts compared to the amounts used in Japan and Taiwan.

198. Cultivation is already so intensive that the possibilities of expanding agricultural acreage are small. The Chinese thus are dependent primarily on the use of capital-intensive measures to increase production. Chemical fertilizer is the most promising method for increasing yields, but substantial amounts would be required. For example, in order to produce the grain needed to feed the population in 1970 at the 1957 rate, the Chinese would probably need an additional 25 million tons* of chemical fertilizer. However, domestic production of chemical fertilizer is not expected to exceed 8 million tons in 1970. Other measures that might be used to increase yields include improved grain varieties; improved methods to control insects, diseases, and weeds; and irrigation. Improved seed varieties, however, are of minor significance unless accompanied by improved agricultural practices. Furthermore, China's supply of chemical pesticides and herbicides is small. In addition, China's prospects are not favorable for the expansion of its irrigation systems. Small and medium irrigation projects have probably already been used to the maximum; and the construction of large projects in the south is precluded by topography and in the north is limited by excessive silting, alkalinity, inadequate water resources, and scarcity of technical skills. The operation of irrigation systems could be enhanced considerably, however, by the increased use of mechanical pumps. Other types of mechanization would have only a small effect on improving yields because of the intensity of present land use.

199. Historically, China drastically over-cut her forests, so that today the people are woefully deficient in wood and wood products. Artificial and natural regeneration of forests have not kept pace with the cutting rate, and in the long run China must either curtail the consumption of wood or increase reforestation sharply. Nevertheless, China is believed to have sufficient national reserves to continue the current low cutting rate of about 30 million cubic meters annually through 1970.

200. China is not exploiting her fishing potential to the fullest. Further development depends on the introduction of equipment needed for deep-sea fishing and the improvement of transportation services and processing facilities. There appears to be no technological limitation to further substantial expansion of the industry.

2. Basic Industries

201. China's basic industries were expanded during 1949-60 with large-scale assistance from the USSR and the European Satellites and were oriented heavily toward serving a large construction program and the production of military and civilian machinery and equipment. Major emphasis was placed on the rapid expansion of plant capacity and production of a few important commodities, such as steel, coal, electric power, and cement. Since 1960, however, priorities in the basic industries have centered on the expansion of facilities to produce more complex commodities such as petroleum products, agricultural chemicals, plastics, and special steels. Plant capacity in the steel, electric power, and cement industries has been only partially used and probably will not return to full operation for several years. In the case of the current priority basic commodities, however, expansion of production will be limited by a scarcity of domestic technical skills and by the Chinese ability and willingness to import equipment, technical data, and technical personnel from abroad.

202. a. METALLURGY—With the exception of chrome, nickel, and cobalt, China's metallurgical industry probably has sufficient capacity for producing most of the present requirements for commonly used metals and alloys. In the early years, requirements for alloy and special steels and many nonferrous metals and alloys were limited by the simple nature of the economy, and required metals were produced domestically in accordance with Soviet specifications or they were imported. With increasing demands for high-strength and corrosion-

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* Tonnages are given in metric tons.

resistant materials imposed by advanced military and civilian requirements, the Chinese increased substantially the electric furnace capacity and the training of metallurgists in the late 1950's. However, the Chinese still do not have the capability to produce high-quality grain-oriented steels or to fabricate refractory metals, such as molybdenum, tungsten, columbium, and tantalum. The Chinese also do not have sufficient rolling equipment to produce in adequate quantities the variety of shapes needed for a wide range of modern industrial and military construction. The metallurgical equipment industry is unable to produce the large precision finishing mills needed to complete the rolling mill program that was started but only partly completed with Soviet aid.

203. Raw materials for the production of most metals are available in China, although the quality of some ores is inferior. However, China has only small known reserves of chrome, nickel, and cobalt—three important steel alloying materials. Expansion of the modern mining sector is an essential prerequisite for any sustained large-scale increase in production by the metallurgical industry.

204. The main problems in increasing the supply, variety, and quality of metallurgical products in the near future are: (a) putting into operation modern finishing mills (b) training additional metallurgists and skilled production workers, and (c) securing the additional equipment and technology needed for the production of the more sophisticated metals and alloys. China probably has available sufficient metallurgical competence and the necessary equipment, including vacuum melting equipment, to produce small quantities of superalloys, electrical steels, and stainless steels. However, substantial increases in high-grade alloy steel production will depend on expansion of capacity, primarily electric furnace capacity; there is no evidence that an expansion program is currently taking place even though production of alloy steels is believed to be roughly equal to the former peak year of 1960. Most of the equipment is available in the Free World; but, to the extent that such expansion would involve the acquisition of vacuum-type electric furnaces, COCOM restrictions would be an inhibiting factor. Expansion will also be required in rolling mill capacity, if China is to meet a large part of its requirements for certain types of finished steel—particularly sheet and strip—from domestic production. The expansion in rolling capacity will require imports of equipment and/or complete plants. Several years will be required before rolling capacity can be increased, because 2 to 4 years of leadtime is required to design, manufacture, and install a modern large-capacity rolling mill.

205. b. CHEMICALS—The technological development of China's chemical industry lagged behind that of other heavy industries up to 1960. In general, China is 10 to 15 years behind the West in chemical engineering. Although considerable progress was made in the production of basic chemicals, the Chinese neglected some key sectors, such as chemical fertilizers, plastics, and chemical fibers. Since 1960, the Chinese have emphasized the importance of chemicals in increasing agricultural yields and as substitutes for natural products. They have established programs to convert machinery plants to the production of fertilizer equipment and to import chemical plants from the Free World.

206. Production of chemical fertilizers was only about 2.9 million tons in 1963. Most of the increase in production achieved since 1960 has been obtained through fuller use of existing plants; attempts to enlarge productive capacity through domestic resources have yielded only small results to the present. [redacted] (b)(1)

(b)(1) [redacted]

208. [redacted] output of chemical fertilizer in 1970 probably will reach no more than 8 million tons. [redacted] In addition, new technological problems will confront the Chinese in developing fertilizers which do not consume large amounts of sulfuric acid in their manufacture. (b)(1) (b)(1)

209. The plastics industry of China is relatively new and undeveloped. Production has increased from about 10,000 tons in 1957 to perhaps 50,000 tons in 1964. Chinese chemists have succeeded in producing some of the more common types of polymers but are lacking in the ability to mass-produce specialized types that are useful in military weapons. Current output consists primarily of three basic types of products: phenolics, polyvinyl chloride, and urea-formaldehyde. Other plastics, produced only in small amounts, include polystyrene, methyl methacrylate ("organic glass"), ion-exchange resins, aminoplasts, chlorinated polyvinyl chloride, organic-silicone, epoxy resins, and various plastic intermediates including formaldehyde, acetaldehyde, and synthetic phenol. Most of these plastics were produced as a result of considerable technical aid and some equipment provided by the USSR. Although China claims to produce Teflon, polyethylene, and polyester, the production of each is limited to the output of batch operations.

210. No substantial development of the plastics industry during the period through 1970 is foreseen, without significant concomitant improvements in the domestic supply of materials and skilled labor and additional technical assistance from abroad. [redacted] (b)(1)

211. The small chemical fiber industry has increased production from 200 tons in 1957 to 30,000 to 40,000 tons in 1964. This gain was largely attributable to plants built and equipped by Soviet Bloc countries. Viscose rayon and "Chin-lun" (nylon-6) are produced in sizeable quantities while small quantities of vinyl perchloride and polyacrylonitrile are also produced. Expanded production of artificial fibers (for example, viscose rayon) is hindered by shortages of woodpulp and sulfuric acid. Production may be 100,000 tons by 1970, an insignificant amount compared to China's need for textile fibers. Even this level of production will depend on the purchase of several more plants from the Free World. [redacted] (b)(1)

212. Present production of rubber is insignificant. China is still lacking in processes capable of mass-producing silicone rubbers, oil-resistant synthetic rubbers, and light-weight, highly chemical resistant materials. Natural rubber can only be grown in a small area; therefore China is forced to import natural rubber or to develop a synthetic rubber industry. In the 1950's, a 50,000-ton synthetic rubber plant was built by the USSR at Lan-chou, but production from this plant remains far below capacity.

213. China is unlikely to make significant gains in the synthetic rubber industry by 1970. Imported plant and technology would be required for expansion. Moreover, a major reorientation would be necessary in the rubber fabricating industry if synthetic rubber were to be used in volume because the present technology in rubber fabricating is based on natural rubber.

214. c. FUELS AND POWER—The fuels and power industries of China have a low level of technology by Western standards. Except for petroleum products, however, these industries can meet present requirements for their products. Coal supplies 90 to 95 percent of the energy that is obtained from primary fuels. Natural gas and petroleum are minor sources of power by contrast with their prominence in modern industrial nations. Reserves of coal and hydroelectric power are abundant and reserves of petroleum and natural gas are sufficient for needs in the foreseeable future.

215. The level of technical skills in mining coal is low and the Chinese lack experience in the manufacture of such crucial items as electric and hydraulic control and switch gear, bearings, and similar components for mining machinery and

equipment. The Chinese are attempting to modernize the coal industry. As a result, the supply of machinery and equipment from domestic sources may become larger, of better quality, and more diversified in the future.

216. While the Chinese are technically able to develop and exploit oilfields and are believed to be able to build and operate refining facilities capable of providing most of the country's needs for petroleum products, China does not have sufficient secondary processing units to produce the desired quality and mix of petroleum products. For example, without such secondary processes as alkylation, reforming, and/or catalytic cracking, China does not have the capability to produce high-grade aviation gasoline. The production of jet fuel, however, does not require the use of these types of equipment or material, therefore China is believed to have the capability to produce jet fuel. However, any production of jet fuel would be at the expense of other products such as motor gasoline and lamp kerosene.

217. The Chinese probably will remain dependent on outside sources for secondary refining equipment through 1970. Purchases of such equipment from the Free World will provide China with the capability to produce important raw materials for the petro-chemical industry and will serve to improve the over-all technological level of China's refining facilities. Acquisition of such equipment, moreover, will enable the Chinese to gain experience in the operation of more sophisticated processes and could provide prototypes for eventual domestic manufacture of similar equipment. The selected purchases of complicated equipment through 1970 are expected to include arrangements for technical training.

218. By 1960, the electric power industry of China had reached a level of technology comparable to the US power industry during the late 1920's and the 1930's. The industry is comprised of a mixture of the small, old, inefficient powerplants that the Communists inherited in 1949 and of the relatively modern thermal electric and hydroelectric powerplants which have been constructed since 1949 with extensive equipment and technical assistance from the USSR and the European Satellites. Technological developments within the industry have remained static during the last 4 years. Present capacity is probably sufficient to meet requirements for electric power through 1970, but some installation of new capacity will take place to meet specific local requirements for electric power as they arise. The Chinese electro-technical industry can produce most of the generating and transmission equipment needed. The only apparent technical obstacle that the Chinese will encounter in the completion of plants now under construction is in the manufacture of large generating equipment for such projects as the San-men Hsia Hydroelectric Powerplant. Such equipment probably will be imported.

219. The construction materials industry in China is extremely backward and will remain so through 1970. However, the Chinese construction materials industry can provide the basic materials needed to build most types of projects. The Chinese have built small-scale plants, which produce a low-grade product for local construction and have built large plants to produce materials for construction in the more modern sectors of the economy. The average quality of Chinese construction materials is below Western standards, but it is adequate to build projects that are structurally safe and functional in nature. Moreover, the Chinese are selective in the use of these materials, reserving the high quality construction materials for export or for military projects.

3. Machine Building

220. a. GENERAL—China is able to produce a fairly wide variety of basic types of machinery and equipment for industry, transportation, and conventional military use. Specific items include general purpose machine tools, trucks, tractors, locomotives, power generating equipment, simple petroleum equipment, radio equipment, piston aircraft, textile machinery for both natural and manmade fibers, and less complicated types of farm machinery.

221. Although progress since 1950 in acquiring industrial technology has been impressive, the present volume and variety of production is small in relation to industrial needs and military aspirations. The most basic problem is the small size of the present machine building sector in terms of plant capacity and of skilled labor. There are

only a few important plants in each major machine building category, and these plants do not have the advantage of the support of a complex of smaller subcontracting plants. Special problems include a shortage of facilities for making and processing large castings and forgings and for making precision machinery and precision hydraulic equipment, the poor quality of Chinese ball bearings, a deficiency in designing capability, a low degree of specialization, and inferior plant practices.

222. The Chinese will not achieve by 1970 the technological capability to produce machine tools for either a substantial variety and volume of advanced weapons or a wide range of civilian items. Rapid progress and useful results may be attained in a few special fields, with possibly a few spectacular achievements. The breadth of progress in machine building depends most importantly on the extent that construction of new plant capacity can be resumed and maintained. This in turn depends on availability of resources, including imported machinery and equipment and foreign technical advice, as well as domestic technical skills.

223. b. MACHINE TOOLS—Most of the machine tools produced in China are general purpose tools of simple design and of the type that has been manufactured abroad for the past 20 years. The Chinese claim to be able to produce native-designed machine tools, but there is no evidence of the existence of such tools. [redacted] Only very small numbers of precision machine tools are produced. The Chinese do not make transfer lines, numerically controlled, or other specialized mass-production machine tools. Bevel gear cutting machines and interior grinders for antifriction bearing races particularly are in short supply.

224. The Chinese have been attempting to make up for deficiencies in machine tool production by importing precise, automatic, and specialized types of equipment, which will be required in increased quantities during the next 5 years, and by collecting technical information from abroad. Through these means, some improvement in the production of precision machine tools may take place by 1970.

225. c. CIVILIAN MACHINERY AND EQUIPMENT—The Chinese are able to produce most of the simple types of machinery required for industrial construction. They have produced several hydroelectric generators of 72,500 kilowatts, and recently reported production of a 100,000 kilowatt hydroelectric unit. They also have produced thermal electric generators of 50,000 kilowatts, some nitrogen fertilizer equipment, coal mining equipment, simple steel and petroleum production equipment, and nearly all of the equipment needed for light industry. The chief fabrication problems are in the production of machines requiring large castings and forgings or fine balances and close tolerances, equipment requiring high pressure, and devices for precision measuring and testing. Importations of equipment to produce alloy metals, metallurgical rolling equipment, complex petroleum refining equipment, and specialized chemical equipment will be necessary in order to achieve increases in the production of such priority commodities as chemical fertilizer, special steels, and petroleum products. Equipment of this type already is being sought and purchased in the Free World.

226. Although the production of most transportation equipment is well below peak levels attained in 1958-60, the Chinese have built small quantities of steam locomotives, freight cars, trucks, piston aircraft (the Colt An-2), and ships of over 10,000 tons. The Chinese have not yet produced satisfactory diesel or electric locomotives; because of low priority, inadequate production facilities, and shortages of some materials, diesel locomotives are unlikely to be produced in significant numbers by 1970. In the past year or so, truck production has been resumed and is showing steady gains. The Chinese still cannot produce the modern aircraft required for long-distance commercial flights and have imported Viscounts from the UK and IL-18s from the USSR. Further imports will probably be required by 1970, especially for international flight operations. Merchant ship production also has been resumed recently, though the Chinese probably still import some of the more complicated components for these ships. (b)(1)

227. The Chinese, with Soviet Bloc assistance, have established a well-equipped production base for electronic components and end-items. The industry, comprising more than 70 plants and capa-

ble of employing about some 200,000 persons, features the production of military equipment. Civilian production is limited to priority requirements of industry and government, such as communications equipment needed to spread propaganda to the populace and overseas.

228. d. MILITARY MACHINERY AND EQUIPMENT—*General*—The level of technology in Chinese plants producing military hardware has been raised only slightly since 1960. Progress has been confined largely to development and production facilities in the nuclear and missile fields. The present state of military production technology is as follows:

i. Continuation of a basic orientation toward the production of ground armaments.

ii. A lack of mass-production-type technology and little use of automation.

iii. An incompleted aircraft industry lacking some key units of production equipment and possessing only a small production and technical capability for advanced aircraft.

iv. A very small capability for the production of high-precision components for the control and instrumentation of advanced military systems.

v. A shortage of designers and production engineers competent to set up serial production of components for new weapons systems.

vi. A naval shipbuilding industry with a capability for a small annual output of attack submarines, destroyers, and patrol craft but lacking adequate capability for serial production of some key components and lacking ability to design indigenous production models.

229. *Advanced Weapons*—Growing access to Free World production equipment and technology, as well as domestic programs in scientific and engineering education, may permit by 1970 the improvement of military production technology on a broader base; but energies still will be strongly oriented toward the development of advanced weaponry and toward the production of advanced weapons on a small serial basis. By 1970, China will have only a small capability to produce relatively advanced weapons, assuming that it has access to foreign equipment and technology without any marked improvement. Imports of precision machine tools from such countries as Czechoslovakia and Switzerland have increased since 1960, and Japan is likely to become a more important supplier than in the past.

230. Present Chinese production technology is capable of providing missile components in the small quantities required to support present research and development programs for ballistic missiles of medium range. However, there are estimated deficiencies in the capability to support production of certain elements of missile systems. The Chinese probably will attain a limited production capability for an MRBM system by 1967 or 1968. The Chinese may be producing some kind of SAM, either replacements for the SA-2 or prototypes of a native Chinese version, or both. The evidence is not sufficient to permit a firm judgment, but it is considered highly unlikely that either version is being produced on a substantial scale. It may be 2 or 3 years before larger scale production is within their capability. Foreign technical assistance may be a primary factor in future development of the Chinese missile programs, depending on the types of missiles selected for production and the scale of the planned deployment efforts. The availability of Free World scientific and technical literature [redacted] have aided China's SAM development. (b)(1)

(b)(1)

[redacted]

[redacted] An added indicator is the recent identification of a new, large, experimental ship model testing basin near Wu-hsi, which is nearing completion.

233. The Chinese have been faced with two major problems in shipbuilding: (i) the need to establish production facilities capable of supplying the full range of marine components, and (ii) the design and manufacture of complex modern components that require advanced theoretical concepts and/or manufacturing techniques, particularly for naval ship construction. The Chinese now are dependent on foreign sources for some advanced equipment and for designs and will continue to be so through 1970. However, we anticipate that increasing numbers of ships will be completed annually, probably having increased complexity. The Chinese have produced destroyer escorts, torpedo boats, minesweepers, submarines, submarine chasers, and various types of small craft. The recent appearance of a *Komar*-class and an *Osa*-class guided missile patrol boat suggests the possibility of their serial production before 1970. Production of these boats, however, is dependent on the Chinese development of their missile systems. It is unlikely that the Chinese will produce their own native version of either a modern major warship or modern submarine in the period of the estimate.

234. *Aircraft*—[redacted] The Chinese had produced the Fresco (MiG-17) jet fighter, the Colt (AN-2) piston transport, and the Hound (Mi-4) helicopter and were preparing for production of the Badger (Tu-16) medium bomber and the Farmer (MiG-19) twin-jet fighter. Since 1960, the only production has been a small number of Colts (the small number of Fishbeds (MiG-21) are not considered to have been of Chinese fabrication). The specific causes of the collapse of the Chinese aircraft industry in 1960 have never been identified but probably include inability to produce certain components, dependence on Soviet technical advice or blueprints that were removed in 1960, and inability to maintain standards and tolerances in manufacture.

235. Activity at aircraft plants in late 1964 and early 1965 suggests that the production of some of the advanced craft may soon start, including probably the Farmer and possibly the Fishbed. Shortages of special metals and of technological skills may continue to limit the production of aircraft, although some gaps can be filled by imports from the Free World. The production of native models is not likely to reach significant proportions by 1970 because of backwardness in design, research, and production.

236. *Land Armaments*—China has more than 60 arsenals for the production of land armaments. This includes plants of pre-1949 vintage, some of which have been expanded and re-equipped, and newer ones built with Soviet aid. About seven plants appear to be related to armored vehicle production, including a Soviet-aid plant at Pao-tou that has produced the T-54 tank. Activity at the arsenals was at a modest level during 1960-63, because of general shortages of raw materials, the general economic dislocation, and the lack of skilled personnel to replace the Soviet advisors and technicians withdrawn in mid-1960. Some of the plants that were built in the late 1950's may not have been fully equipped with production machinery and ancillary equipment before the Soviet withdrawal.

237. China probably can supply small arms and small-caliber crew weapons in sufficient quantities to meet the requirements of the ground forces through the 1970 period. Present facilities probably could not meet all requirements for large-caliber weapons, tanks, armored cars, and other vehicles by 1970, but modernization and re-equipping of the ground forces is not urgently required barring full-scale war.

4. Light Industry

238. Most light industrial plants in China are characterized by techniques that are within Chinese capabilities. China's textile, food processing, and paper plants are operating below capacity at present, largely because of insufficient raw materials.

Little, if any, plant expansion will be required by 1970. No serious technological problems should be encountered in the use of manmade fibers in the textile industry because the Chinese can produce most of the needed textile equipment themselves and can use the under-utilized cotton textile mills to process cotton mixtures. Through 1970 some food processing, paper, and woolen plants may be imported in order to modernize production techniques.

5. Services

239. a. CONSTRUCTION—Measured by Western standards, the technical level of the construction industry of China is extremely backward and will remain so through 1970. However, advanced technology is not needed to get most of the jobs done. The Chinese construction effort relies heavily on labor-power instead of machine-power and on conventional construction materials instead of the newer types developed in the West. As a result, Chinese projects usually require long periods to complete and are often crude in appearance, but the functional nature of Chinese projects is not greatly impaired by these drawbacks. Despite the labor-intensive methods followed by the Chinese, they do use some construction machinery. Before 1961, much of the heavier construction machinery was obtained from the USSR and the European Satellites. Although the Chinese claim to produce most of their construction machinery themselves, they still must import selective lines of heavy construction machinery, such as bulldozers, motorized graders, and scrapers.

240. b. TRANSPORTATION—The technical level of transportation in China is very backward by Western standards. The Chinese still depend almost entirely on steam locomotion for railroads. Signaling, communications, and automation of railroad operations lag far behind similar activities in the United States and even the USSR. The freight car inventory of about 129,000 units at the beginning of 1964 is fairly modern, though some of the more common improvements found in the West, such as shock control devices, are rare in China. The Chinese themselves state that, of the 300,000 miles of roads in China, 44 percent are in poor or bad condition, and that no noticeable reduction has been made in the number of dangerous bridges in the country. Motor vehicle repair and service facilities appear generally adequate to meet the needs of China. The civilian air transport fleet is made up largely of imported planes, and standards of maintenance are sufficient to keep most of the fleet in operation. Ground facilities and aircraft communications and control equipment appear adequate, but not much flying is done at night or in poor weather. The general level of technology in water transport of China is far below that of the United States, though loading and unloading facilities at many of the main ports have been mechanized.

241. Significant technological developments are unlikely to take place before 1970 in transport operations, though some minor improvements undoubtedly will be made. Although transport facilities are not modern by Western standards, and operations are inefficient, the transport system is generally adequate for the needs of the economy, especially when the availability of large quantities of muscle-power is taken into account.

242. c. TELECOMMUNICATIONS—In the field of telecommunications, China's objective is to join all major cities with high-capacity common-carrier systems. Immediate plans call for multiplexing the existing landlines and for supplementing them with microwave radio-relay and scatter facilities. To fulfill these plans, the Chinese will continue to import more multichannel carrier and radio-relay equipment, particularly from Western countries. Domestic production of this equipment will also be stepped up.

243. An increase in the use of the radioprinter, with some new uses of radiofacsimile and radiotelephone have been observed on civil links since 1959. The domestic manufacture of these equipments, which has frequently been mentioned in the Chinese press, has been confirmed.

244. High-frequency communications will continue to be used. By the end of 1970, China is expected to have a more modern, nationwide common-carrier network by using integrated multiplex wire and cable circuits, line-of-sight circuits, and possibly scatter circuits.

C. MILITARY TECHNOLOGY

1. Guided Missiles [redacted]

[redacted]

246. Although interest in space projects has been noted in the Chinese press [redacted] no evidence is available that may indicate that China has a major space program under way. The Chinese could have a capability to orbit a small satellite eventually, using its MRBM when it is finally developed along with relatively simple upper stages. Also, if the Chinese efforts to purchase foreign missile equipment and technology are successful, a program to demonstrate a space capability could get under way any time before 1970.

247. b. MISSILES—The size and type of the research and development facilities point to the possibility of Chinese-manufactured operational surface-to-surface and surface-to-air systems in the not too distant future. In addition, China is believed to be engaged in a development program that includes air-to-surface, air-to-air, as well as cruise missiles for naval use. The largest and possibly the most important missile complex is the Shuang-ch'eng-tzu Missile Test Center. The extensive research and development complex, situated in an isolated area about 40 miles northeast of Shuang-ch'eng-tzu (41°02'N – 100°17'E), has substantial rangehead instrumentation for support of both SSM and SAM launch complexes. [redacted]

[redacted]

[redacted]

249. The Ch'ang-hsin-tien Missile Test Center, a research and development complex located approximately 12 miles southwest of Peiping, is designed in part to static testfire large liquid engines of indeterminable size. Three vertical test stands are available. Also, a horizontal test stand is being used at the present.

[redacted]

251. The center apparently was designed to conduct research and to develop and fabricate missiles and missile ground support prototype equipment for surface-to-surface missiles. The stands at this facility are credited with the capability of testing missiles of at least MRBM size, and the industrial buildings are believed capable of fabricating R&D missiles and of limited series production.

252. The cruise launch sites at the Lien-shan (40°42'N – 120°52'E) complex are close to a naval airfield, naval air school, and a shipyard. This proximity and type of sites point to the complex as being a candidate for a naval missile training facility, as well as a naval research and development facility for cruise-type shore defense SSM's.

253. The facilities at Tai-yüan (37°59'N – 112°33'E) are believed to consist of an SA-2 type of solid-propellant booster test stand and a missile solid-propellant production plant.

[redacted]

[redacted] (b)(1)

[redacted] the missile could be an adaptation of the Soviet SS-3 or Soviet SS-4. The payloads and ranges for those systems are:

SS-3	2,800±300 lbs	603 nm
SS-4	3,200±500 lbs	1,020 nm

However, because of the length of the test range, the collaterally reported MRBM range of the Chinese missile, Chinese military requirements in the Far East, and the size of the Chinese launch pad at SCTMTC, we believe that the Chinese missile being developed is probably an adaptation of the SS-4.

[redacted]

[redacted] (b)(1)

260. 2. *Surface-to-Surface Missile Systems (Tactical, Land-Based)*—China is believed to have received some Soviet 150-mile range missile systems prior to mid-1960. Vehicular mounted missiles possibly were fired to compatible ranges at SCTMTC during the first half of 1960. [redacted] (b)(1)

[redacted] (b)(1) (b)(1)

261. 3. *Surface-to-Surface Missile Systems (Naval)*—The submarine detected on 7 November 1964 at Dairen is similar in outward appearance to the Soviet G-class submarines capable of launching the SS-N-4 missile when surfaced. Initial construction more than likely began about mid-1962 in the Dairen shipyard, and the vessel probably was launched [redacted] (b)(1)

(b)(1)
(b)(3)

[redacted]

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262. The fact the Chinese have launched this submarine indicates that they probably have a program to place a missile system on board; however, there is no intelligence information regarding the missile system. Since the Soviet G-class submarines were designed specifically for launching the SS-N-4 missile, we estimate that the SS-N-4-type missile will be the immediate goal of the Chinese, though we cannot predict the time frame for this accomplishment. The Soviets may have provided SS-N-4 missile hardware and components and/or plans for the G-class submarine.

263. In the area of guided missile patrol boats, the presence of at least one *Osa*-class PTFG and one *Komar*-class PTG in China has been detected. The Chinese have the capability of modifying the P-6 motor torpedo boat, of which they have a significant number, to the missile-firing *Komar* configuration. They also are considered capable of constructing the *Osa*-type, which is built from the keel up as a guided missile craft. The Soviet SS-N-2 is an aerodynamic vehicle fired from launch tubes or ramps fitted on the *Komar/Osa*-class missile patrol boats. The SS-N-2's may have been delivered with the *Komar/Osa*'s by the Soviets, as in the case of Indonesia, the UAR, and other nations which have received these systems from the USSR. If the P-6 motor torpedo boats are being converted by the Chinese, initiation of SS-N-2 production by Chinese aircraft plants is a distinct possibility.

264. In regard to coastal defense missiles, China was apparently supplied by the USSR with limited numbers of the coastal defense variant of Kennel at least as early as 1959. The Chinese established a test range and/or training center for this missile at Lien-shan in the Gulf at Liaotung, and this complex is believed to be still active. [redacted] Although the site near Dairen has been in existence since at least 1962, no vehicles or missile-related equipment have been observed in the area. [redacted] (b)(1)

267. 4. *Surface-to-Air Missiles*—The Chinese were apparently supplied by the Soviets with a small number [redacted] of complete SA-2 sets of six launchers each. SA-2 sites were identified as early as 1959, and [redacted] SAM sites have been observed to date. Some of these sites were never equipped, and in several cases equipment has been moved from one site to another. The Chinese appear to be purposely moving the few sites of SAM equipment in their possession from one place to another in an effort to surprise and destroy U-2 reconnaissance aircraft. In this manner they hope to maintain a deterrent against these flights. [redacted] (b)(1)

[redacted]

2. Aircraft Research and Development

[redacted]

(b)(1)

[redacted]

276. The Chinese initial efforts may be to produce modest-sized engines capable of operating in the subsonic regime. With some outside aid or further experience in providing and fabricating high-temperature materials, the Chinese could develop supersonic engines.

277. Although the Chinese have a very low capability in the field of reciprocating aero-engine design, they are able to build Soviet-designed engines from Chinese-manufactured components. [redacted] (b)(1)

278. The Chinese have a capability for producing light and medium types of aircraft from designs, piston engines, and other components supplied by foreign manufacturers, in many instances by the Soviets, but the withdrawal of much of the Soviet support has greatly reduced this production. As yet, China has not produced gas-turbine engines. [redacted] (b)(1)

(b)(1)

[redacted]

(b)(1)

[redacted] (b)(3)

[redacted]

(b)(1)
(b)(3)

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279. The Chinese, however, are continuing to increase aircraft and engine factory floorspace. [redacted] (b)(1)

280. The Chinese have demonstrated a very limited aircraft design capability. In 1958, they introduced 13 "Chinese copies" of the Soviet Colt and copies of foreign designs of light utility and transport aircraft. This capability is also supported by the Chinese ability to set up production lines to assemble Soviet aircraft, an ability which entails the development of at least a partial design capability, even if complete blueprints are supplied [redacted]

281. China probably can continue to acquire necessary air transports from the USSR. With sufficient priority and some foreign help on the engines, it could possibly produce a prototype within 2 or 3 years. However, there is a more urgent need to build a capability in the military combat field. Western military aircraft are not available to the Chinese, and the Soviets, although supporting some production and supplying of aircraft, have discontinued or at least have reduced spare-part support for aircraft in service and have withheld support essential to the success of the Chinese Badger program.

282. China is believed to be capable of reproducing the Fishbed by 1965-66 and the Badger by 1968. However, the Chinese probably do not have the native capability to design and build a militarily significant aircraft until the 1970's. This is based on the normal time scale for developing aerodynamic systems and the problems of developing materials for use in modern military aircraft. (b)(1)

3. Ground Weapons and Equipment

283. a. GENERAL—China has conducted practically no research and development work on conventional ground force combat materiel and has been content to import and to adapt types and models of proven capability. Developmental work has been restricted to modifying existing designs (generally of Soviet origin) to meet local requirements. A desire has been indicated by the Chinese to institute a long-range conventional armaments research and development program. As yet, however, no concrete evidence is available of the program's implementation nor of any details on its exact scope. It is believed, therefore, that the technological level of China's research and development of conventional ground force combat materiel will not have advanced significantly by 1970.

284. b. INFANTRY WEAPONS—During the time frame of this assessment, China will continue to manufacture Soviet-type infantry weapons on which data and tooling were provided by the USSR prior to the 1960 break between the two countries. (b)(1) China will increase her technical intelligence collection efforts against the USSR and other producers of modern infantry weapons as a start toward the development of an in-house capability to design her own infantry weapons. The development of such a capability, however, is not expected to receive a high priority, and China will not gain a worthwhile native capability to design and develop modern infantry weapons by 1970.

285. c. ANTIAIRCRAFT ARTILLERY—Antiaircraft artillery units of the Chinese armed forces employ Soviet-designed 37mm, 57mm, 85mm, and 100mm guns to support the Air Defense Organization. All of these weapons have proven effective against slow flying aircraft within the limits of their range capabilities. The 37mm gun, M1939, is a towed weapon which has no radar or remote control equipment. The gun, capable of firing 80 rounds per minute, utilizes optical sights and has a maximum effective AA range up to 4,500 feet. The towed 57mm AA gun, S-60, utilizes both on-carriage (optical) and off-carriage (radar/director) fire control equipment. This gun, which is the most recently developed Soviet AA gun, has a sus-

tained rate of fire of 60 rounds per minute and has a maximum effective AA range of about 13,120 feet. The 85mm weapon, of World War II vintage, and the 100mm AA gun, designed in 1949, utilize off-carriage fire control equipment. The maximum effective AA range of these weapons is 27,500 feet and 39,000 feet respectively. Although research, development, and deployment of surface-to-air missiles is increasing, conventional tube artillery is expected to continue to be used in an AA role by the Chinese during the period of this forecast. No newly designed antiaircraft guns are expected to appear in China's inventory for the next 5 years.

286. d. FIELD ARTILLERY WEAPONS—The Chinese People's Liberation Army is equipped with proven weapons which are characterized by simplicity of design, operation, ruggedness, and field maintainability. The loss of Soviet technical support is expected to have long-range effects on a weapons modernization program. In the past, the Chinese have relied almost entirely on foreign designs while neglecting to develop a research and development capability necessary for continued progress. The Chinese are believed to have recognized this problem; though there is little indication that a vigorous research and development program for improved artillery weapons exists at the present time.

287. During this forecast period, Chinese artillery units probably will continue to be equipped with the foreign-designed weapons currently in their inventory. The artillery rocket launchers of 132mm and 140mm probably will be supplemented by a Chinese version of the Soviet-designed 240mm launcher. Current indications of the extensive research and development effort in the field of rockets should aid the Chinese to establish a design capacity applicable to field artillery-type launchers. A single-round, truck-mounted rocket launcher of the FROG (free flight rocket over ground) type may appear as a prototype, or in limited quantities, thus providing the Chinese with a 10- to 30-mile range weapon having a CW, HE, or eventually a nuclear delivery capability.

288. e. COMBAT VEHICLES—Past efforts on the part of China to develop and produce tanks, armored personnel carriers, and assault guns have been practically negligible. This is evidenced by the current Chinese inventory of armored combat vehicles of Soviet origin, the majority of which are of World War II vintage. China possesses a capability for manufacturing in limited quantities the Soviet T-54 medium tank and also an artillery prime mover based on an old Soviet design. During the forecast period, the Chinese are not expected to develop any significant combat vehicle of native design. Moreover, during the period, the Chinese are not expected to develop any mobility devices or methods which would significantly improve the mobility capabilities of current tanks, armored support weapons, armored personnel carriers and transporters or special purpose armored vehicles.

4. Naval Weapons Systems

289. PRESENT R & D CAPABILITIES AND TRENDS—At present, the Chinese possess a minor capability in the design and development of warships and their associated propulsion plants. This capability is based on experience gained as a result of Soviet technical assistance which began about 1954 under an agreement with the USSR to furnish technical help and prefabricated components of naval vessels. The Soviets furnished the Chinese with detailed information, such as the working drawings of ships under construction, with technical advisors from the Soviet shipbuilding industry who aided the Chinese in solving design and construction problems, and with material aid in the form of prefabricated sections for warships under construction. This Soviet aid was furnished to the Chinese in the construction of several classes of warships, namely the W-class submarine, the *Riga*-class destroyer escort, the *Kronstadt*-class submarine chaser, and possibly to some degree the recently constructed G-class ballistic missile submarine.

290. Concurrently with the start of the Soviet aid program, a department of shipbuilding was instituted at Chia-tung University, Shanghai, and a serious effort was initiated to build research facilities and to train technical personnel. This organization [redacted] and is expected (b)(1) to strengthen the Chinese research and development capability as it begins to turn out technically educated and qualified personnel. As a result of past Soviet technical assistance, the ship design personnel have acquired a limited native design capability.

[redacted] (b)(3)

[redacted]

(b)(3)

Figure 19

48067

Chinese-manufactured 75mm recoilless rifle

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291. The two organizations that are associated with all aspects of Chinese ship research, design, and construction are the Scientific Research Institute for Shipbuilding, which operates a relatively small model basin at Shanghai, and the Central Design and Construction Office for Shipbuilding, Shanghai, both under the control of the Sixth Ministry for Machine Building.

292. In addition, the Chinese have constructed a probable model basin, 1,600 feet long at Wu-hsi, about 60 miles northwest of Shanghai. This installation should become operational sometime in the period 1965 to 1967. It should enhance China's ship designing capabilities considerably by permitting the Chinese to test fast merchant ship and warship models.

293. HULL DESIGN AND SHIP CONSTRUCTION—The Chinese, with Soviet material and technical aid, were able to build a number of *Whiskey-* and *Riga-*class destroyer escorts of Soviet design. More recently they completed construction of a *Golf-*class ballistic missile submarine and a *Romeo-*class submarine, apparently without the aid of Soviet personnel and quite possibly without Soviet materials.

294. Although the Chinese lack of sufficient number of qualified personnel for the production of significant new naval ship designs embodying original contributions, they are designing coastal and river ships of their own by the application of Soviet technical information. In all marine design work, they are making every effort to incorporate the most modern materials. [redacted]

295. The Chinese have a native design capability in small naval craft and have already designed and constructed a number of fast patrol boats of the *Shanghai-*class, which do not represent any radical advances in design. The *Shanghai-*class patrol boat probably is propelled by Soviet-designed engines, but the basic hull probably was designed and developed by the Chinese.

296. SHIP PROPULSION—China's design and development of main propulsion engines for commercial ships is difficult to distinguish from that devoted to naval ships. The Chinese have depended heavily on Soviet technical assistance in this area. Main propulsion units for *Whiskey-*class submarines and *Riga-*class destroyer escorts probably were obtained from the Soviet Union. However, it is believed that the production of commercial diesel propulsion units for small ships speeded up in 1962. [redacted] (b)(1)

[redacted] (b)(1)

297. Capabilities in submarine design and construction exist in the ability to copy or modify existing Soviet submarine designs of the *Whiskey-*, *Romeo-*, *and Golf-*class. Capability in original submarine design is unlikely by 1970. Original design and construction of midget submarines may be emphasized; a capability may already exist in this area.

298. If existing trends continue in diesel and gas turbine research and development, China likely will be able to produce medium-size diesel engines for marine use and marine gas turbines of 5,000- to 8,000-horsepower output. These engines would provide the Chinese with the hardware necessary for developing a CODAG unit to be employed in MTB- or PCE-type surface craft.

299. By 1970, China should be able to design or copy and construct any of the more sophisticated steam turbine propulsion plants presently in existence. (b)(1)

300. There presently are no known indications of Chinese research in unconventional forms of propulsion, such as fuel cells. Marine applications of this mode of propulsion by the Chinese are not likely to occur by 1970.

301. Although China is not known to be vigorously pursuing the development of hydrofoils for military applications, [redacted] (b)(1) [redacted] (b)(1) Capabilities to design and construct this type of craft for inland waters and near shore operations should be adequate by 1970.

5. Antisubmarine Warfare

302. Research and development in antisubmarine warfare (ASW) and naval weapons, if they exist at all, appear to be token efforts. The Chinese Navy cannot expect any large-scale improvements in its ASW weapons systems until such time as the country receives massive aid from an outside source.

303. Little evidence exists to show China's current activity in the design, development, or production of sonar equipment for naval use. For the most part, the Chinese probably have relied on Soviet sonars, such as the Tamir, Feniks, and Plutoniy, which are believed to have been installed aboard Chinese naval ships during the 1955 to 1960 period of Sino-Soviet collaboration. [redacted] (b)(1) (b)(1) At that time, the Chinese were not attempting to perform original research but were trying to modify the Soviet equipment to meet their own production requirements. [redacted] (b)(1) (b)(1) China is producing fishfinders and has produced a fathometer that is comparable to the Soviet NEL-4 fathometer. It may also have developed an omnidirectional sonobuoy.

6. [redacted] (b)(1)

[redacted] (b)(1)

[redacted] (b)(1)

(b)(1)
(b)(3)

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[redacted]

312. KOKO NOR COMPLEX—A major complex with some facilities that bear a resemblance to certain facilities at Soviet nuclear weapons research and development sites and at weapon production sites is under construction in north-central China near Koko Nor. [redacted]

(b)(1)

313. The Koko Nor complex is believed to be associated with the Chinese atomic energy program. [redacted]

(b)(1)

314. LOP NOR TEST SITE—The first Chinese nuclear test was conducted on 16 October 1964 at the test site located at Lop Nor (40°50′N – 89°40′E) in western China. [redacted]

(b)(1)

(b)(1)

[redacted]

7. BW/CW Activities

318. a. GENERAL—In 1956, a separate branch was created as the Antichemical Warfare Corps within the Chinese People's Liberation Army. This Corps was given the mission of training and equipping CPLA units for defense against chemical, biological, and radiological (CBR) warfare agents. The Corps was placed under the command of Major General Chang Nai-keng and subordinated to the General Rear Services Department of the Ministry of National Defense. The Ministry reserved for itself the authority to initiate the development of CBR materials. [redacted]

319. b. BIOLOGICAL WARFARE—[redacted] China has a sufficient number of competent scientists and facilities to conduct offensive BW research and development, [redacted] China possibly could produce limited quantities of BW-agent material and could develop a BW munition

(b)(1)

with suitable means of delivery by 1970. If the Chinese had taken over and continued the Japanese BW research effort in Manchuria, they now could have such a system, but we have no evidence of this.

320. [redacted], the mil (b)(1) and civilian BW defense posture is weak. Adequate respiratory protection equipment is available to first line Chinese troops but not to militia or civilians. Sufficient vaccines and antibiotics are probably available for normal military needs in China but even by 1970 probably will not be adequate for national defense against large-scale attack. Military training in BW defense follows the pattern established by the USSR; such training is given to limited numbers of officers and NCO's. BW defense is expected to remain at a generally low level through 1970.

321. Civil defense training in China is mainly devoted to educating the public in carrying out sanitary measures as defense against BW attack. Improvement of the BW civil defense could occur by 1970, probably by support from an improved public health system, but civilian protective and decontamination equipment probably still would not be available in sufficient quantity.

322. [redacted] The veterinary sciences in Ch (b)(1) include programs designed to prevent, control, and eradicate animal diseases affecting livestock. Portions of such research and development concerning serums and vaccines for prophylaxis and thera (b)(1) rigid quarantine procedures, and effective decontamination measures, could be applicable to a livestock defensive BW program. [redacted] (b)(1) Chinese plant-crop research and development program is applicable to defense against BW and (b)(1) directed toward the protection of plant life from disease and insects for the ultimate prevention of crop losses.

323. c. CHEMICAL WARFARE—The Chinese, though lacking a strong offensive CW capability, recogni (b)(1) that toxic chemical weapons are highly effective for tactical employment and have trained the individual soldier to protect himself against their effects. The CW doctrine of China is sound and

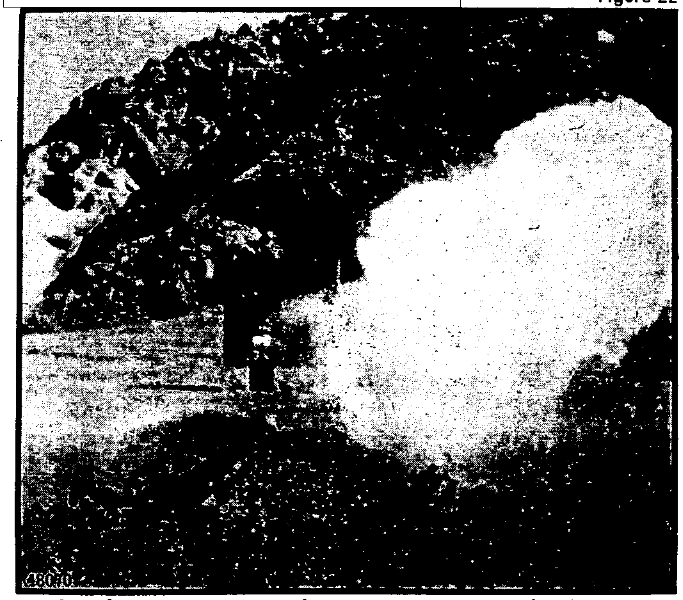
(b)(3)

Figure 21

Students at the CPLA Chemical Warfare School training with electronic equipment

Figure 22

(b)(3)



Smoke-generating demonstration at the CPLA Chemical Warfare School

Figure 23

(b)(3)

CPLA Smoke-generating equipment, possibly of Chinese manufacture, being operated by students of the CPLA Chemical Warfare School follows closely that of the USSR in regard to the role of persistent and nonpersistent agents, munitions employed for agent dissemination, and the role of all types of CW materiel in tactical operations. Defensive rather than offensive doctrine is emphasized. Much of China's CW materiel is made from Soviet designs or has been furnished by the USSR.

[redacted]

325. China's offensive CW capability is impaired by a limited production and stockpile capability in both World War I-type CW agents and the nerve agents, which could, nevertheless, pose a significant threat to poorly prepared neighboring countries. However, if Soviet logistical support were again available, the Chinese do have ground weapons and aircraft (of Soviet design) capable of disseminating massive quantities of CW agents in a large-scale offensive tactical operation. The CPLA has large stocks of smoke munitions and a well-developed tactical doctrine, which give it an excellent screening-smoke capability. Expanding stocks of flame weapons and additional emphasis on training in flame warfare techniques have given the armed forces a small but growing flame warfare capability.

[redacted]

[redacted] (b)(1)

(b)(1)

328. The lack of adequate research facilities and an adequate number of personnel experienced in CW research appears to have caused CW research and development in China to remain as a minor effort. [redacted] (b)(1) China, however, is producing a number of organophosphorus insecticides for agricultural use and is known to be carrying forward an active research program in this area at several agricultural institutions. Research and production facilities working on organophosphorus insecticides can be converted to work on CW nerve agents. The shortage of CW-experienced scientists is expected to continue at least until 1969.

329. Civil defense in China is under the Ministry of Public Security. There is little evidence of an effective civil defense program.

8. Military Electronics Technology

330. The increasing importance of China as a military power will necessitate the development of tactical communications equipments comparable to those of other countries. These equipments, however, probably will not be as sophisticated as those of the more advanced countries. Nevertheless, by 1970, the Chinese should be able to meet most of their essential electronics requirements. [redacted] (b)(1)

(b)(1)

[redacted]

331. At present, China's military electronics industry produces components for and assembles complex electronic systems similar to those employed in the Soviet air defense systems during the late 1950's. [redacted] With the decline in 1960 of the sizable amounts of electronic materials being shipped from the Soviet Union, new military needs began to be met chiefly by China's own adaptations of foreign-designed equipment.

332. Almost all of the Chinese effort that is devoted to military electronics today is concerned with adapting Western, Japanese, and Soviet Bloc devices, systems, and equipment to the manufacturing conditions of China. Work on military electronics is so intermixed with work on civilian electronics that progress in one sector is tantamount to progress in the other. [redacted]

333. RADAR—Basic radar research and development are probably conducted at various institutes and plants throughout the Chinese economy. [redacted]

(b)(1) [redacted] (b)(1) (b)(1)

334. COMMUNICATIONS—China places heavy reliance on imports from the more advanced countries for its military communication equipment, especially for the more sophisticated equipment operating above the HF band. Some of this equipment, however, is probably adapted by the Chinese.

335. The Chinese continue to express considerable interest in the use of microwave links. However, their attempts to duplicate and/or design microwave equipment have apparently not been completely successful, [redacted] (b)(1) (b)(1)

[redacted]

(b)(3)

Figure 24

CPLA Assault Troops training with Soviet-type LPO flame thrower

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[redacted] (b)(3)

Figure 25

CPLA Engineer Troops using Soviet-type ROKS flame thrower

[redacted]

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[redacted]

336. The present Chinese research and development emphasis apparently is on creating simple radio equipments of original native design while copying either wholly or in part the more complicated sets of foreign design. This trend is expected to continue through 1970. Possibly between 1965 and 1970, transistorized radio equipment will be introduced into ground forces materiel. Basic designs, however, will remain the same. Chinese research and development capabilities to design wholly native equipments, which have more advanced features, such as burst transmission or scatter, will not be realized by 1970, unless China receives substantial outside assistance.

337. ELECTRONIC COUNTERMEASURES—The Chinese rely heavily on passive detection in support of military needs. [redacted] They have frequently used chaff and are expected to continue using it. They may develop it for use against S-, X-, and L-ba[redacted] (b)(1) radar. [redacted] (b)(1)

338. COMPUTERS—[redacted] Some [redacted] (b)(1) the recent Chinese analog units are technically comparable to early versions of Soviet and Western missile control computers, and it is believed that a continued research and development effort through 1970 will enable the Chinese to re-design and manufacture Soviet models of fire control and missile guidance computers. (See section on Mathematics and Computer Technology, page 24.)

339. INFRARED DEVICES—The Chinese have displayed an awareness (in published articles) of the potential applications of infrared radiation to ground weapons. In 1957, they exhibited a naval type of infrared direction finder that may have been obtained from the Soviet Bloc. While (based on the above) they show some present capability to develop infrared devices, they do not show any apparent trend to apply infrared principles to ground forces weapons. The Chinese have obtained a Sidewinder in good condition for dup[redacted] (b)(1) cating purposes. They may have developed an infrared seeker of the type used in the Sidewinder or AA-2 (Atoll) air-to-air missile and may be producing such a weapon system in limited quantity.

Communist China:

(b)(1)
(b)(3)

(b)(3)

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