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NIE 13-2-60
13 December 1960

NATIONAL INTELLIGENCE ESTIMATE
NUMBER 13-2-60

THE CHINESE COMMUNIST ATOMIC ENERGY PROGRAM

THIS DOCUMENT CONTAINS CODE WORD MATERIAL

Submitted by the

DIRECTOR OF CENTRAL INTELLIGENCE

The following intelligence organizations participated in the preparation of this estimate: The Central Intelligence Agency, the National Security Agency, and the intelligence organizations of the Departments of State, the Army, the Navy, the Air Force, The Joint Staff, Defense, and the Atomic Energy Commission.

Concurred in by the

UNITED STATES INTELLIGENCE BOARD

on 13 December 1960. Concurring were The Director of Intelligence and Research, Department of State; the Assistant Chief of Staff for Intelligence, Department of the Army; the Assistant Chief of Naval Operations for Intelligence, Department of the Navy; the Assistant Chief of Staff, Intelligence, USAF; the Director for Intelligence, The Joint Staff; the Assistant to the Secretary of Defense, Special Operations; the Atomic Energy Commission Representative to the USIB; and the Director of the National Security Agency. The Assistant Director, Federal Bureau of Investigation, abstained, the subject being outside the jurisdiction of his Agency.

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NATIONAL INTELLIGENCE ESTIMATE

THE CHINESE COMMUNIST ATOMIC ENERGY PROGRAM

NIE 13-2-60

13 DECEMBER 1960

This estimate was prepared and agreed upon by the Joint Atomic Energy Intelligence Committee, which is composed of representatives of the Departments of State, Defense, Army, Navy, Air Force, the Atomic Energy Commission, The Joint Staff, the National Security Agency, and the Central Intelligence Agency. See appropriate footnotes, however, for dissenting views. The FBI abstained, the subject being outside of its jurisdiction.

The estimate, with footnotes, was approved by the United States Intelligence Board on 13 December 1960.

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THE PROBLEM

To determine the current status and the probable future course of the Chinese Communist atomic energy program to mid-1965.

SUMMARY AND CONCLUSIONS

GENERAL

1. Communist China is energetically developing her native capabilities in the field of atomic energy. Since the early 1950's she has been making a concerted effort to develop the corps of scientists and technicians and establish the research facilities essential to the exploitation of nuclear energy. The over-all effort has progressed steadily since 1955 with the benefit of a substantial amount of Soviet aid. This assistance has been obtained by the Chinese Communists via negotiated, formal arrangements under which they apparently have maintained a considerable degree of autonomy. However, we believe that the Soviets have provided this aid at a deliberate pace, hoping to postpone the attainment of a native Chinese nuclear weapons capability as long as possible.

ORGANIZATION

2. Control of the Chinese Communist military atomic energy program and direction of much of the total atomic energy program is currently vested in the Second Ministry of Machine Building (SMMB), which was established in February 1958. This ministry is probably patterned after its Soviet counterpart, the Ministry of Medium Machine Building. The peaceful uses aspects of the program, covering nuclear research, training, and isotope applications, are largely under the control of the Scientific and Technological Commission of the State Council, with the Institute of Atomic Energy of the Academy of Sciences as the most prominent research establishment.

TECHNICAL CAPABILITIES

3. The Chinese Communists have acquired a small but highly competent cadre of Western-trained Chinese nuclear specialists. Their nuclear research effort has expanded rapidly since the early 1950's and more than twenty nuclear research facilities have been established at institutes and universities. In addition to the Soviet-supplied research reactor and cyclotron, there are a variety of cyclotrons and other accelerators, most of which are of Chinese manufacture. The Chinese have access, through the Joint Institute for Nuclear Research, to the large Soviet accelerators at Dubna. China's share of the financial costs of the institute is 20 percent, a share exceeded only by that of the Soviet Union. We believe that the widespread Chinese training and research effort is coordinated to the needs of the military atomic energy program. The Chinese Communists are now capable of comprehending and exploiting the large body of open scientific literature in the nuclear sciences. However, the present shortage of

trained scientists and engineers will probably persist throughout the period of this estimate. This shortage would hamper Chinese efforts to design, construct, and operate facilities for the production of fissionable materials and would be particularly serious, should the Soviets decide to reduce or terminate their technical aid.

URANIUM ORE PRODUCTION

4. During the period 1950–1954 the Chinese Communists, with some Soviet aid, explored a number of areas for uranium resources. In 1955 this quest for uranium, as well as the supporting Soviet aid, was intensified. [redacted] Soviet ore concentration plant designs developed for the Chinese in 1957 were probably intended for the exploitation of these southern deposits and expansion of Sinkiang operations.

5. Although we have no information on the actual grades of the ore, we estimate that Communist China is currently producing ore equivalent to about 500 tons of recoverable uranium metal per year (see Table 3, page 16), and by 1963 will be capable of producing more than a thousand tons per year. We have no evidence that any Chinese Communist uranium ore has been supplied to the USSR, and believe that it has all been retained for domestic use.

URANIUM METAL

6. [redacted] evidence that a uranium metal facility was constructed during the 1957–1960 period. [redacted] Accordingly, we estimate that a Chinese uranium metal plant came into operation in late 1960.[1]

FISSIONABLE MATERIALS

7. Chinese development of uranium resources and the construction of ore concentration and uranium metal plants certainly imply an intended use for the uranium in plutonium production. Although uranium metal is not required for U–235 production, the first stages of the process could also supply feed for U–235 separation. Planning and design of fissionable materials production facilities could have been in progress in China as early as 1957.

8. We estimate that a first Chinese production reactor could attain criticality in late 1961, and the first plutonium might become available late in 1962.[1] Since there is no conclusive evidence for the date of the uranium plant startup, and since the construction of reactor and chemical separation facilities has not been directly established, the actual start of plutonium production could be a year earlier or several years later.

9. It is possible that a U–235 plant is now under construction. Considering the magnitude of the developmental work and industrial support required for the construction of a gaseous diffusion plant, however, it is improbable that the Chinese could produce highly enriched U–235 earlier than late 1962.[1]

[1] The Assistant Chief of Staff, Intelligence, Department of the Air Force, disagrees with the uranium metal and fissionable materials production schedule in paragraphs 6, 8 and 9. An alternative interpretation [redacted] is that a plutonium separation plant came into operation in late 1960. See his footnote to paragraph 10, page 3.

NUCLEAR WEAPONS

10. On the basis of all available evidence, we now believe that the most probable date at which the Chinese Communists could detonate a first nuclear device is sometime in 1963, though it might be as late as 1964, or as early as 1962, depending upon the actual degree of Soviet assistance.[2, 3] If the Soviets provide fissionable materials, and assist in the design and fabrication of a nuclear device, the Chinese could produce a nuclear detonation in China at almost anytime in the immediate future. On the other hand, if there were a lessening of Soviet assistance in the nuclear field as a result of current Sino-Soviet dissensions, progress would be substantially retarded.

11. While the explosion of a nuclear device would give the Chinese Communists political and propaganda rewards, they would almost certainly proceed to create an operational nuclear capability as quickly as feasible. However, at least two years would probably be required after the explosion of a nuclear device to produce a small number of elementary weapons.

[2] The Assistant Chief of Staff, Intelligence, Department of the Air Force believes that the Chinese will probably detonate their first nuclear device in 1962, and possibly as early as late 1961. The great political, psychological, and military advantages to be gained are such that the Chinese would accord top national priority to the development of a nuclear weapons program. He interprets the available evidence on the production schedule of uranium metal and fissionable material to indicate that in 1959 a uranium metal plant started producing fuel elements for the production reactor which is believed to have gone critical in 1960. The first nuclear device will probably use plutonium from this reactor. Finally, he believes that after late 1961 highly enriched U-235 will be available for subsequent devices.

[3] For the view of the Assistant Chief of Naval Operations (Intelligence), Department of the Navy, see footnote 8, page 19.

NUCLEAR POWER

12. Since the Chinese nuclear program appears to be weapon-oriented, we believe that production reactors would be given precedence over reactors designed for nuclear power. Further, we do not believe that the Chinese would complicate the design of their first production reactors in an effort to extract by-product power. We estimate that the Chinese will not construct nuclear power stations in the 1960–1965 period.

SOVIET ASSISTANCE

13. Soviet assistance has been an important factor in the Chinese atomic energy program. Under an agreement for cooperation concluded in 1955, the Soviets have provided to the Chinese a research reactor, cyclotron, technical assistance and training. A Sino-Soviet Scientific and Technical Agreement for the years 1958–1962 was concluded in 1958. Other known Soviet aid has been largely concerned with uranium prospecting and the preparation of designs for uranium ore concentration and uranium metal facilities.

14. We have no firm evidence of Soviet assistance in designing or constructing fissionable materials production facilities or in supplying the materials or equipment needed for such production. [redacted]

15. There is some evidence that Soviet aid may have been curtailed. [redacted] reports that a general withdrawal of Soviet technicians from China took place in mid-1960. [redacted]

DISCUSSION

I. INTRODUCTION

16. There is ample evidence that Communist China is placing great emphasis on atomic energy in its quest for the scientific and military stature essential to a major world power. Two major related efforts are being accorded a very high priority:

a. The development of schools and laboratories required for the training of scientists and engineers and the conduct of research essential to the understanding and exploitation of the nuclear sciences;

b. The development of the scientific and industrial base which would be needed for the development and production of nuclear weapons.

17. A large body of information is available concerning the Chinese quest for trained manpower and research facilities, and how this effort is organized and controlled. Information on their military atomic energy program is quite scanty; however, their large scale exploitation of their uranium resources and statements by key Chinese Communist officials are strong evidence that they intend to develop a native nuclear weapons capability. [redacted]

II. HISTORY AND ORGANIZATION OF THE CHINESE COMMUNIST ATOMIC ENERGY PROGRAM

General

18. Control of the Chinese Communist military atomic energy program and direction of much of the total atomic energy program is currently vested in the Second Ministry of Machine Building (SMMB) (see Figure 1). This ministry is probably patterned after its Soviet counterpart, the Ministry of Medium Machine Building. The peaceful uses aspects of the program, covering nuclear research, training, and isotope applications are largely under the control of the Scientific and Technological Commission (STC) of the State Council, with the Institute of Atomic Energy (IAE) of the Academy of Sciences as the most prominent research establishment.

Military Atomic Energy Program

19. Evolvement of the organization of the military aspects of the Chinese Communist atomic energy program can be traced through several stages of development. Early in 1955, widespread activity by uranium prospecting/mining units [redacted] In [redacted] 1956, Liu Chieh, the Deputy Minister of Geology and Deputy Head of the Third Bureau, was [redacted] the one with whom Soviet atomic energy advisers in China had to deal, an indication that Liu was in over-all control of the program. In addition, Liu headed the Chinese delegation to the March 1956 conference in Moscow which resulted in the formation, by eleven Bloc countries, of the Joint Institute for Nuclear Research (JINR) at Dubna, USSR. It is evident that his atomic energy responsibilities were not limited to uranium procurement.

20. In November 1956, the Third Ministry of Machine Building (TMMB) was established under General Sung Jen-ch'iung. A third ministry had been originally established in April 1955 to handle the manufacture of machinery and electric generators, but was abolished in May 1956 when its responsibilities were taken over by the Ministry of Power Equipment Industry. The functions of the new Third Ministry were not made public, [redacted]

[redacted]

21. In April 1957, the Chinese press announced that Liu Chieh had been relieved of his duties in the Ministry of Geology and the Third Office of the State Council without mention of the reasons for his relief or of his future assignment. It is reasonable to assume that Liu assumed a comparable position with the TMMB.

22. In February 1958, the TMMB was renamed the Second Ministry of Machine Building. We do not believe that this change in name represented any real change in the nature or functions of the former TMMB. This belief is supported by an announcement in the Chinese press on 18 September 1959 that Liu Chieh was Deputy Minister of the SMMB, and on 13 September 1960 he was appointed minister.

23. Some of the elements of the present SMMB have been identified [redacted] The First and Seventh Bureaus, referred to in the Chinese Communist press in December 1957 as being under the TMMB, may have continued to function after establishment of the SMMB. A list of these elements is given in Table 1.

Organization of Nuclear Research

24. Promotion of science was an announced policy of the Chinese Communist regime after its takeover in 1949, and emphasis was accorded to nuclear studies from the outset. The new regime established the Chinese Academy of Sciences in November 1949 (with 15 to 20 institutes), by reorganizing and consolidating the various institutes and laboratories of the Chinese Nationalist's Academia Sinica and the National Academy in Peiping. The new Academy's Institute of Modern Physics (later named the Institute of Physics and then renamed the Institute of Atomic Energy in early 1957) was assigned nuclear studies as a priority mission. The Chinese have stated that the research program of this institute did not begin until 1953. In March 1954, they announced their intention of asking the Soviet Union for aid in their nuclear program, and in April 1955, an agreement was signed under which the Soviets were to supply a research reactor, cyclotron, and technical assistance and were to train Chinese specialists (see paragraph 69).

25. The nuclear research and training effort was intensified during the years 1955 to 1957. The goals of scientific and nuclear policy were clarified, local resources and capabilities were surveyed, the necessary steps were taken toward setting up a nuclear research organization, and a number of basic research projects in nuclear science and technology were launched. The nuclear energy program was given a further boost with the completion of the research reactor and cyclotron at the Institute of Atomic Energy, Peiping in mid-1958.

26. In May 1956, the State Council of the CPR established the Scientific Planning Commission, composed of high-level scientific, communist party, and military members. The commission formulated a Twelve Year Plan for Science (1956–67), wherein stress was given to research in certain broad fields of endeavor, the leading field to be atomic energy.

27. Chinese nuclear research is also being assisted by China's membership in the Joint Institute for Nuclear Research (JINR) at

Table 1
SOME ELEMENTS OF THE SECOND MINISTRY OF MACHINE BUILDING

UNIT	[redacted]	REMARKS
First Bureau	...	Per Chinese press, existed under TMMB before it was renamed SMMB
Third Bureau	December 1956 (Subordinate to Min. of Geology), October 1957 (Subordinate to TMMB), February 1958 (subordinate to SMMB)	Control of [redacted] units throughout China, engaged in uranium prospecting and mining
Sixth Bureau	16 June 1959	As supplier of atomic energy related instruments
Seventh Bureau	...	Per Chinese press, existed under TMMB before it was renamed SMMB
Twelfth Bureau	[redacted]	[redacted]
	17 July 1959	As contracting organization for the Tientsin Municipal Chemical Industry Bureau for the delivery of deep-well water pumps

[redacted]

Dubna, USSR, since 1956. China's share of the financial costs of the institute is 20 percent, a share exceeded only by that of the Soviet Union.

28. Currently, the nuclear energy research and development program is controlled and directed by two main bodies, the Scientific and Technological Commission (STC) and the Academy of Sciences (AS). (See Figure 1). The STC is the most powerful organization for controlling scientific research in Communist China. Formed in 1958 by merger of the Scientific Planning Committee and the State Technological Commission, it supervises closely the cooperation and coordination of research between the AS and other research organizations. The Academy of Sciences is the chief organization for research in Communist China (see Figure 2). Certainly, the most important nuclear research is carried out by the Academy's Institute of Atomic Energy's two locations in Peiping. We believe that the SMMB also exerts considerable influence in the area of nuclear research and training.

29. More than twenty different installations for nuclear energy research have been identified (see Annex A), and there is good reason to believe that the Chinese will continue to stress nuclear energy research through the establishment of additional facilities. A number of institutes of the AS, dealing with physics, chemistry, mathematics, geology, and electronics are known to be engaged in various aspects of the Chinese Communist atomic energy program.

III. TECHNICAL CAPABILITIES

Nuclear Research

30. The Communist Chinese have steadily advanced their nuclear research effort since the early 1950's. Principally under the IAE the

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Figure 1

ORGANIZATION OF THE CHINESE COMMUNIST ATOMIC ENERGY PROGRAM

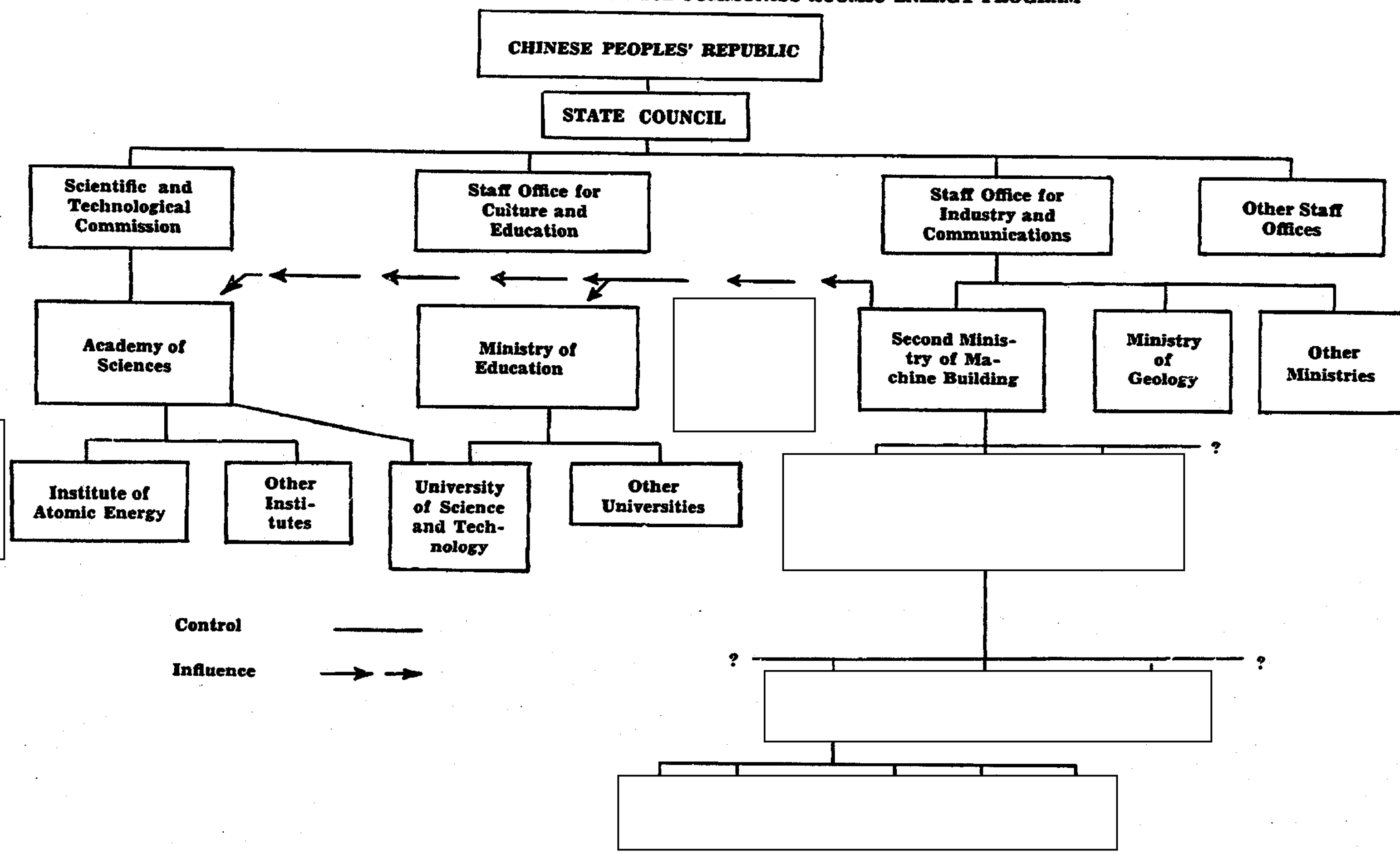

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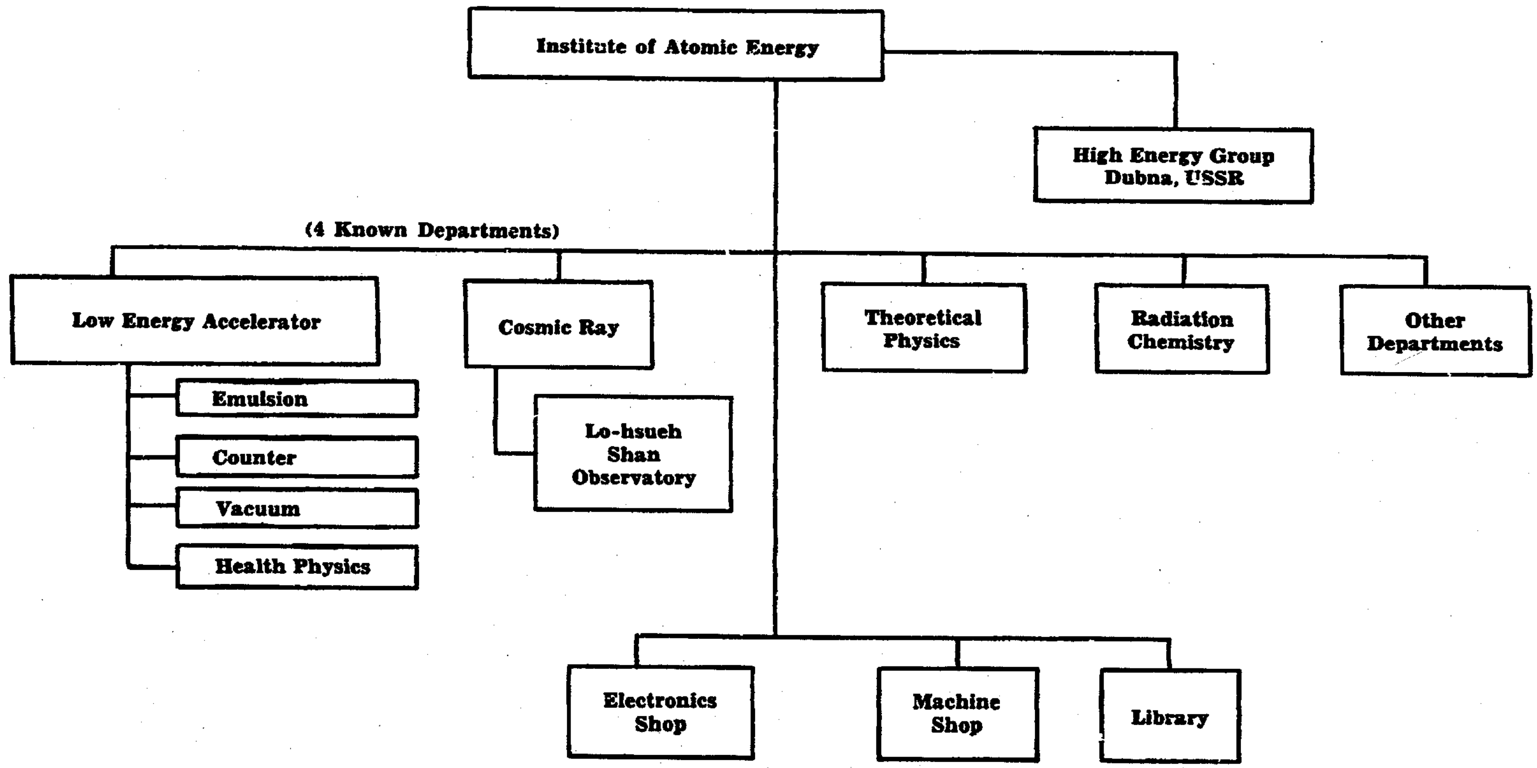
Figure 2

ORGANIZATION OF THE INSTITUTE OF ATOMIC ENERGY



Communist Chinese, with varying degrees of Soviet assistance, have established more than twenty facilities engaged in nuclear research in various parts of the country (see Figure 3). The major institute, located in the suburbs of Peiping (see Figure 4), about 20 miles southwest of the city, houses the Soviet-supplied 7.5 to 10MW research reactor and the 25 Mev cyclotron (Figures 5 and 6). The reactor uses two percent enriched uranium fuel and heavy water as moderator. It has been one of the less successful examples of Soviet assistance to the Chinese. For nearly one and one-half years after the reactor became critical in 1958 its operations were suspended because of mechanical difficulties.

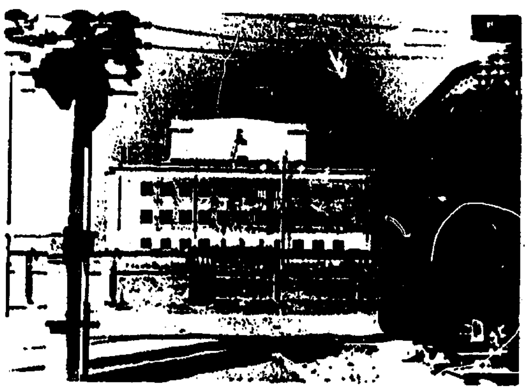


Figure 4

Research reactor and cyclotron building of the IAE, Peiping, 1958

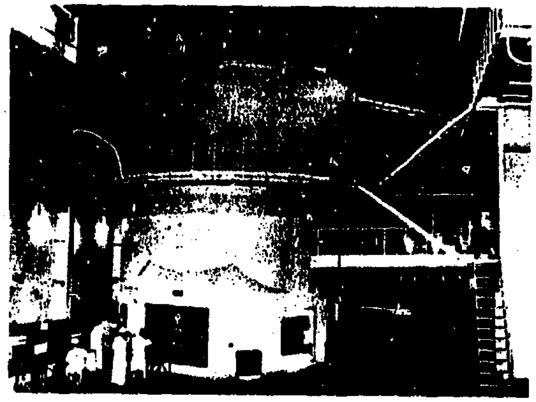


Figure 5

Research reactor at the IAE, Peiping, 1958

31. Chinese high energy physics research is carried out at the Joint Institute for Nuclear Research at Dubna, USSR. Nuclear reactions of high energy mesons and protons are studied utilizing the 10,000 Mev synchrotron and the 680 Mev synchrocyclotron, bubble chambers, emulsions, and Cherenkov counters. Wang Kan-ch'ang, leader of the Chinese scientists at Dubna, and also Deputy Director of JINR, recently has been credited as being one of the discoverers of a new nuclear particle, the anti-sigma minus hyperon.

32. Theoretical research in cosmic rays is conducted by a department of the IAE. Experimental data are gathered at the Lohsueh Shan Observatory in Yunnan Province (see

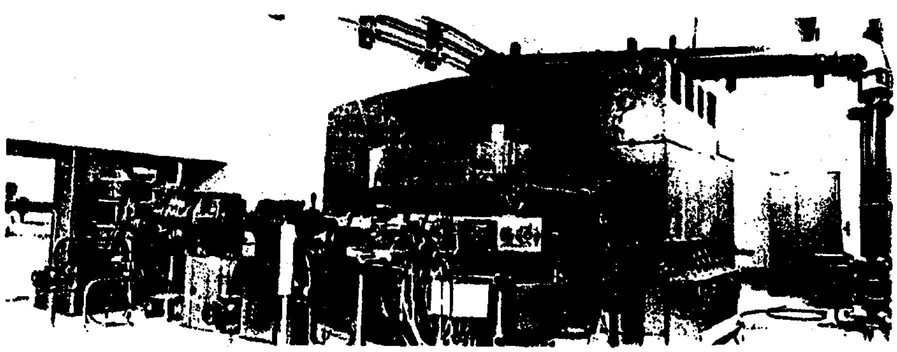


Figure 6

The IAE's 25 Mev cyclotron, Peiping, 1958

Figure 7), which is equipped with multi-plate and magnetic-field cloud chambers (see Figure 8). There are also facilities for the observation of cosmic ray strength, including a cubical-shaped meson monitor, a neutron recorder, and a large-sized, Soviet-furnished ionization chamber. Closely allied to the theoretical research in cosmic rays is the work conducted by a small group of scientists at the IAE in nuclear physics, which is similar to that conducted in a number of other countries. This includes calculations of energy levels, utilizing the shell-model concept, and studies of the inter-actions of nucleons and the characteristics of fundamental nuclear particles.

Figure 7

Lohsueh Shan Observatory for cosmic ray research, Lohsueh Shan, 1957

Research Equipment

33. Although the Communist Chinese have received large quantities of laboratory equipment from the USSR, they have been quite successful in building scientific apparatus for their research. (Major items of nuclear research equipment are listed in Table 2). They have built two accelerators at the IAE's location about eight miles northwest of Peiping, (Figure 9), which is primarily concerned with theoretical nuclear physics and low energy acceleration. These machines are a 2.5 Mev electrostatic proton accelerator and a 6.75 Mev Van de Graaff accelerator. Other native equipment includes the 1 Mev cyclotron at the Physics Department of Southwest Normal Colleg the 2 Mev cyclotron at Tientsin University, a 10 Mev induction-electron accelerator (betatron) at the Central China Engineering Institute in Wuhan, and a 5 Mev induc-

Figure 8

Multiplate equipment for cosmic ray research at Lohsueh Shan Observatory, 1957

Table 2

MAJOR ITEMS OF NUCLEAR PHYSICS RESEARCH EQUIPMENT IN COMMUNIST CHINA

Item	Location	Research Facility	Rating	Remarks
Reactor	Peiping (SW)	IAE	7.5-10 MW	Soviet Supplied
Reactor	Peiping (NW)	Tsinghua University	2 MW	
Reactor	Tientsin	Nank'ai University	3 watt	
Accelerator	Peiping (SW)	IAE	25 Mev	Soviet Supplied Cyclotron
Accelerator	Peiping (NW)	Tsinghua University	5 Mev	"Induction Electron Cyclotron"—Betatron
Accelerator	Tientsin	Tientsin University	2 Mev	Cyclotron
Accelerator	Chungking	Southwest Normal College	1 Mev	Cyclotron
Accelerator	Ch'engtu	Szechwan University	.06 Mev	
Accelerator	Peiping (NW)	IAE	2.5 Mev	Electrostatic Proton
Accelerator	Peiping (NW)	IAE	0.75 Mev	Van de Graaff
Accelerator	Peiping (NW)	Peiping University	30 Mev	"Induction Electron Cyclotron"—Betatron
Accelerator	Peiping (NW)	Peiping University	0.7 Mev	Electrostatic
Accelerator	Tientsin	Nank'ai University	2 Mev	Electrostatic
Accelerator	Canton	Chungshan University	(unknown)	Rotary
Accelerator	Hsian	Chiaotung University	1.5 Mev	Electrostatic
Accelerator	Luta (Dairen)	Institute of Petroleum AS	2 Mev	Van de Graaff
Accelerator	Wuhan	Wuhan Atomic Energy Research Institute	2 Mev	

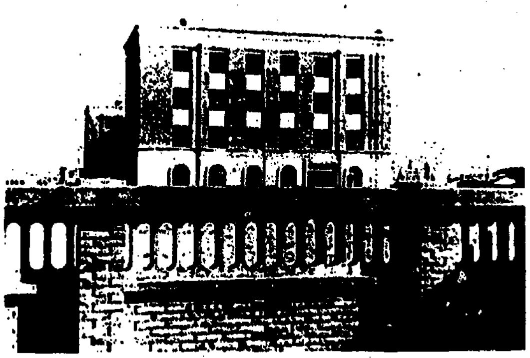


Figure 9

The IAE research establishment, Peiping, 1958

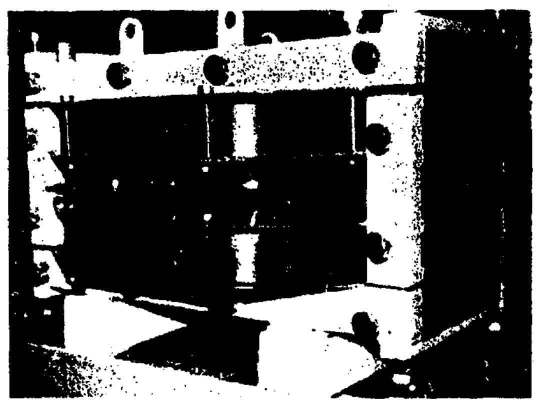


Figure 10

5 Mev betatron designed and built at Tsinghua University, Peiping, 1958

tion-electron cyclotron at Tsinghua University in Peiping (see Figure 10).

34. The Chinese have made considerable progress in establishing a broad capability to manufacture a wide range of necessary equipment for training young nuclear scientists and for supporting the nuclear research of their institutes and universities. An intensive effort has been made to provide from domestic sources a sufficient quantity of nuclear radiation detectors, high grade emulsions, scintillating crystals, photomultiplier tubes and accessory electronic equipment (see Figure 11). More recently, Chinese developments with pulse height analysers and micro-second measuring equipment might imply future work in neutron time-of-flight studies or even in nuclear weapon development. By about 1967,

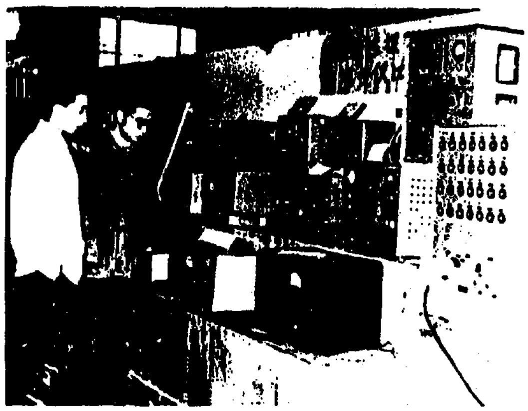


Figure 11

Examples of electronic equipment built by the Chinese, Peiping, 1958

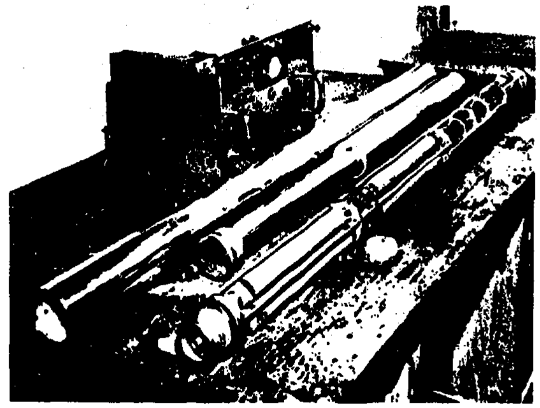


Figure 12

Chinese-produced radioactive deep-well surveying equipment

the Chinese could be as well provided with laboratory equipment for research in nuclear physics as are the larger western European countries at the present time.

Nuclear Chemistry

35. Studies in nuclear chemistry are conducted in a number of institutes of the Academy of Sciences. The IAE is concerned with the production of radioactive isotopes in the Soviet-supplied reactor, and with the production of radioactive isotopes in the Soviet-supplied reactor, and with the separation of stable isotopes using the ion exchange method. The reactor reportedly has produced over 30 different radioactive isotopes, including cobalt-60, sodium-24, phosphorus-32, and calcium-45. Isotopes are being used in industry in conjunction with Chinese-produced gamma-ray instruments for detecting flaws in machinery; in geology, to detect types of rock and the geological formations of strata (Figure 12); in medicine, in radioactive cobalt apparatus for treating tumors and cancer (Figure 13); and in agriculture, to improve fertilization and cultivation of crops. Academy of Sciences institutes, other than the IAE, are conducting studies on reactor corrosion problems, uranium and thorium chemistry, and the separation of the rare-earths. In 1957, it was reported that Communist Chinese scientists had ob-

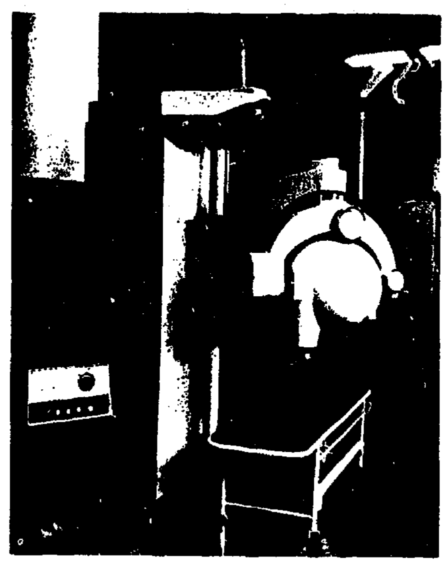


Figure 13

Radiocobalt unit for medical therapy, Shanghai, 1958

tained pure uranium and thorium on a laboratory scale.

Manpower and Training

36. When the Communists came into power in China in 1949, only about ten scientists were engaged in nuclear physics research. Since 1949, Communist China has made an intensive effort to train scientists and engineers in the

numbers necessary to support a comprehensive atomic energy program, building from a core of highly competent, Western-trained scientists. Nevertheless, the present shortage of trained scientists and engineers will probably persist throughout the period of this estimate. This shortage would hamper Chinese efforts to design, construct, and operate facilities for the production of fissionable materials and would be particularly serious should the Soviets decide to reduce or terminate their technical aid. Annex B contains a listing of leading Chinese Communist nuclear scientists, [redacted]

IV. NUCLEAR MATERIALS PRODUCTION

Uranium Ore

37. In March 1950, a Sino-Soviet Non-Ferrous and Rare Metals Stock Company was established, with headquarters at Urumchi, for the development of resources including uranium in the Sinkiang-Uighur Autonomous Region. [redacted] sources report uranium prospecting and mining activity in the area. Chinese Communist open literature indicates that the company was operated until 1954 when it was dissolved as a joint stock company. Apparently, Soviet participation in Chinese uranium problems continued under different arrangements, however, [redacted]

38. Chinese uranium prospecting and mining units, to which Soviet geologists and technicians were attached (see Section VII), [redacted] Until early 1957, these units were subordinate to the Third Bureau of the CPR Ministry of Geology; they are now subordinate to the Third Bureau of the SMMB. [redacted]

[redacted]

39. Although uranium deposits of varying size are known to exist in a number of areas throughout the CPR, very few specific mining locations are known. The Chinese are believed to be working two deposits in the Haich'eng district of Liaoning Province. [redacted]

[redacted] Nothing is known of the grade of any of the Chinese ores. However, assuming that the average grade permits economical mining operations, [redacted] Our estimate of Chinese Communist recoverable equivalent uranium metal production for the years 1952 through 1963 is presented in Table 3, below.

Table 3

ESTIMATED CHINESE COMMUNIST RECOVERABLE EQUIVALENT URANIUM METAL PRODUCTION 1952–1963
(Metric Tons)

Year	Annual	Cumulative (Rounded)
1952	40	40
1953	40	80
1954	60	140
1955	60	200
1956	80	300
1957	100	400
1958	200	600
1959	400	1,000
1960	500	1,500
1961	700	2,200
1962	1,000	3,200
1963	1,200	4,400

42. [redacted]

43. Currently [redacted] the Soviets designed and helped to construct a pilot chemical concentration plant in Peiping. [redacted] The high priority accorded this experimental installation suggests that a similar urgency was attached to the construction of the larger ore concentration plants.

URANIUM METAL

[redacted] Soviet specialists who have published on subjects related to both ore concentration and uranium metal production have been noted at the Ch'angsha Mining and Metallurgical Institute.

46. Assuming the construction time required to be two to three years, the uranium metal plant could have been completed in 1959 or 1960. [redacted]

[redacted] On this basis, we estimate that a Chinese uranium metal plant came into operation in late 1960, probably in the Ch'angsha area.[4]

Other Nuclear Materials

47. There is evidence that the Chinese produce other materials such as thorium, heavy water, graphite, etc., which have nuclear energy applications. Some of these products are now exported, but could be diverted to internal use.

48. Thorium deposits have been reported at various sites in China, but the most likely areas appear to be in the Ch'aitamu Basin in Tsinghai province; Hsinhua, in Hunan province; Hainan Island; and near Paot'ou, in Inner Mongolia. Present information does not permit an estimate of thorium production. In the past they have imported thorium, probably for non-nuclear uses, for example, the manufacture of gas mantles.

49. Chinese interest in heavy water production was indicated by an October 1959 statement by Ch'ien San-ch'iang, Director of the IAE, that an analysis of heavy water concentration in various waters had been made, and that the deuterium content of some oil field waters offered the most promise. The possibility that the Chinese may be following the Soviet practice of associating small heavy water production plants with nitrogen fertilizer producers is indicated by Chinese statements that the SMMB has supplied various types of equipment for the Szechwan Chemical Plant, a large new nitrogen fertilizer plant located near Chengtu, which began trial production in October 1959. There is evidence of atomic energy activity in the Szechwan Basin, [redacted] Thus it is possible that a small-scale heavy water production program is in progress in China.

50. Certain other raw materials, useful in an atomic energy program, have been noted in numerous shipments from China to the USSR. Notable among these are large quantities of beryllium, lithium, and fluorite ores. Molybdenum, niobium and tantalum ores have also been exported to Russia.

[redacted]

[4] For the view of the Assistant Chief of Staff, Intelligence, Department of the Air Force, see footnote 1, page 2.

53. From 1955 to 1960 the Communist Chinese attempted to obtain from foreign sources many materials required in an atomic energy program. The pure metals included uranium, thorium, beryllium, lithium, boron, and some of the less known rare earth metals.

54. The quantities desired were initially very small, sometimes amounting to only a few grams but hundreds of kilograms of metals such as beryllium, cerium, and zirconium were specified by the Chinese in international trade requirements in 1960. It may well be that the Chinese focussed their effort on production of uranium metal and could not satisfy their requirements for supplementary nuclear metals from domestic sources. The Chinese may not be able to become self-sufficient in their production of supplementary nuclear metals until the early to mid-1960's.

Fissionable Materials Production

55. Chinese development of uranium resources and of ore concentration and uranium metal facilities strongly implies an intended use for the uranium in plutonium production. Although uranium metal is not required for U-235 production, the first stages of the process could also provide feed material for U-235 production. Since provision for these uranium users would ordinarily coincide with or even precede that for the feed materials plant, planning and design of fissionable material production facilities may have been in progress in China as early as 1957.

56. *Plutonium*. We have no evidence of the planning or subsequent construction of production reactors. However, the lack of such evidence cannot be considered conclusive. [redacted] the Peiping Research Reactor, an overt project which must have required extensive correspondence with Moscow.

57. Our estimate of when the Chinese may attain a plutonium capability must be based on the estimated startup date of the Chinese uranium metal plant. Allowing a year of uranium plant operation to perfect technology and to produce enough uranium to supply a small plutonium production reactor, reactor criticality might occur in late 1961, and the first plutonium might become available late in 1962.[5] Since there is no conclusive evidence for the date of the uranium plant start-up, and since the construction of reactor and chemical separation facilities has not been directly established, the actual start of plutonium production could be a year earlier or several years later.

58. *U-235*. It is possible that a U-235 plant is now under construction. In this case, a somewhat shorter delay between feed availability and fissionable materials production could be effected. Considering the magnitude of the developmental work and industrial support required for the construction of a gaseous diffusion plant, however, it is improbable that the Chinese could produce highly enriched U-235 earlier than late 1962.[5]

V. NUCLEAR WEAPONS

59. Although we have no conclusive direct evidence of a Chinese nuclear weapons program, we believe that such a program exists and has been given priority by the Chinese. We believe that the Chinese would almost certainly consider that a demonstration of their capability to produce nuclear weapons would confirm their claim to great power status.[6] While we believe that the Chinese Communists will carry their nuclear weapons program forward as rapidly as possible, success will depend in large measure upon the degree of assistance received from the Soviets. Recent evidence strongly suggests that the USSR may have given the Chinese Communists more technical assistance leading toward the eventual production of nuclear weapons than we had previously considered likely. However, we believe that the Soviets have provided this aid at a deliberate pace, hoping to postpone the

[5] For the view of the Assistant Chief of Staff, Intelligence, Department of the Air Force, see footnote 1, page 2.

[6] For a discussion of Chinese incentives for a nuclear weapons program see NIE 100-4-60, 20 September 1960.

attainment of a native Chinese nuclear weapons capability as long as possible.

60. On the basis of all available evidence, we now believe that the most probable date at which the Chinese Communists could detonate a first nuclear device is sometime in 1963, though it might be as late as 1964, or as early as 1962, depending upon the actual degree of Soviet assistance.[7, 8] If the Soviets provide fissionable materials or assist in the design and fabrication of a nuclear device, the Chinese could produce a nuclear detonation in China at almost any time in the immediate future. On the other hand, if there were a lessening of Soviet assistance in the nuclear field as a result of current Sino-Soviet dissensions, Chinese Communist progress would be substantially retarded.

61. After the explosion of their first nuclear device, the Chinese would almost certainly proceed to create an operational nuclear capability as quickly as feasible. However, at least two years would probably be required after the first test to produce a small number of elementary weapons.

VI. NUCLEAR POWER

62. The Chinese Communists announced in 1956 that "atomic power stations would be built." However, such stations were not included in the Second Five Year Plan (1958–1962), and there is no present evidence for a power program. Since the Chinese nuclear program appears to be weapon-oriented, we believe that production reactors would be given precedence over reactors designed for nuclear power. Further, we do not believe that the Chinese would complicate the design of their first production reactors in an effort to extract by-product power. We estimate that the Chinese will not construct nuclear power stations in the 1960–1965 period.

VII. SOVIET ASSISTANCE TO THE CHINESE COMMUNIST ATOMIC ENERGY PROGRAM

63. Soviet assistance has been an important factor in the Chinese atomic energy program to date, ranging from participation in uranium prospecting and processing to the supply of a research reactor and cyclotron. This aid has been furnished under formal contractual agreements under which the Chinese Communists have apparently maintained a considerable degree of autonomy.

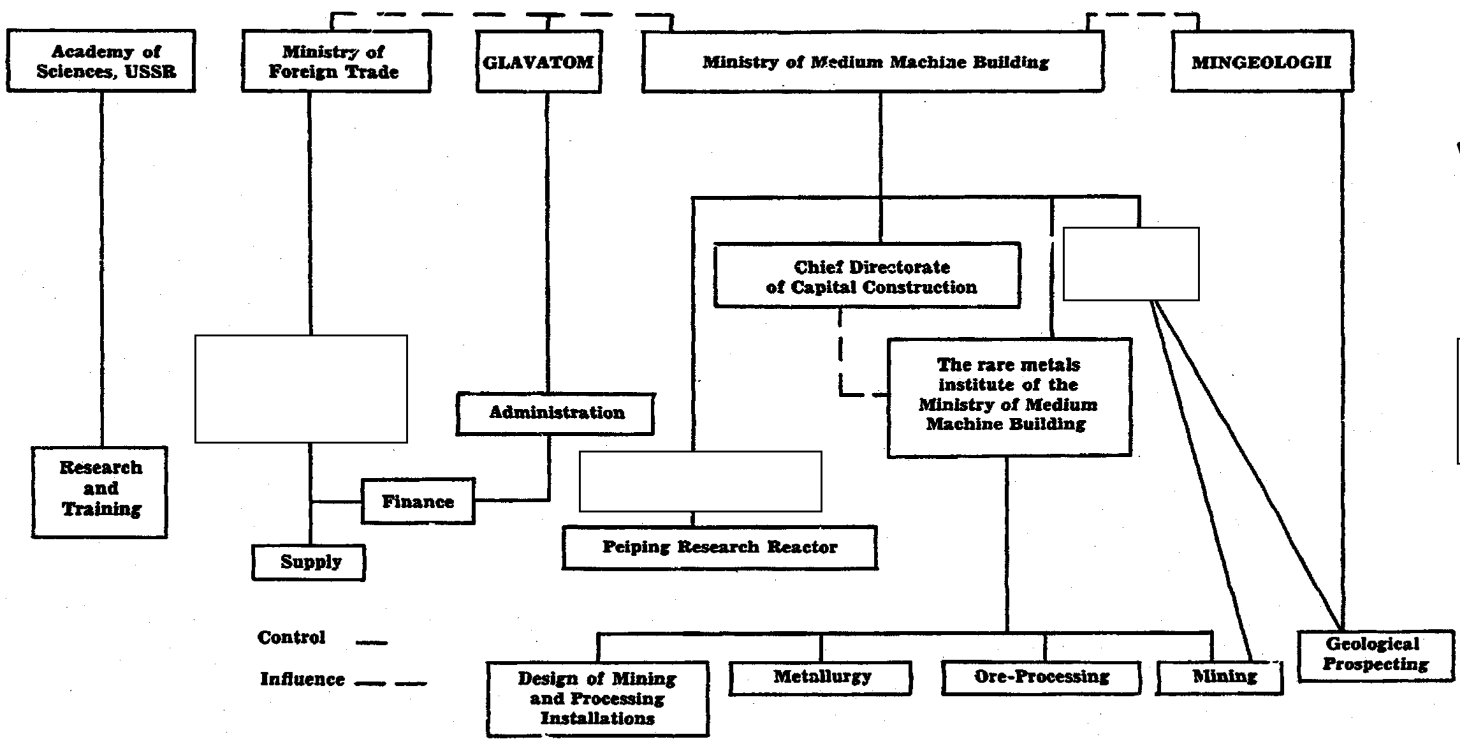
64. [redacted] a number of Soviet organizations have participated in aid to the Chinese atomic energy program, including several groups from the Ministry of Medium Machine Building (MINSREDMASH), the organization in charge of the Soviet military atomic energy program. The Soviet organizations and their sub-units known to be participating in the Chinese atomic energy program are shown in Figure 13, [redacted] The USSR Chief Directorate (now called State Committee) for Utilization of Atomic Energy (GLAVATOM) has carried out overt aid programs [redacted]

[7] For the view of the Assistant Chief of Staff, Intelligence, Department of the Air Force, see footnote 2, page 3.

[8] The Assistant Chief of Naval Operations (Intelligence), Department of the Navy believes that information on the nature and extent of Soviet aid to Communist China is as yet insufficient for a reliable estimate of the year in which the Chinese Communists could detonate a nuclear device. He considers however, that certain basic information should have become available to us by this time if the Chinese Communists were progressing toward detonation of a domestically produced nuclear device very much before the final stages of this five-year estimate. In the absence of what he considers to be any evidence pertaining to or indicative of the production of fissionable materials in Communist China and in the light of the relatively elementary state of known nuclear research facilities, he is unable to accept the time schedule for nuclear weapons as given in this paper.

Figure 15

SOVIET ORGANIZATIONS CONNECTED WITH THE CHINESE COMMUNIST ATOMIC ENERGY PROGRAM



[redacted] The Chief Directorate of the Civil Air Fleet (GUFVF) of the Moscow AVIA group has conducted aerial prospecting surveys for the Chinese atomic energy program since 1955. The USSR Academy of Sciences has furnished much of the known scientific research and training assistance and may have assisted in Chinese prospecting for rare metals.

65. The earliest Soviet participation in the Chinese atomic energy program was concerned with exploration for and exploitation of uranium resources. The Sino-Soviet Non-ferrous and Rare Metals Stock Company organized in 1950 may have been intended to develop ore resources for ultimate Soviet use. However, we have no evidence that Chinese uranium ore was ever supplied to the USSR, and at least since 1954, when the company was dissolved as a joint operation, the Chinese uranium appears to have been intended for domestic use only. Soviet participation in the Chinese ore program has included field assistance as well as technical guidance. The degree of Soviet aid to the uranium ore production program apparently decreased after mid-1957. [redacted] Soviet participation in uranium prospecting continued, however, at a reduced level [redacted]

[redacted]

66. There is some evidence that Soviet aid may have been curtailed. [redacted] a general withdrawal of Soviet technicians from China took place in mid-1960, [redacted]

67. The Soviets have also assisted the Chinese by designing uranium ore concentration and uranium metal facilities. [redacted] The main body of personnel appears to have been active in China until mid-1957, but a smaller group concerned largely with ore-processing technology was noted in China as late as January 1958, when it was winding up its affairs. [redacted]

68. Aid in the peaceful uses of atomic energy has been largely provided by GLAVATOM and the USSR Academy of Sciences, [redacted]

69. A Sino-Soviet Nuclear Energy Agreement was signed in 1955, and published to the world. Under its terms the USSR agreed to:

a. Provide an experimental heavy-water moderated research reactor with thermal capacity of 7.5-to-10 megawatts, and a 25 Mev cyclotron; render scientific and technical assistance in building, assembling, adjusting and starting the reactor and cyclotron; and to assist in the design of the scientific and experimental installation to house these pieces of equipment; and

b. Supply the Chinese with fissionable and other materials for the reactor and for carrying out research in nuclear physics, train Chinese specialists in nuclear physics in the USSR and supply Soviet specialists to work in China.

70. On 18 January 1958, after nearly ten weeks of negotiations in Moscow by a Chinese scientific delegation led by Kuo Mo-jo, president of the Academy of Sciences, a Sino-Soviet Scientific and Technical Agreement, covering the years 1958–62, was signed. None of the details of this agreement have been made known, yet it is likely that certain aspects of Soviet aid to the Chinese Communist atomic energy program were provided for.

71. Soviet specialists have also assisted the Chinese with the installation of an ASK-1 ionization chamber, with a volume of 1,000 liters, filled with argon at 10 atmospheres, and screened by a 12 cm layer of lead. This chamber, which was a gift of the Soviet Union, was probably installed at the Chinese Institute of Atomic Energy's location northwest of Peiping, for the use of the Cosmic Ray Department of the Institute.

ANNEX A

SIGNIFICANT RESEARCH FACILITIES

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SIGNIFICANT RESEARCH FACILITIES

1. *Chinese University of Science and Technology, Peiping*—President: KUO Mo-jo, who is also president of the Chinese Academy of Sciences. The university is under the joint control of the Ministry of Education and the Academy of Sciences. It was established in September 1958 to provide qualified scientists to staff the institutes of the Academy of Sciences. It has 13 departments, with particular emphasis on nuclear energy and related subjects. The original enrollment totalled 1,600 students. [redacted]

2. *Department of Physics, Nank'ai University, Tientsin, Hopei Province.* In accordance with the 12-Year Plan for Science, this university was to become one of the centers for nuclear research, and was to be comparable with Leningrad University, U.S.S.R., in size, standard, and amount and quality of research by 1967. The Physics Department, headed by Professor CHIANG An-ts'ai has built a small homogeneous experimental atomic reactor with maximum permissible power of 3 watts, in addition to a high pressure electronic static electricity accelerator with a capacity of 2 Mev, and also a beta spectrometer for the study of isotope properties and nuclear structure.

3. *Hsian Atomic Energy Research Center, Hsian*—Director: Dr. CH'IEN San-ch'iang, also director of the Institute of Atomic Energy in Peiping. Located on the campus of the Hsian Division of Chiaotung University, the center is a branch of the Institute of Atomic Energy and comes under the administrative control of the Shensi Branch of the Chinese Academy of Sciences. The center—jointly with the Physics Department of Chiaotung University—reportedly manufactured an electronic accelerator with a maximum planned capacity of 1.5 Mev.

4. *Institute of Physics, Peiping*—Head: Dr. SHIH Ju-wei who received his training in the United States, and has been identified as one of China's leading nuclear scientists. Subordinate to the Chinese Academy of Sciences, the institute concerns itself mainly with fields such as solid luminescence or radiation, metal physics, and various other subjects related to atomic energy and applied physics.

5. *Institute of Atomic Energy, Peiping*—Head: Dr. CH'IEN San-ch'iang, who was trained in France. Subordinate to the Academy of Sciences, the institute carries on most of the research in Communist China in atomic energy. The institute is capable of carrying out advanced research in the field of atomic energy. The institute controls the research done with the Soviet-supplied 7.5 – 10 MW research reactor and 25 Mev cyclotron, both of which are located at a point almost 22 miles southwest of Peiping and slightly less than 6 miles west-northwest of Lianghsiang. Other equipment in use at the institute northwest of Peiping includes 2 Van de Graaff accelerators (2.5 Mev and 0.75 Mev), various counters, vacuum pumps, a decatron, numerous spectroscopes and microscopes, and other varied measuring instruments. Although there is a sufficient number of scientifically well-qualified scientists to occupy the top level positions within the institute, there is a shortage of sufficient research personnel. However, improvement will be noted as the Chinese University of Science and Technology begins the supply of its graduates into the IAE and its branch institutes, as well as into other institutes of the AS. Branches of the

IAE have been reported at Hsian, Shensi Province; Lanchou, Kansu Province; Wuhan, Hupeh Province; Ch'engtu, Szechwan Province; and Urumchi, Sinkiang Province. Each of these branches is administratively controlled by the corresponding branch of the Chinese Academy of Sciences located at each of these locations. High energy nuclear physics research is carried out by a group of institute scientists at JINR.

6. Research at the Institute of Atomic Energy has dealt largely with the production of radioisotopes and atomic energy equipment, with considerable emphasis on theoretical research. Recent work includes studies of weak interaction between nuclei and elementary particles, and work on the development of millimicrosecond pulse techniques. This latter work would seem to imply that future work in the relatively sophisticated field of neutron time of flight will be done. The table of organization of the Institute of Atomic Energy is given in Figure 2.

7. *Institute of Geology, Peiping*—Head: HOU Te-feng. The institute is subordinate to the Chinese Academy of Sciences and has a laboratory located in Changch'un, Kirin Province (head: YU Te-yuan). There is also an Academy of Geology Research affiliated with the Ministry of Geology, which currently carries out all the research for the Ministry in support of the numerous geological surveys being conducted in China.

8. *Laboratory of Agricultural Application of Atomic Energy, Peiping*—Director: Dr. HSU Kung-jen, who was educated in the United States. Established 26 August 1957, the laboratory is under the Chinese Academy of Agricultural Sciences. It is the leading research organ for the study of applications of radioisotopes and ionized irradiation in agriculture especially in regard to plant cultivation.

9. *Peiping University, Peiping*—Its departments of Physics, Atomic Energy and Radio Electronics comprise one of the centers for nuclear research under the 12-Year Plan for Science. Teachers and students of the Department of Physics produced a 0.7 Mev electrostatic as well as a 30 Mev induction electron accelerator. The vice-president of the university, CHOU Pei-yuan is often identified as one of China's leading nuclear scientists.

ANNEX B

LEADING COMMUNIST CHINESE NUCLEAR SCIENTISTS

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LEADING COMMUNIST CHINESE NUCLEAR SCIENTISTS

1. The following Chinese Communist scientists are considered to be among the leading personalities in China, associated with the atomic energy program [redacted]

2. *CHANG Chia-hua, Dr.—Nuclear Physics.* Research scientist at the Institute of Atomic Energy since 1958. Returned to Communist China in 1955 after having spent several years in the United States, where he received a Ph.D. degree from the University of Washington, and subsequently worked as an instructor at Oklahoma A&M. In 1956, he published a paper entitled "Positrons" and in 1958 a paper dealing with Chinese accomplishments in the use of radioactive isotopes in recent years. Born: 15 October 1915.

3. *CHANG Wen-yu, Dr.—Nuclear physics and cosmic rays.* Deputy director of the Institute of Atomic Energy since 1959; he has been a member of the staff of the institute since 1956, when he returned to Communist China from the United States. In June 1958, he was reportedly going to the USSR. The purpose of his visit is not known, but it is likely that he visited the JINR, Dubna. Dr. CHANG served as a research professor in atomic and theoretical physics at Purdue University, 1949–56; visiting professor in physics, Princeton University, 1946–49; research associate in physics, Princeton University, 1943–46. Awarded a Ph.D. degree from Cambridge University, United Kingdom, 1938. He became a professor of physics at National Southwest University in China, 1934–38, prior to his work in the United States. Dr. CHANG has conducted research on radioactivity, nuclear disintegrations by high speed particles, interaction of mesons with matter, and cosmic rays. In his study on cosmic rays, he has done research on gamma rays originating from mu mesons in lead and iron. He is the author of numerous scientific papers, including "Analysis of Beta-disintegration Data"; "Study of Showers Produced in Lead, Carbon, Beryllium"; and "Further Results from the Study of Sea Level Penetrating Showers." Born: 9 January 1910.

4. *CHAO Chung-yao, Dr.—Nuclear energy.* A member of the scientific council of JINR, Dubna, USSR, since 1957. He is also a deputy director of the Institute of Atomic Energy, and has been affiliated with this institute since 1951, when it was named the Institute of Modern Physics. Awarded a Ph.D. in physics from California Institute of Technology in 1930, Dr. CHAO subsequently did research at Massachusetts Institute of Technology, 1947; the University of Halle, East Germany; and Cavendish Laboratory, Cambridge. Author of at least two books dealing with principles of nuclear energy, he was credited by the late Dr. Robert Millikan with the discovery of gamma rays produced by the annihilation of a positron and a negatron through collision. Born: 22 May 1902.

5. *CH'IEN San-ch'iang, Dr.—Nuclear physics.* Regarded as Communist China's leading nuclear physicist. Director IAE since its inception in 1950. Dr. CH'IEN holds or has held many important scientific positions in Communist China since he returned in 1948 from France, after having received a Ph.D. degree from the University of Paris in 1943. He was Chief of Research, National Center for Scientific Research, 1944–48. Dr. CH'IEN currently holds several positions within the Academy of Sciences (Secretary General, since 1954; member of the Department of Physics, Mathematics and Chemistry; and Chief of the Hsian Atomic Energy Research Center, of the Shensi Branch of the Academy of Sciences). [redacted]

[redacted] Although he is not believed to have been engaged in re ch since 1949, he did much valuable research prior to that time. His most important and best known work was the discovery of the third and fourth phases of nuclear fission. Born: 13 October 1913.

6. *CHOU P'ei-yuan, Dr.—Theoretical physics, specializing in aerodynamics and fluid mechanics.* Vice-president, Peiping University, and member of the standing committee, Department of Physics, Mathematics and Chemistry, Academy of Sciences. Secretary of the World Federation of Scientific Workers. An active Communist Party member, Dr. CHOU received a doctorate degree in physics from California Institute of Technology in 1928, and returned to China where he became a professor of physics at National Tsinghua University, and subsequently at National Southwest College. The greater portion of CHOU's research was carried on in the early years of his scientific career. His most recent thesis, in 1956, was entitled "The Vorticity Structure of Homogeneous Isotopic Turbulence in its Final Period of Decay." Born: 28 August 1902.

7. *CHU Hung-yuan—Cosmic rays.* Presently at JINR, Dubna, USSR. Has been a researcher at the IAE since at least 1956. Educated in the United Kingdom prior to his return to Communist China, c. 1955. Recently published research includes: "The Electric Multipole Internal Conversion Induced by Neutron Transition," and "Angular Distribution of the Decay Products of the Hyperon."

8. *FENG Hsi-chang, Dr.—Nuclear chemistry.* A member of the IAE since 1956, he received his postgraduate education in the United States, at Washington State College and the University of California at Berkeley. In 1954, Dr. FENG worked as a researcher at the Institute of Nuclear Studies at the University of Chicago, remaining in this capacity until his return to Communist China sometime during 1955 or 1956. Born: 20 November 1918.

9. *HSIEH Chia-lin, Dr.—Nuclear physics.* Dr. HSIEH has concentrated his research efforts on the cyclotron at the IAE, with which he has been associated since 1956. In January 1956, he returned from the United States where he had worked and studied since 1947 at California Institute of Technology and at Stanford University. Subsequently, he worked as a research assistant in the Microwave Laboratory of Stanford University, became an instructor at the University of Oregon, 1952, and finally assumed the position of technical supervisor with the Argonne Cancer Hospital at the University of Chicago until prior to his return to China. Two of his papers, published in 1957, were entitled: "A New Method of Beam Extraction for the Electron Cyclotron," and "Contributions to the Theory of Wave Guides with Stratified Medium." Born: 8 August 1920.

10. *HU Ning, Dr.—Nuclear physics.* Currently, a member of the Scientific Council of JINR. Dr. HU has been affiliated with the IAE as well as serving as professor in the Department of Physics at Peiping University, since 1953. Prior to his return to Communist China in 1950, he was on the Staff of the National Research Council, Ottawa, 1949–50; a staff member, Department of Physics, Wisconsin University, 1948–49; and did post-doctorate work at the Institute of Theoretical Physics, University of Copenhagen, prior to 1948. Dr. HU received his Ph.D. degree in nuclear physics from California Institute of Technology in 1944. Both before and after he acquired his doctorate, HU spent brief periods in research at the Princeton Institute for Advanced Studies. His theses were entitled "On the Quadruple Correlation in Isotropic Turbulence" and "A Quantum Mechanical Theory of Neutrons." Included among his more recent publications are "On Multiple Production of Mesons by High-Energy Nucleon Collisions," and "Further Investigation on the S-Matrix in Meson Theory." Born: 9 January 1915.

11. *HUA Lo-keng, Dr.—Mathematics.* Communist China's leading mathematician, and director of the Institute of Mathematics of the Academy of Sciences since 1951. Since

1954, he has been a deputy director of the Department of Physics, Mathematics and Chemistry of the AS, as well as head, in 1956, of the preparatory committee for the establishment of the Academy's Institute of Computation Techniques. Dr. HUA has held a number of important scientific posts after receiving his D.Sc. from Cambridge University. Has done research at the Princeton Institute of Advanced Studies, and served as professor in the Department of Mathematics of the University of Illinois prior to 1948. In 1948, after his return to China, he became a member of the Mathematical and Physical Sciences Group of the AS until 1950, when he became professor of physics at National Tsing-hua University. Research papers published in 1958 include "A Convergent Theorem in Space Forming by a Continuous Function of a Densing Group," and "Harmonic Analysis of a Typical Form in the Theory of Function of Several Complex Variables." He received first prize in 1956 from the AS for the last work cited. From 1950 to early 1957, seventeen of his research papers were published. Born: c. 1910.

12. KO *T'ing-sui, Dr.—Physics of metals, spectroscopy.* A member of the Scientific Committee of both the Institute of Physics, since 1956, and the Institute of Metallurgy and Ceramics, since 1955, of the AS, Dr. KO became deputy director of the latter institute in 1958. He was also identified with the Scientific Committee of the Institute of Metals, Shenyang Branch of the Academy of Sciences, in 1954, and from 1950–53, he served as a professor at Tsing-hua University. Prior to his return to Communist China in 1950, Dr. KO received a Ph.D. degree from the University of California in 1943; did post-doctorate work at Massachusetts Institute of Technology; and became an assistant professor at the University of Chicago in 1949. Most of his work at the university was done for the Office of Naval Research and involved the deformation of metals. He has done outstanding work since his return to China on the development of materials for use at high temperatures. [redacted]

[redacted] Born: 3 May 1913.

13. *LI Ssu-kuang, Dr.—Geology.* One of Communist China's leading and certainly most influential geologists. Dr. LI holds or has held the following positions: Minister of Geology since 1954; member of the Department of Earth Sciences of the Academy of Sciences since 1955; vice-president (one of several) of the Academy since 1954; formerly director of both the Academy's Institute of Geology, 1943–49, and the Institute of Paleontology, 1950–58. Dr. LI attended Birmingham University, U.K., from which he received three degrees, and was awarded an honorary doctorate from the University of Oslo. He received the A. P. Karpinski Gold Medal for outstanding achievements in Geology, Paleontology, Petrography and Mineralogy from the Academy of Sciences, USSR. Since 1949, Dr. LI has been primarily involved as an administrator and "popular front" representative for the Communist regime. However, on two occasions, he was reported as closely associated with China's nuclear energy program; he met with Russian and Chinese specialists in 1952 to discuss the exploitation of uranium deposits in Sinkiang province; and, in 1955, played an important part in formulating plans for the program as a whole. Born: c. 1889.

14. *P'ENG Huan-wu—Theoretical physics.* Deputy director of the IAEA, since 1952. Member of the standing committee, Department of Physics, Mathematics and Chemistry of the AS. Graduated from the University of Michigan in 1947; worked as an assistant professor at the Dublin Institute for Advanced Studies prior to his return to Communist China in 1949. Professor of physics at Tsing-hua University, 1950–52, when he became associated with the AS. In 1956, was a Chinese delegate sent to Moscow to plan for the establishment of the Joint Institute for Nuclear Research. In 1959, he was again in Moscow attending an International Conference on Cosmic Rays.

15. *WANG Kan-ch'ang, Dr.—Nuclear physics.* Deputy director and head of Chinese research at JINR, and associated with the institute

since its beginning in 1956. After acquiring a Ph.D. degree in 1934 from the University of Berlin, he returned to China and worked as a professor of physics at Chekiang University until 1947, when he became a student at the University of California. Deputy Director of the IAE, 1950–56. He recently has been credited as being one of the discoverers of a new nuclear particle—the anti sigma minus hyperon. He is reported to have designed a large bubble-type chamber for the synchrophasotron at the Dubna institute, as well as a radioactive counter and film detector. His recent papers include "Electron-Proton Showers in Lead," "A Suggestion on the Detection of the Neutrino," and "Nuclear Field and Gravitational Field." Born: 17 April 1907.

16. *YEN Chi-tz'u, Dr.—Nuclear physics, specializing in optics and spectroscopy.* Director of the Department of Technical Sciences of the AS since 1954, and currently a member of the Physics Faculty of the Chinese University of Science and Technology. Although possessing a high degree of technical competence, Dr. YEN has concerned himself largely with administrative duties in line with Communist Party directives since 1950. After receiving his doctorate from the University of Paris in 1927, and prior to 1946, he had published at least fifty scientific papers in English, French, and Chinese. His research efforts included studies of the resolution and shift of spectral lines in an electric field and the widening, shift and asymmetry of atomic spectra of alkali metals. He has also done research on spectrography, piezoelectric crystals, applied optics, radiochemistry and crystallography. He headed a "metallurgical delegation" to the USSR in June 1958. Born: 4 December 1900.